Plate 8 never published
See remarks in Vol. i.

Engraved by Knight from a Portrait by Mair, Engraver to the Academy of Sciences, Petersburgh.

Princess Dashkoff.
Directress of the Imperial Academy
of Sciences. Petersburgh.

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THE

PHILOSOPHICAL MAGAZINE:

COMPREHENDING

THE VARIOUS BRANCHES OF SCIENCE,

THE LIBERAL AND FINE ARTS,

AGRICULTURE, MANUFACTURES,

AND

COMMERCE.

BY ALEXANDER TILLOCH,

HONORARY MEMBER OF THE ROYAL IRISH ACADEMY, &c. &c. &c.

"Nec aranearum sane textus ideo melior quia ex se fila gignunt, nec noster vilior quia ex alienis libamus ut apes." JUST. LIPS. *Monit. Polit.* lib. i. cap. 1.

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THE

PHILOSOPHICAL MAGAZINE.

I. *Researches respecting the Action exercised by Caloric on the Vitality of Animals.* By Victor Michelotti, *M.D.**

The necessity of caloric for the maintenance of life has at all times been acknowledged †: in consequence of the ingenious experiments of Haller on irritability, which showed with what facility caloric excites the irritable parts of animals, a very eminent exciting property has been ascribed to it.

If the motion of the irritable parts increases in the ratio of the degree or of the dose of the irritants applied, every other circumstance being equal, it is no less certain that by heating the irritable parts their motion is increased. It has also been found that the application of caloric to excite an animal or an irritable part ought only to be made by degrees, especially if the living being is in a state of torpor; which agrees with what has been observed in regard to certain known excitants; for to bring by their means a living being to a state of less excitement it is necessary to proceed only by degrees in removing the excitants. But caloric in this respect presents one difficulty to be resolved.

* From the *Journal de Physique*, Brumaire, an. 12.

† What Cicero says in his sublime work De Natura Deorum, is very remarkable:—Sic enim res se habet, ut omnia quæ alantur et quæ crescant, contineant in se vim caloris, sine quâ nec ali possent nec crescere; nam omne quod est calidum et igneum cietur et agitur motu suo; quod autem alitur et crescit, motu quodam utitur certo et æquabili; qui quamdiu remanet in nobis, tamdiu sensus et vita remanet; refrigerato autem et extincto calore, occidimus ipsi et extinguimur . . . . Jam vero venæ et arteriæ micare non desinunt, quasi quodam igneo motu; animadversumque sæpe est cùm cor animantis alicujus evulsum ita mobiliter palpitaret ut imitaretur igneam celeritatem. Omne igitur quod vivit sive animal sive terrâ editum, id vivit propter inclusum in eo calorem. Etc.—lib. ii. 9.

The experiments of the celebrated Hunter are well known. By these he found that several living beings are more injured by a successive and slow passage to cold than by a rapid change of temperature. It is known that Hewson observed that blood rapidly frozen still possesses the property of coagulating, which never takes place if it has been frozen slowly. It is certain that the arguments of Hunter for a certain vitality in the blood, deserve the attention of physiologists.

M. Dufay* and the celebrated Blumenbach † have had occasion to observe that salamanders and frogs speedily frozen are preserved alive in the midst of ice, for they may be brought to life by exposing them slowly to heat. Besides, it is a fact well known that the men in several of the northern nations, after they have heated themselves thoroughly, immediately plunge into cold water, or even into snow, without any inconvenience ‡.

Whatever method may be taken to explain this phænomenon, it appears to me that it must always be admitted that a sudden passage to cold can be followed only by a privation of caloric greater and more rapid, according as the two temperatures to which the bodies are successively exposed are more distant, that is to say, when there is always a sudden removal of an excitant.

Since the action of caloric does not here correspond with what has been observed in regard to other excitants, the removal of which is the more dangerous to animals the speedier it is, it will be necessary to seek for the cause in the action itself which caloric exercises on living beings. But before we deduce from these facts the consequences which might overturn the opinion commonly entertained of the action of caloric, and which seems to be supported by a great number of experiments, I think it necessary to make better known, and more directly, what takes place to animals deprived slowly or rapidly of the caloric necessary for the state of life.

The object here in view will be only the caloric necessary for the state of life, and not that which is necessary for an organized being to retain its vitality, as it may be in the latter state, without being what is called *alive*.

To ascertain what would happen to animals during a slow transition to cold, it appeared to me at first that in-

* Mem. de l'Acad. des Sciences de Paris 1729, p. 135.

† Blumenbachii Specimen Physiologiæ Comparatæ, &c.; Göttingæ 1787, p. 20.

‡ Coxe's Travels.

sects

sects would be very convenient for my experiments, because, as it was necessary that they should be comparative, I should thus be enabled to try several animals at the same time and under a similarity of circumstances.

The first which I tried were caterpillars of the *phalænia chrysolea*. The most favourable temperature for these animals is between + 10 and + 20 *, and the further it is distant from temperate the less vivaceous they are, till they become entirely torpid at + 2, 0, &c. I took twelve of the most lively of a multitude of these caterpillars and made them pass from the temperature of + 5°, at which they were, to that of + 2°, 0 and — 2°, always leaving the space of a quarter of an hour between each temperature. Having left them at + 2° for four hours, I brought them, in equal spaces of time, to + 16°, in order to excite them to life: but my attempt was fruitless, since the heat of the fire was not able to produce in them any vital motion.

But as my phalænæ were killed by a slow passage from heat to cold, it was necessary to examine what would be the case by a rapid transition. For this purpose I conveyed twelve other caterpillars, as lively as the former, from a place the temperature of which was + 5° to another where it rose to + 7°, in order to render more sensible the rapid passage to that to which I intended to make them descend. I then took the small phial in which they were and immersed it suddenly in pounded ice at — 2°. Having left them in this state for four hours, I gradually raised the small phial, in which they remained completely torpid, to the temperature of + 16°, at which they gave signs of life.

I repeated these experiments on other caterpillars with results entirely similar. I at length made the same experiments on spiders; but as they are much less sensible of cold, it was necessary to keep them a longer time in a cold temperature. The results, however, were similar to those given me by caterpillars.

Sometimes I raised the temperature of the spiders to + 30°, at which they were exceedingly lively, and then threw them speedily into phials immersed to the neck in pounded ice. I always observed that these spiders returned sooner to life than those which passed as speedily to cold, but which had proceeded from a temperature much lower.

It was therefore sufficiently confirmed that these animals were more injured by being slowly rather than rapidly deprived of caloric. But it was of importance to ascertain what

* Probably Reaumur's thermometer is intended.

would take place during a continued privation of the caloric necessary for the state of life. This might serve to explain whether the real death of animals rendered torpid by cold arises from the want of that caloric necessary to the state of life, or rather from the manner in which they are deprived of it. I thought it necessary also to ascertain what would take place by rendering torpid and reviving alternately the animals, or by making them to pass slowly from heat to cold, and from cold to heat, or rapidly from heat to cold.

Being desirous of subjecting animals to these three different circumstances, I employed ants. It is well known that these insects pass the whole winter in a state of torpor in their hills: those which I subjected to experiment were inclosed in the large trunk of an oak, where, notwithstanding the severe cold, they were not in a state of great torpor. I exposed to the north during winter nineteen of these ants in a flask in such a manner that they should receive none of the sun's rays. During the warmest hours, the thermometer indicated $+ 5^{\circ}$ and $- 2^{\circ}$ for the mean cold. These animals, in consequence of the continued cold, remained in a state of perfect torpor during seven days. On the eighth day I resolved to recal them to life by subjecting them gradually to the influence of heat; and I had the pleasure to see them all return to life.

At the same time I exposed nineteen others to the open south, where the highest temperature in the sun was $+ 25^{\circ}$, while in the shade it was only $+ 5^{\circ}$ or $+ 6^{\circ}$, and the greatest mean cold $- 2^{\circ}$. In this manner the ants were alternately and slowly thrown into a state of torpor at sunset, and revived at sunrise. On the eighth day I exposed them gradually to heat; and recalling some of them in this manner to life, I found eight of them dead. By these facts it is seen that in the first experiment the privation of the caloric necessary to the state of life was not fatal to ants though continued for a considerable time, but rather the slow privation of it which they daily experienced.

Before I proceed to other facts I must take notice of the state of weakness into which living beings fall after the state of torpor. It is to facts of this kind that I reduce the ingenious experiments of the celebrated Hunter, who observed that blood, eggs, &c. freeze more readily after they have been once frozen.

Not being well acquainted with the method of preserving ants alive, I had left them all exposed to the open south in a flask, hoping that the beneficent rays of the sun would

preserve

preserve them alive much rather than a temperature constantly cold.

One may readily foresee that the fate of these ants, which I had thus collected for other experiments, would not be more fortunate than that of those which, for the sake of comparison, I had purposely exposed to the south; that is to say, the mortality daily increased, and the vitality of the living ones was so much weakened that they could not resist, with the same force, a continued state of torpor, and still less an alternate change of temperature.

It was no doubt for the same reason that the attempts of M. Gleditsh * and others to preserve in life swallows, larks, frogs, &c. after they were revived from their state of torpor proved ineffectual; since this kind of weakness, which arises in consequence of the torpor, takes from animals the strength necessary to resist new cold, and therefore in this state of weakness a small excitant may be mortal.

I shall now relate the three last experiments which I made on these ants.

Seventeen ants, contained in one flask, having remained for seven hours in a state of torpor exposed to the north, I revived them to life on the eighth day, and found sixteen of them alive: of seventeen ants contained in the second flask, which had been exposed to the south, two only on the eighth day were found alive.

The third flask contained seventeen ants also. As soon as the sun appeared on the horizon I exposed the flask, and when the ants were well heated, the thermometer being often at + 25°, I immediately immersed the flask up to the neck in pounded ice. I kept it in this state during the night at a cold which was several times — 2°, until the sun had again risen. The ants were exposed seven times successively to this rapid change of temperature. I recalled them to life every day before I exposed them to the solar rays; and on the eighth day, having attempted the same thing, I found thirteen of the seventeen alive.

If we therefore take into consideration these last experiments, in which the same insects were tried in three different ways, it is seen that if 9·9 in 100 died of those who were preserved in a state of torpor on account of the cold continued for eight days, 88·2 in 100 die of those who are subjected to an alternate and slow privation of caloric, and that 25·5 in 100 die of those who have been suddenly and alternately deprived of the caloric necessary to the state of life.

* Mem. de l'Acad. de Berlin, 1769.

Such are the results which I obtained by trying the action of caloric on insects: I shall here add what I observed in regard to frogs, reserving for another occasion my experiments on other animals.

It is well known that Spallanzani several times reduced frogs to a state of torpor even after depriving them of their blood, heart, &c., and recalled them to life. In repeating the curious experiments of that philosopher, I thought proper to make the following variations:—I separated the thighs of a frog by two cuts, and then buried them both in pounded ice. I in like manner took the heart, still palpitating, and immersed it also in ice. At the end of an hour all these parts appeared to me to be exceedingly torpid and stiff: the heart not only had lost all motion, but on touching it with a pin it seemed as rigid as the rest. I threw one of the thighs into water which was at + 20°: it manifested no sensible motion, and was also entirely pale. I exposed the other thigh slowly to caloric: it retained its colour, and even showed some signs of irritability. In the last place, the heart, an organ highly irritable, having been slowly exposed to heat, resumed its motion, which was not weakened and did not cease till an hour after it had begun to move.

But it is still more remarkable that if vital beings do not return to life but when they have been speedily deprived of the necessary caloric, this law should be general, as animals exposed to excessive heat do not return to life but when their temperature is rapidly changed. As this may be easily conceived, I shall mention only one example.

Of four lively frogs, which appeared to be of the same age, exposed in water to a heat equal to + 35°, a degree fatal to these animals, only two, which were immersed suddenly at that temperature in water at + 16°, were recalled to life. It is always, therefore, a sudden privation of caloric which leaves organic beings in a state susceptible of life.

Since our present knowledge of physiology inclines us to admit an identic vital principle throughout the whole of living nature, it is very probable that the general laws of vitality are the same in all living beings, and particularly in animals. For this reason, facts which relate to one only of the universal agents, such as caloric, cannot fail of being applicable to several other living beings. For if attention be paid to the difference which there is, for example, between the œconomy of the spider and that of a caterpillar, one will be convinced that an agent which exercises its action in a manner altogether similar on these two species of animals,

animals, ought not to vary much in its manner of acting on others.

In making experiments on ants, spiders, frogs, &c., I have found,

1st, That I may consider as highly applicable to my animals what was observed by Hunter and Hewson in other vital beings, such as pullets' eggs, and even blood, which one might suppose to have no relation to living beings if this grand and universal principle, which communicates life to all organic beings did not give, even in the blood, signs of its existence.

2d, By inquiring directly what would take place in different temperatures, I have sufficiently proved, in my opinion, that we must not seek for the reason of the preservation of life during sudden transitions from one temperature to another, but in the speedy privation of caloric.

To explain the phænomena here related, I find myself obliged to recur to three hypotheses, and to consider caloric first as a particular excitant.

1st, It seems to me that we must admit that the slow privation of caloric produces a greater debility than rapid privation. It is well known that an animal when kept very warm, well clothed, &c., may resist more the debilitating causes; but it is true that in this case the animal contains a greater quantity of excitants, and for a similar reason a greater degree of excitability ought to be ascribed to oxygenated animals *. Is it therefore a greater or less loss of the exciting caloric that deprives animals of life or preserves it? But then it is seen that animals exposed to cold and at equal temperatures during a considerable time, ought to have lost only that quantity of caloric which is indicated by the temperature, yet so great is the difference between them.

2d, If caloric be considered only as a modification of matter, a kind of motion for example, I can the less conceive that the animal should be colder. But how are animals preserved in life by losing in a speedier manner this kind of movement? It is because the organic parts, by the help of a slow change, assume dispositions which they could not acquire by a sudden privation.

3d, A similar explanation may be given if we consider caloric as a matter which disposes living beings to motion and sensation.

* I shall make some observations hereafter on these facts, which have been treated in an able manner by Dr. Beddoes and M. Socquet.

II. *History*

II. *History of Astronomy for the Year* 1803. *Read at the Cóllege de France by* Jerome De Lalande.

[Concluded from p. 221.]

Astronomical geography this year has made some progress, particularly at New Holland. This immense part of the world, which contains almost five hundred thousand square leagues of surface, might alone maintain four hundred and fifty millions of inhabitants, which is more than half the number on the whole earth: This is sufficient to show the importance of the voyage.

Captain Baudin, who set out on the 13th of October 1800, from Havre-de-Grace, wrote on the 12th of November 1802, that he had sufficiently explored, for the security of navigation, Lewin's-Land, Concordia and De Witt's Land, d'Entrecasteaux's Channel, the island Maria, the eastern coast of the large island of Van Diemen, Basse's and Banks's Straits, and the whole of the southwest coast of New Holland, from Cape Wilson to the islands of St. Peter and St. Francis. He proposed to direct his course through Basse's Straits, in order to explore a large island discovered by English fishermen, King's Island, Kangaroo Islands on the south-west coast of New Holland, the southern part of which neither he nor captain Flinders were able to examine, and he expected to go thence to the islands of St. Peter and St. Francis, to ascertain the direction of the continent in that part which is unknown to him; then to proceed to Lewin's Island, to terminate the labour of the large Bay De Geographe, and then to De Witts's Land, the northern coast of New Holland and Carpentaria. They hope to return in a year. If all this is not performed, it will not be the fault of the astronomer Bernier; for he possesses all the zeal and ability which I announced when I proposed him for the expedition, which I did with great regret.

The French have admired the immense labours performed by the English during the twelve years they have been established in Port Jackson; and the splendour and opulence of this colony, formed near our antipodes, which is the fruit of a large navy, by which they can easily unite the extremities of the universe, and which will long be wanting to the prosperity of France. The observations of Bernier at New Holland, from the 27th of May 1802, are indicated in the Moniteur of August 15, 1803. The examination of of the whole southern coast, which is owing entirely to France, has been completed.

Captain Hamelin set out from Port Jackson on the 19th of November 1802. On the 9th of December he separated from Captain Baudin to return to France with a collection of natural history and curious animals, an account of which has been given to the Institute by M. Lacepede. This philosopher is of opinion, that there must be in the midst of this immense country a sea like the Caspian; but no information has yet been obtained in regard to the interior parts of it.

Bernier has sent me an observation of the transit of Mercury, made at New Holland. He concludes his letter by saying, " I beg of you, my dear master, not to forget your pupil, who, at the extremities of the world, renews to you the assurances of lasting respect and gratitude." In this manner my ardent zeal for astronomy has sometimes procured to me great enjoyment, in which self-love is not the least sensation, but it is not the only one.

This long voyage to New Holland is not the only one of which I have to speak:—On the 9th of August two Russian ships, the Hope and the Neva, captain Rasanon, set out on a voyage round the world. They will proceed to Brasil, Chili, the South Sea, Japan, and to China. There are on board naturalists and artists, who will enlarge geography and natural history.

Captain Krusenstern, destined to circumnavigate the globe, has received from the emperor of Russia an estate worth three thousand rubles per annum. The minister, count Romanzof, has requested from M. Von Zach an astronomer for the expedition.

The astronomer Horner writes from the island of Teneriffe, October 25th, " Baron Von Humboldt, one of the most learned and most intrepid travellers that ever existed, after having visited the unknown parts of South America, says, in a letter dated November 25th, 1802, that he had traversed the snows of the Cordillera, to go to the province of Quito. On the 23d of June 1802, he was at Pinchincha and Chimborazo, at the height of 3015 toises, which is only 236 toises below the summit. No person was ever at such a height before; the blood issued from his eyes and his lips; he experienced retching, and an uneasiness which continued several days after this terrible journey." Yesterday M. Delambre received a letter of the 19th of July, from Mexico:—With M. Bonplan he has formed a herbal of six thousand plants. He has been of equal use to geo-

graphy.

graphy. He hoped he should be able to return in the spring of 1804, to publish the immense and valuable collection of observations he has made in the course of five years.

The taste for travelling into Africa, which I strongly recommended, has continued to produce curious enterprises: —M. Domingo Badia, a Spaniard, sent by the Prince of Peace, caused himself to be circumcised, and assumed the name of Ali-Beik-Abdallah, that he might travel in greater security. M. Durand, celebrated by his work on Africa, has communicated to me the observation of an eclipse at Tanger, and I have deduced from it the longitude. This new Mussulman is at present in unknown deserts, where, supported by his zeal, he braves want, sufferings, and dangers. The dépôt of war, under the direction of general Sanson, continues its labours for geography; and details respecting it may be seen in the Moniteur for November 9, 1803. Five numbers of its memoir, for the instruction of geographical engineers, have been published. M. Henry continues the map of Helvetia; Tranchot that of the four departments of the left bank of the Rhine; Nouet that of Savoy. Engineers are now employed on maps of Hanover and the island of Elba.

The maps of Bavaria and of Swabia will soon be connected with that of France. The fifty sheets of the map of Egypt are finished, and the map of the Morea, on which M. Barbier de Boccage has been employed with that knowledge of which he has given so many proofs.

M. Lapie has published a beautiful map of general Bonaparte's expedition in Italy, from the passage of the Great Saint Bernard on the 14th of May 1800, to the battle of Marengo on the 14th of June.

On the 25th of December 1802, the vice-president of the Italian republic decreed that the three astronomers, de Brera, Oriani de Cæsaris, and Reggio, shall continue the map of the Milanese, begun in 1788, and measure an arc of the meridian. They set out in the month of May to erect a portable observatory at the extremity of the base measured in 1788. They observed with a repeating circle which we gave them, the angles employed for the map of Lombardy. They will unite their measurement to that which general Von Zach, brother of our celebrated astronomer, made in the Venetian territory; and with the triangles of Beccaria in Piedmont, of fathers le Maire and Boscovich in the states of the church, and of Tranchot in Corsica. Brassier is charged with the details.

The legislative body of the Italian republic has decreed the

the establishment of the decimal measures; the more necessary as Italy had in its measures an inexplicable variety, as may be seen in my *Travels in Italy*.

The king of Spain has ordered a map of his states to be constructed by a body of geographical engineers, under the direction of M. Ximenes. We have already maps of all the coasts; but it will require a long time to survey the interior. M. Chaix, an able Spanish astronomer, will be the first co-operator. M. Megnié, an ingenious mathematical instrument maker, has settled at Madrid, and will furnish the necessary instruments.

The king of Prussia and the elector of Saxony, desirous of having maps of their states, M. Von Zach, who is at the head of this labour, will take advantage of it to measure a degree of longitude which is still wanting notwithstanding the efforts made for that purpose by Cassini.

Since the longitude of Brest and Manheim is known, it appears to me, that, by applying the measurements made in France, we might have the 13° of longitude which there are under the 49th parallel to a six hundredth part, or 60 toises nearly for a degree; but we ought to obtain greater precision, and the chief of the state waits only for peace to procure to the sciences this new benefit.

In the month of August, Baron Von Zach established himself with Brug on the mountain called the Brocken, at the height of 550 toises. He made signals with gun-powder from the top of a tower; they were seen at the distance of thirty-three leagues. The astronomers took different posts, and they were joined by Prussian officers, who served an apprenticeship at Gotha. They were provided with sextants, artificial horizons, achromatic telescopes, and chronometers. They were able to take corresponding heights within half a second, and they observed by their chronometers the signals made by night, and by day at convenient moments. M. Von Zach kindled only half a pound of gun-powder each time. In the day the explosion and flame were seen at the distance of thirty-three leagues, by means of a small common telescope, which magnified only twenty times; in the night they were seen by the naked eye. The duchess of Gotha, who is short-sighted, saw these fires in her garden, between nine and ten at night, without the assistance of a telescope; they appeared like lightning, though the distance is nearly twenty-three leagues in a straight line. The principal places which baron Von Zach has determined, and where there are observers, are the towns of Magdebourg, Halberstadt, Quidlembourg, Bernberg, Coethen, Dessau, Cassel, Brunswick, Wolfenbuttel, Helmstadt, Wernigorde, Ilsemburg, Naumburg, Leipsig, the mountains of Petersberg near Halle, Weissenstein, the Meisner in Hesse, the Gleichen near Göttingen, and the Possen near Sonderhausen. Each place will be determined by at least thirty or forty observations. Thus the celestial arc of the parallel will be perfectly determined. He will repeat the same thing in another manner the next year. Baron Von Zach expects that he shall be able to proceed gradually to Nimeguen, which is six degrees towards the west in the fifty-second parallel. No arc of longitude will have ever been measured with so much precision. The case will be the same with the meridian of the Brocken. There are already three hundred observations of latitude with a multiplying circle of nineteen inches made by Lenoir, to whom we are indebted for the largest and best instruments of this kind. He has just constructed one for Palermo, in Sicily, where M. Piazzi proposes to measure a degree; but artists of this kind are still too few at Paris. M. Jecker has made several reflecting circles and sextants for the navy. Baron Von Zach employed the sun and the eagle, and he found a singular agreement: the results will appear in his journal. Thirty observations, made indiscriminately, gave him the same second as three hundred: he measured a base of a thousand toises to within an inch. Such extensive operations have never been conducted with so much exactness.

Messrs. Goldbach and Seyffert have determined six places of the electorate of Saxony during an astronomical tour, undertaken for the purpose of observing the signals by fire which baron Von Zach made on the Brocken. I shall mention only the two principal towns: Eisleben 51° 32′ 30″ and 8′ 45″ in time to the west of the meridian of Dresden; Merseburg 51° 21′ 33″ and 1′ 29″ to the west of the meridian of Leipzic. The last determination is exceedingly exact, having been verified by the result of a trigonometrical measurement begun by M. Goldbach, and for which he had been collecting for several years the best instruments; namely, a toise made by Lenoir; a repeating circle by the same artist; a sextant by Ramsden; a circle by Baumann; a steel chain of fifty feet, constructed like that made by Ramsden for general Roy's measurement; a clock by Syffert, and a travelling time-piece that beats half seconds. It is much to be regretted that so zealous and able an amateur as M. Goldbach, can devote only a small part of his time to astronomy. The chronometer he employed in this journey was made by M. Syffert.

The

The history of meteorology is every year connected with that of astronomy: but this year meteorology has furnished remarkable phænomena: the equinoctial winds have been little felt, and the autumnal rains were very weak.

The tide at the end of March ought to have been exceedingly strong, according to the theory of Laplace. Traulée, of Abbeville paid attention to this object at that place, and sent curious observations to the Board of Longitude. M. Maignon observed the tides at Brest: precautions had been taken, and indeed if the west wind had been strong we should have had inundations. We request from every quarter observations on the tides; and during my journeys to Cherburg and Ostend I had the pleasure this year of seeing that scales of the tides are preparing. I received observations from M. Caron, a lieutenant in the navy at Ostend; and I have been a witness to his assiduity and correctness.

The thermometer this year was only once at 12° 30′ of cold, or 43° of my new thermometer. The heat was of as long continuance as it was extraordinary: the drought lasted three months and a half, yet the heat was only 29° 30′, or 37° of my new thermometer; while in 1753, 1765, and 1793, it was at 42°: but the duration of it occasioned one of the hottest summers we have had for a century. If I speak of my new thermometer, it is because the division I have adopted, which is more philosophical, more natural, simpler, and more convenient, contains numbers easier to be retained: every body speaks of 30 and 40; and it happens, by a singular chance, that these numbers 30 and 40 are those which express the moderate and scorching summers, the mild and severe winters, the degrees of heat and of cold. These numbers hitherto decried will be ennobled by becoming the key of the thermometric science. Our ablest artist for this kind of instruments, M. Mossy, known by his excellent and accurate works, has undertaken to construct my thermometers, and flatters himself he shall be able to extend the use of them.

M. Thulis has sent us observations of the barometer, which give for the mean height at the borders of the sea 28 inches 2·8 lines, instead of 2·2 lines which I found as the mean of several determinations. M. Burckhardt found from 2·2 lines to 2·8*. There still remains an uncertainty of half a line in regard to this fundamental determination of meteorology. It exists even at Paris; for the thermometers at the observatory indicate half a line more than that

* Connoissance des Temps, an 13. p. 349.

of

of M. Fleurieu and mine, which were made with the greatest care.

The water of the Seine sunk lower than ever before observed. It has been seen lower than the zero at the Pont de la Tournelle, or the low water of 1719. In 1731, September 23d, it was 5½ inches; in 1742, between the 7th and 14th of September, 3 inches; in 1753, from September 28th to October 1st, 1 inch; in 1766, December 5th, 2 inches; in 1757, January 1st, 3½ inches; in 1778, September 8th, 4 inches; in 1800, August 8th, 6½ inches; and in 1803, from the 12th to the 15th of September, it fell to 10 inches, according to M. Fiot, inspector of the salubrity of the prefecturate. The year concluded with a very extraordinary phænomenon,—the hurricane of December 28, —which unroofed houses, overturned chimneys, and tore up trees by the roots, in a manner never before known at Paris.

Mr. Wheatcroft, an Englishman, settled at Caen, and who has made many observations on the variation of the magnetic needle, has sent us a memoir on the auroræ boreales. He has observed some of the most remarkable; the nucleus or focus of which seemed to be in that place of the heavens which corresponds with the magnetic pole: I gave the position of this pole in lat. 77° and long. 282° from the first meridian *. We have therefore a new reason for believing that the aurora borealis is an electric phænomenon, for it is well known that there is a great affinity between electricity and magnetism.

In regard to the position of the magnetic pole, as soon as peace takes place we mean to propose that government should send observers to verify on the spot this important and curious fact in natural philosophy, and the zeal which it shows for the sciences gives us reason to hope that our request will be attended with success.

I shall conclude this history of meteorology with an account of a fire-ball which burst on the 26th of April near l'Aigle. I class these fire-balls among shooting stars, and I have enumerated thirty-six instances of them †. They have given rise this year to a great many dissertations. The noise of it was heard at Evreux, Caen, and Havre. A great many stones similar to those collected on other occasions of the same kind fell at l'Aigle. They were analysed by Vauquelin. M. Izarn has published a volume on this subject under the title of *Lithologie Atmospherique*. Some consider

* Connoissance des Temps, an 13.

† Connoissance des Temps, an 7. 1799.

them

them as formed in the atmosphere; others as coming from the moon in two days and a half: some ascribe them to volcanic eruptions, the focus of which is unknown; and others to small planets, the revolutions of which have by some obstacle been suspended.

After that which appeared June 17, 1798, several stones, one of which weighed twenty-six pounds, were picked up at Villefranche, near Lyons*. Hitherto there have been nine instances of such stones falling from the heavens: they are all of the same nature, and have no resemblance to any of those known on the earth in mines or near volcanoes. As for my part, when I consider that these stones are friable; have an odour of sulphur; that the explosion is heard to the distance of thirty miles round; and that the rolling noise resembles that of musketry; it appears to me that all these circumstances, collected by M. Biot in his learned report, which has been printed, indicate their formation in the fire-ball, which is heard to detonate. Chemists are divided in regard to the possibility of this formation; but M. Cadet Gassicourt, son of our celebrated chemist, who has already distinguished himself in the same career, and who has published an excellent dictionary of chemistry, reasoned with me in this manner:

"Hydrogen gas dissolves sulphur, charcoal, phosphorus, zinc, and iron: its gravity is not thereby sensibly increased, and it may rise thus charged to a considerable height."

May not hydrosulphurets which assume the gaseous state, and which dissolve a great deal of earth and metals and volatile acids, carry with them silex and magnesia, or the elements of the latter, which is strongly suspected to be a compound body? There is nothing in the received theories which opposes this idea. If the constituent principles then of atmospheric stones can be at the same time in solution in very light gases, when the hydrogen gas inflames they will be formed into stones; for the gas, by detonating, abandons the bodies it held in solution; the vacuum which it forms draws towards the centre the moleculæ of the revived substances; they yield to the general attraction, and tend to unite: as they pass from the fluid to the solid state, they necessarily disengage enough of caloric to produce incandescence, and that vitrification which we see at their surface, but not enough to fuse them or oxidate them entirely. Yesterday† the Institute received from the minister Chaptal a stone of seven pounds weight, which fell on the 8th of

* Journal de Physique, Germinal, an 11. † November 21, 1803.

October near Apt, in Provence, under similar circumstances, and which resembles all the others of the same kind *.

I shall terminate my history by an account of some losses which astronomy this year has sustained.

M. Prosperin, one of the ablest astronomers of Sweden, died on the 28th of March, at the age of sixty-four. He gave a great many calculations of comets and of longitudes deduced from eclipses, which may be seen in the Transactions of the Academies of Stockholm and of Upsal. He never published any separate work, but he rendered great service to astronomy by his memoirs. He calculated the comet of 1795 †.

We lost in France, on the 7th of March, the oldest of the astronomers in Europe, esteemed for his long labours, Edme-Sebastian Jeaurat. He was born Sept. 24, 1724; he was the son of an ingenious artist, engraver to the king, and grandson of the celebrated Sebastian Leclerc, of whom we have more than 4000 engravings.

His uncle Etienne Jeaurat, who was afterwards painter to the king, taught him early to draw; and an intimate friend of the family, Lieutaut, astronomer of the academy, instructed him in the mathematics. He improved under these two masters; for at the age of twenty-two he obtained a medal for drawing from the Academy of Painting, and in 1749 he was employed as a geographical engineer in constructing the large map of France, 600 square leagues of which he surveyed. In 1750 he published a treatise of perspective, which has always been of great use to painters in consequence of the clearness of the operations and demonstrations. In 1753 he was professor of mathematics in the military school, the first established provisionally at Vincenne, where I had an opportunity of knowing him.

I engaged him to cooperate in our astronomical labours, for which we were then in want of assistants. Jeaurat exerted himself with zeal: he calculated the oppositions of 1755 and following years; he observed the comet of 1759 and that of 1760; and he gave analytical formulæ for calculating the motions of the planets. His formulæ contain the sixth power of eccentricity, and prove that he possessed great readiness in analysis, which at the time was rarely employed by astronomers.

The academy published several of his memoirs in the collection *Des Savans Etrangers* in 1763; and the same year he participated with Bailly in the suffrages of the academy

* See Moniteur, November 24.

† Connoissance des Temps, an 6, 1798, p. 16.

demy for succeeding the abbé De la Caille, and they were both nominated.

The volumes of this society for twenty-five years contain memoirs, observations, and calculations by him. In 1766 he gave new tables of Jupiter, which appeared with the theory formed by Bailly for the satellites and the diplautidian telescope, which he constructed with Navarre, an ingenious optician. After the year 1763 he obtained a wooden observatory at the military school, together with some instruments; but in 1768 the duke De Chatelet enabled him to construct a complete and more solid observatory, which in 1788 led him to the building of the present one, which is one of the most useful in Europe.

In 1775 he succeeded me in the calculation of the *Connoissance des Temps*. He published in succession twelve volumes, each of which contains new things; tables by different astronomers, and many calculations; a reduction of the large English catalogue of stars; calculations of the moon; a determination of the longitude of all countries, the most extensive that ever appeared; the position of the steeples of Paris, determined with the assistance of M. Prony and another engineer; tables of aberrations, and other objects useful to astronomy. The Institute paid him a flattering compliment by nominating him a member on the 25th of December 1796, though there were a great number of well known and respectable competitors. When he was no longer able to labour on account of his age, he still interested himself in favour of astronomy. He assisted M. Rotrou in observing the last transit of Mercury over the sun on the 9th of November 1802, though then seventy-eight years of age.

After rendering justice to Jeaurat in regard to the constancy of his labours, it is my duty to observe that he was equally estimable by his character. He was beloved by his pupils at the military school and to his associates in the academy. I have seen him do a kindness with great pleasure, and even to some who had offended him.

Father Kautsch, whose calculations of eclipses I have quoted, died at Leutomischel, in Moravia.

M. Witzleben, who translated into German the abridgment of my astronomy, died on the 23d of April.

An astronomical poet deserves to participate in our regret:—Dominic Ricard, born at Toulouse on the 23d of March 1741, died at Paris on the 28th of January 1803. He is known by a translation of Plutarch, and by a long poem on the sphere, which is very correct, and written in an interesting manner.

 III. *Letter*

III. *Letter from* JOHN FLAXMAN, *Esq. to the President and Council of the Royal Academy of London**.

GENTLEMEN,

IT is well known that the late demand made by France on Rome for the finest works of Greek sculpture and the best paintings in that city produced two petitions, from different bodies of French artists, to the executive directory; one praying that those works might not be removed, signed David, Giroudet, Vincent, &c., which was answered by a second, blaming the first, and desiring that all the fine works might be immediately brought into France, to form an university, in which all nations should be obliged to study the arts of design, signed by Hubert, and thirty-eight other artists.

This question, whether the fine works should be brought from Italy to Paris, is of the greatest importance to art, science, and literature, and of consequence, in this respect, to all Europe; and although it is much more likely to be decided by force than reason, yet every artist, of whatever country, will have an equal right with the petitioners, to consider the object of this latter petition and its probable consequences.

I shall therefore avail myself of this privilege; and without engaging in any political discussion further than is absolutely necessary, I shall examine the arguments contained in this second petition by the test of truth only.

I shall first consider upon what pretence the French nation have made this demand on the papal state, and how far it is reasonable with respect to the rest of Europe. When compensation is demanded by one state from another, it is for some injury or loss sustained: but France has sustained neither loss nor injury from the papal state; on the contrary, by the formation of the French republic and the progress of the French arms in Italy, the papal state has lost the provinces of Avignon, Bologna, and Ferrara; and therefore in justice the Romans might demand a compensation from France; and without doubt would were they strong enough to make their claim good. The memorial says: " The French artists were persecuted by the Romans, and

* Having been favoured with a copy of this letter, which was written about seven years ago, when the French demanded from Rome those inestimable works of art which have since been transported from that city, we are persuaded our readers in general will feel gratified by seeing it preserved in our work.—EDIT.

have

have escaped from their barbarity." However, this persecution, as it is called, was only an endeavour on the part of the Roman government to secure itself against an attempt made by Messrs. La Flotte, Basville, and their adherents, to excite a revolution in the city. All of this party were sent out of the territory; such as had been imprisoned were indemnified for their losses, and such as had no money were supplied by the Roman government with a sufficiency to bear their travelling charges. From this statement it is certain that there is no justice in the claim which France has made: now let us see how far it is reasonable respecting the rest of Europe. The petitioners say: "If we request that the master-pieces of art should be transported hither, it is solely for the honour and glory of the French name, and the veneration in which we hold those great efforts of genius." Upon this it may be remarked that the codes of law in all countries consider such veneration for valuables as criminal in an individual; for instance, if any one should break open another man's house and by force carry away any fine statue or gem, the laws of England would hang him for his virtù. Now this crime is certainly not diminished, but aggravated, when it is extended to a hundred gems or statues, and committed against a whole nation instead of an individual.

But the arts of design are cultivated in different degrees in most countries of Europe. Fine museums of sculpture and painting have been formed in Naples, Tuscany, Spain, Germany, England, and Russia; each of these countries doubtless would be glad to give such an increase to their museums as should make them universities for the world to study in. Let us now suppose each of those powers to be animated by the same sentiments of patriotism with the petitioners, to decorate their countries with the spoils of Rome; and that the emperors of Russia and Germany, the kings of Prussia, England, Spain, and Naples, and the grand duke of Tuscany, should severally say, "The honour and glory of my country and the veneration in which I hold those fine works have made me determine to bring them into my own capital." What would be the consequences of all this patriotism? Discord! war! Europe would be more abundantly deluged with blood: the possessors of those works would be destroyed, as well as, most likely, the fine works themselves in the contest. Such patriotism is not virtue; it is a splendid vice. That patriotism alone is virtue, by which we provide for the good of our own country without doing any thing that interferes with the happiness or welfare of another. This is the only way in which we can honour our country, and not, by behaving like highway robbers or pirates, in bringing home whatever valuable plunder we can seize.

Thus we see that the intended removal of the fine works of sculpture and painting is as unreasonable respecting the rest of Europe as it is unjust respecting Rome; for, as France does not appear to have any claim upon Rome for compensation, any other plea might be urged, with as much reason, by any other country of Europe.

If France in her demand on Rome for those works had any motive of state policy, or view of indemnification for general losses, these I can say nothing to, as being out of the way of my intention, which was to enter into no political discussion: but surely it may be said that these works supply no means to support a war; and it must be doubtful whether their removal to Paris would facilitate the study of design even in that city; whilst the great community of arts and letters both of the present and future ages, natives as well as foreigners, would have reason to blame France for having dismembered the university of the world.

However, before I quit this part of the subject, I shall notice one argument of the petitioners for wishing to bring those works to Paris: it is this:—"The Romans, although antiently rude and unpolished themselves, civilized their nation by transplanting into it the productions of conquered Greece." It is true that the Roman orators and poets owe almost the whole of their splendour to what they had learned from the Greeks. But Rome profited little by Grecian philosophy and mathematics; they were reduced to be the handmaids of politics and war in that metropolis; and, according to the testimony of Pliny the elder, as well as the remaining monuments, we have but slight grounds to believe that all the painting and sculpture brought from Greece ever produced a Roman artist of real excellence; on the contrary, it has been supposed that the genius of Rome was buried under the ruins of Greece.

I shall now consider how far it is possible to make France an university for the arts of design equal to Italy.

The petitioners desire that France may become the university for the arts of design in the following words:—"It is necessary that all nations should henceforth borrow the fine arts from us with the same eagerness they formerly imitated our follies; and when we shall have granted them peace, they will be anxious to come to this country to imitate the wisdom and taste which those works of genius impart."

part." But let us see what advantages of this kind France possesses, or is likely to be possessed of, in comparison with Italy.

An university or school in which all nations are to study the arts of design should possess all possible assistance to the progress and exercise of painting, sculpture, and architecture. This supposes the greatest number and variety of the most excellent works of Grecian sculpture, groups, statues, busts, and bas-reliefs, in marble and bronze; as likewise gems and medals, of paintings, the greatest number and variety of antient Greek or Roman paintings and mosaics; as also the best of those works which have been produced since the revival of the arts. This university should be situated in a country abounding with buildings erected from the remotest antiquity, through the barbarous ages down to the revival of the Grecian orders in the fifteenth century. Here the student of architecture should see and study the palaces, temples, basilicos, theatres, amphitheatres, baths, aqueducts, fountains, tombs, chapels, altars, sarcophagi, and whatever else of public or private building or decoration might enable him to make the most profound and perfect studies in his art: the painter and sculptor should be excited by the objects to a habit of copying fine living models and draperies: they should have easy access to able masters for instruction. The local situation of such a school should be connected with the classical history of the works which it contains, in order that the natural connection between the arts of design and the belles lettres may be preserved. The very climate itself should be favourable to grand forms of countenance and person, to the limbs being more uncovered than in colder countries; to careless and variegated groups and actions, and flowing draperies. This school of art should likewise lie in the high road to Greece and Egypt, Syria, Balbec, and Palmyra, to enable such as would study art and science, and their source, to make the easier journeys into those countries. Now, as Italy is the only country in the world that has all these advantages, it is evident that is the university in which all nations must study the arts of design.

France, on the contrary, wants them all in common with her neighbours. In France there is no series of Greek and Roman buildings for architects to study; in France there is no collection of antique sculpture worth notice; nay, in this respect, perhaps, England, Saxony, Prussia, Russia, and Spain, excel her; for in those countries there are very fine collections of antient sculpture, notwithstanding that all the first, second, and perhaps third class remain in Italy, where every true lover of arts and letters must hope they may long continue. In Paris there is certainly an extensive and valuable collection of pictures, which will be of the greatest assistance to painters preparatory to their studies in Rome. Among the works of chiefest merit are the Luxembourg Gallery by Rubens, some pictures of Raphael and Corregio, the Battles of Le Brun, and the Life of St. Bruno by Le Sueur. But the paintings of greatest excellence, upon the study of which alone a historical painter can hope to become great, remain in Italy; and there the best of them must remain, as their sizes are enormous, and they are painted on walls. The paintings which we allude to are Michael Angelo's Last Judgment, and the Cieling in the Capella Sestini; the Martyrdom of St. Peter and the Conversion of St. Paul in the Capella Paulini, by the same artist; the Chambers of Raphael in the Vatican; the Chapel painted by Signorelli at Orvietto; paintings of Titian in the Ducal Palace of Venice, and the Domes by Corregio and Parmegiano, &c. &c. To which I may add the antient paintings in Naples; for these are in Italy, although not of the number of immovables. If to the objections already stated we add the disadvantages of the climate and local situation of France in comparison with Italy, we shall immediately see that nothing less than a new dispensation of Providence, and arrangement of things in this part of the globe, can ever give France the advantages which Italy possesses as an university for the arts of design.

If it should appear from what has been said that this scheme of making France the university is impracticable as well as unreasonable and unjust, all the lesser arguments of the petitioners must of course fall to the ground; but if any one is dissatisfied with what has been advanced, although I could produce other arguments I cannot produce stronger to convince him.

It would be great and disinterested in France, as she is valiant in war, to be moderate in peace, and to suffer Italy to remain, as it has been, the university for all nations to study in, from which she will ultimately derive much greater advantages in common with the rest of Europe than she can in future by dismembering that venerable school. Such an instance of moderation would secure to France the praise of the present and future generations; it would prove that her love for the fine arts is equal to her professions: those inestimable collections should be sacred and inviolable which are contained in Rome, Florence, and Naples, cities so conveniently

veniently situated for communication with each other, and which, together with the surrounding country, make up the great university of Italy, which may be said immediately or mediately to have produced all the great restorers of arts and letters. The collections of Rome are not in the same danger of being dispersed as formerly; for all the fine works of art which have been found or purchased for many years past are lodged in the Clementine museum, and belong to the Roman people; the nephews of popes do not now marry into the families of crowned heads, and by that means give their powerful relations the power to seize their collections by inheritance; besides which, the Roman government will in future permit only duplicates of antique statues or inferior works to pass out of the state.

I can assure the petitioners that the Barberini and Giustinian collections are not "wholly carried off:" it is true that a few years back some few articles were injudiciously sold out of them; but they are at this time great and valuable collections: I can assure them likewise that four of the best statues and some other articles from the Negroni collection are in the Clementine museum in Rome.

Having gone through an examination of the object and principal arguments of the petition, it only remains to say something concerning those by whom it is signed. Several of them are persons highly esteemed for their industry and talents in painting, sculpture, and architecture. In this latter study the French have been particularly successful; and in this place I cannot forbear doing justice to the merits of my former friend and fellow-student in Rome, M. Percier, although he is not of the number of the petitioners: he is a man of uncommon virtue, his compositions are the most beautiful architectural assemblages; his drawings have been much admired, and sold for large sums in England. From a considerable knowledge of several of the petitioners whilst we pursued our studies at the same time in Rome, I shall set down the following anecdote only:—About ten years since, a M. Drouvais died, who was a pensioner of the French academy in that city. He was universally regretted for his extraordinary talents in painting. His fellow-students, eleven in number, instantly agreed to honour him with a marble monument. M. Michalton, one of the present petitioners, was the sculptor employed, and nobly gave his labour; the other students paid by subscription for the marble and other expenses out of their little pensions of six shillings per week allowed by their government to each, exclusive of their board and lodging in the academy. The

design

design was the side of a large altar; the pediment presented a medallion of the deceased: on the dodo were three figures in bas relief,—Painting wrote his name, Sculpture supported her arm, and Architecture looked on with a mournful countenance. I have introduced this anecdote to inform Englishmen of particular virtues and talents in an enemy's country which otherwise might not be so generally known, and to let Frenchmen see that we can acknowledge whatever is praiseworthy in them with as much zeal as they would themselves.

I have only to add my earnest wishes as an Englishman and a real lover of my country, that we may in future cultivate the arts of design with as much fervour, and labour as indefatigably to bring them to perfection, as the French have done, by those means only which are just and honourable.

I have the honour to be, &c.

IV. *New Method of separating Tin and Copper from Bell-Metal. By* C. Anfrye, *Assay Master of the Mint**.

France, deprived by war of many of the products which commerce afforded her in ordinary times from foreign countries, was not very long ago almost totally destitute of copper. Pressed by the distress which the scarcity of this metal occasioned in the casting of artillery and other articles for the common purposes of life, all the enlightened chemists were called together, and from their knowledge that assistance was demanded which the science they professed could afford towards warding off the impending danger. These expectations were not disappointed: its hopes were realized even beyond the point to which they were directed. In the year 1792 all the French chemists were busied in finding out an easy and expeditious method of separating the copper from the other metal of which their church bells were manufactured; the only source from which copper could be obtained. They were successful in their attempts, and the method

* From a manuscript of C. Anfrye's not yet printed, communicated by Dr. Bourlaye to professor Tromsdorff, and inserted, by permission, in Gehlen's New Journal of Chemistry, vol. i. part 2. p. 213, whence this translation is made.

Dr. Bourlaye remarks, that by this ingenious invention the republic of France has saved upward of seven millions of pounds of copper and one million of pounds of tin, which were thrown away as an useless refuse of the process formerly adhered to for separating copper from bell-metal.

method pointed out by Fourcroy was deemed the most advantageous.

The method pointed out by this great chemist, which was universally adhered to, consisted in oxidizing one part of the bell-metal from which the copper was to be extracted, and uniting, by long continued agitation, the oxidized portion with another quantity of the same metal rendered fluid by fusion. The oxygen of the oxidized metal became thus transferred to the fused tin of the merely melted bell-metal; and the copper, at least a considerable quantity, was separated. 100 parts of bell-metal treated in this manner yielded from 50 to 60 of copper, besides a considerable quantity of slag, vitreous dross or glassy oxide, consisting of oxide of copper and oxide of tin.

The complete reduction of this vitreous oxide proved extremely difficult: the great excess of oxide of tin which it contained prevented its complete fusion; the reduced particles of copper, in whatever manner the reduction had been accomplished, could not sink through the viscous matter, and the particles of metal could not be collected into one mass; at least no œconomical method could be advised which could be adhered to in the large way. Thus several millions of capital remained as dead stock, and it became a national question, Whether it would not have been better never to pursue this attempt of procuring copper from bell-metal, than to sacrifice the original compound?

Several attempts were made to render the prodigious quantity of slag or vitreous refuse, which was soon produced, useful for other purposes: but they all failed, and no hopes remained of bringing them to account; except of reconverting them again into bell-metal by a fresh addition of metallic copper.

In contemplating this subject I persuaded myself that the decomposition of bell-metal was, perhaps, possible by completely converting one of its compounds into a perfect glass of oxide. Before I attempted this, I reduced the slag obtained in Fourcroy's process to the metallic state, in order to learn its precise nature. The result was a white brittle metal.

I then took 3 cwt. of this metal and oxidized two of it, in order to reserve the other third for deoxidizing the copper of the first oxidized part, by abstracting from it its oxygen, by the admixture of the third unoxidized portion. The product was a mixture of oxide of tin and particles of metallic copper slightly adhering together, from which the greatest part of the oxide of tin could be separated by mere ablution

ablution and other mechanical efforts. The more ponderable part of this mass, thus freed from the greatest portion of its oxide of tin, was fusible, and a bad kind of cannon-metal consisting of 0·80 of tin and 0·20 of copper. It was far too brittle, on account of its containing too much tin. There was also again a loss in the oxide of tin, which carried away with it a portion of copper in the process of ablution.

This process not being satisfactory, I attempted to separate the portion of tin which was united to the copper obtained in the before-mentioned process, by fusing it with a substance capable of effecting a complete fluidity. I substituted for that purpose common glass, and I found that it completely succeeded. Pursuing this method, I became soon sensible that this process was not so œconomical as I first imagined, for one part of the white metal absolutely required three of glass. The great quantity of glass consumed, which was also lost, (for it could only be used once,) was a sufficient reason for giving up this proceeding: in short, the process, on account of the great bulk of the mass as well as the real value of the wasted flux, made its prosecution in the large way unadmissible.

Having found in some other experiments that the oxide of tin obtained by digesting strong nitric acid upon tin was reducible by 1-10th of charcoal, I had recourse to the latter. Without detailing all the different processes which proved unsuccessful, I shall merely state that method which succeeds best in the large way, and which is as follows:

Let the slag from which the metals are to be extracted be ground to powder; mix it with 0·08 of charcoal powder, and fuse the mixture in a reverberatory furnace for six hours; after which remove the fused metal in the usual manner. The glass which covers the reduced metal is to be put aside for further reduction; for it is capable of yielding a metal of 0·75 of tin and 0·25 of copper.

The metal thus obtained by means of charcoal always consists of from 45 to 50 of copper and an equal quantity of tin. To diminish its quantity of tin it must again be fused in a reverberatory furnace capable of exposing a large surface of the fused metal to the contact of air: by this means its surface soon becomes covered with a crust, consisting of oxide of tin and oxide of copper. By thus keeping the metal melted for some time it soon becomes converted into bell-metal, and when this is accomplished it must be drawn from the furnace.

The gray oxide which is during this process obtained, when

when reduced in the melting furnace yields a compound consisting of 0·75 of tin and 0·25 of copper. This metal is put together with that obtained from the vitreous refuse into the calcining furnace, and the whole oxidized to a certain point. The first oxide which is formed is white and light, but it gradually becomes coloured. At this period the oxide produced is not merely oxide of tin, but a mixture of oxide of copper and oxide of tin. The formation of this oxide serves the operator to judge of the quality of his oxidizing metal; for, the moment this oxide begins to appear, the metal consists of equal parts of tin and copper, and it ceases to appear when the metal is in the state of bell-metal: just before this takes place the oxide becomes very black.

As the metal is brought to this standard it is drawn from the furnace, in order to procure from it again, as before, metallic copper and a vitreous oxide; which is again treated as already stated.

All the oxide obtained during the different processes must be reduced by means of charcoal in the melting furnace.

If it should happen that the tin obtained by these processes contains copper, let it be again fused, and cool slowly so far till a piece of paper let fall upon it does not become charred. The tin may then be ladled off, and the copper will be found at the bottom adhering to a portion of tin only, which may be got rid of by oxidation.

V. *On the supposed new Metal lately discovered in Platina.* *By* Jos. Hume, *Esq.*

To Mr. Tilloch.

DEAR SIR,

The new metal lately obtained from crude platina seems, in many respects, so nearly allied to tungsten that I cannot but entertain strong suspicions of their identity; and that the difference, if there be any, possibly arises more from one or the other retaining a slight admixture of chrome or its acid, or some other trifling alloy not yet discovered, than from any specific distinction in their nature. As crude platina is now found to be generally contaminated by various substances, such as iron, copper, titanium, chrome, silex, and this metal, we cannot be much surprised should one or more of these so far influence the new metal, supposing it

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to be tungsten, as to give a new turn to its usual habitudes and character.

It does not appear that tungsten has ever been submitted to the same experiments, nor treated exactly as the metal in question; indeed all that has hitherto been written respecting it seems still involved in doubt, and frequently in error. Can any thing be more ambiguous than the present history of tungsten? What can we infer from such a passage as the following?—"L'acide tunstique se fond avec les phosphates et les borates, qu'il colore en *blanc* ou en *vert.*" (*Systême des Conn. Chim.*) Here it is difficult to decide whether the acid gives constantly a white colour to one class of these salts, and a green to the other; or whether with both salts the colours are merely adventitious. It is also generally affirmed that nitrous acid, which is so potent in acidifying almost every basis, when poured upon tungstic acid, changes it into a yellow oxide; consequently, that the addition of oxygen destroys acidity. This is surely a complete paradox in chemistry, and cannot be fairly ranked amongst anomalies. But not to dwell upon these and many other instances so very open to controversy, I shall proceed to offer the chief reasons on which my doubt is founded.

At present, as no notice of the specific gravity and other essential qualities of the new metal has yet been taken, either by Collet Descotils or any other writer, it is impossible to draw a perfect parallel of the two metals; more especially as the history of tungsten is so very vague and incomplete. This being the real state of the case, nothing I shall now lay before you should be judged of too rigidly; or, I hope, taken in any other sense than as an attempt to promote the inquiry by urging others to take it up. We have been so long accustomed to consider malleable platina, and many other metals, as pure, that we need not wonder should tungsten, by industrious research, be also discovered to be an alloy, and that it has never before been produced pure and isolated.

In comparing the new metal with tungsten, even under all the disadvantages already noticed, we may frequently distinguish a most striking resemblance; and in nothing so much as a disposition to produce colours of a transitory nature, such as from yellow to blue, blue to white, white to yellow; and we may add also green and red to the list. What appears an exceedingly prominent feature in their similitude is, that the blue colour, by whatever method it has been effected, is in both metals equally beautiful, and in

 both

both eminently fugitive. In regard to green, we can suppose it to be easily produced wherever a yellow and a blue can exist; the inference is therefore but natural for any mixture of these to centre in the former. The comparison will, I am fully persuaded, lose nothing of its value by extending it; we may therefore, for the present, further assume the following positions:

1st, That both the new metal and tungsten are difficultly soluble in acids.

2d, That the oxide of one as well as the other is soluble in alkalies.

3d. The new metal, when fused with potash, forms a green mass.

4th. That tungsten may perhaps give the same result, since wolfram, one of its ores, gives a green scoria when fluxed with potash.

5th. Neither of the metals gives colour when fluxed with borax.

6th. That the blue colour in both metals is soluble in water, and may be easily changed or dissipated by heat.

The fugacious nature of the blue tint, so peculiar to both these metals, is often very perceptible in tungsten; and this distinctive mark may be exemplified in many instances. I have observed paper in which some oxide had been filtered, when exposed to the sun become of an elegant blue colour; and the same paper during the night or in the dark lost its colour, and regained it on exposure to the sun. Whether it be the heat or light of the sun, or both, that produces the change, remains to be examined.

In the following experiment it appears that heat is the cause of dissipating the blue when in solution.

If a cylinder of zinc be left for some time in a solution of the triple acidulous salt, generally called tungstic acid, the liquid will soon become of a most brilliant blue; especially if the zinc be frequently moved, as if to stir the fluid. When the zinc has produced a full effect it may be withdrawn, and the solution then placed over the flame of a lamp, or in a gentle heat, to evaporate. In a short time the colour will lessen in its intensity, and at length totally vanish, leaving the remaining solution nearly colourless. This is not the only instance of the fleeting nature of the blue colour of tungsten, though a very effectual one to elucidate this singular peculiarity.

That zinc and iron turn some preparations of tungsten blue, has already been noticed by several authors; I do not, however, recollect that the entire dissipation of the colour

by

by a subsequent application of heat has yet caught the attention of any other person.

Among many other experiments that may be suggested to compare and explore the nature of these two metals, the two following, forming, as it were, reciprocal proofs, naturally present themselves to our notice:

1st, To observe whether the new metal gives a blue colour when fluxed with phosphates and phosphoric acid, and if it be in the same degree of intensity as is produced by tungsten. That tungsten has this property has, I believe, been mentioned only by Klaproth, whose accuracy cannot be questioned.

2d, The next is to form an alloy with pure platina and tungsten, and, from its solution in nitromuriatic acid, endeavour to obtain the same red precipitate which so pointedly characterizes the new metal when so combined.

It is perhaps solely to the admixture of this new metal we should ascribe the present imperfection of platina, that crucibles formed of the latter are liable to be abraded by alkalies; a circumstance first noticed, I think, by Mr. Chenevix. That this is really the truth, admits, I apprehend, of very little doubt; for it has already been observed (*Ann. de Chimie*, no. 143. p. 185), that from the malleable platina, purified by Jannety and Neker Saussure, as much of the black powder or new metal was obtained as if the same proportion of crude platina had been employed. This fact has since been partly confirmed in a note in the last Philosophical Journal.

How far this imperfection of platina may in future be obviated by subtracting this new metal, still remains to be ascertained; we may, however, reasonably expect, that, besides making a complete cure of this defect, the nature and properties of this very singular substance must put on such a change of dress as to render a revision and new arrangement of the whole history of platina absolutely necessary.

With much esteem I remain, sir,

Your obedient servant,

Jos. Hume.

Long Acre,
June 11, 1804.

VI. *Ex-*

VI. *Experiments on the Yolk of Wool; with some Observations on the Washing and Bleaching of Wool.* By *M.* Vauquelin*.

Several chemists have thought that the yolk of wool † is a fat matter; others, finding that it dissolves in water, have not adopted the same opinion. Chemical analysis can alone decide this question, which is the object of the present paper.

1st, Water discharges much colour from wool; and this liquid acquires colour, odour, and taste.

2d, The water with which wool has been washed is milky, like an emulsion of gum-resin, and it passes with difficulty through paper.

3d, It suffers to be deposited by rest a mixture of sand, carbonate of lime, and several other foreign bodies: it froths by agitation and heat like a solution of soap.

4th, Water with which wool has been washed, when filtered and evaporated furnishes a brown extract, thick like syrup, of an acrid, salt, and bitter taste: in this state it still retains the odour peculiar to it.

5th, Alcohol applied to this extract dissolves a part which communicates to it a reddish brown colour. If the alcohol be separated by evaporation from this substance, it exhibits the appearance of thick, viscous, and transparent honey.

The other properties which appeared to me in this substance were as follow:

1st, It dissolves readily in water, and the solution is immediately coagulated by acids, which separate from it grease insoluble in water. This matter, when thus separated by acids, collects itself very slowly, and has a yellowish colour. Acids, as will be seen hereafter, hold a great quantity of it in solution, which gives them a reddish brown colour. By evaporation the greater part of this substance dissolves by acids, deposits itself under the form of black bitumen; and salts, with a base of potash and of lime, are obtained from it. These salts cannot be obtained in a state of purity and whiteness till after several calcinations and solutions, as the fat matter is very adhesive.

At the same time that the acids precipitate this fat matter, they expel a certain quantity of acetous acid, very per-

* From the *Annales de Chimie*, No. 141.

† The French call it *suint*.

ceptible by its odour. Concentrated sulphuric acid blackens the thickened yolk, and disengages from it some vapours of muriatic acid.

2d, Lime water renders the solution of yolk turbid and milky; but it forms in it no coagulum, as in a solution of common soap.

3d, Neither caustic alkalies nor quicklime show the presence of ammonia.

4th, Nitrate of silver produces in it a yellow precipitate, which adheres to the sides of the vessel in the manner of a *greasy substance*. This precipitate dissolves in a great part in nitric acid.

The part of yolk insoluble in alcohol has still a salt taste, but fainter than the portion soluble in that reagent. After being thus treated with alcohol, it does not redissolve entirely in water; there remains a glutinous matter of a gray colour, which effervesces with acids: this announces the presence of an alkaline carbonate. The portion which retains its solubility in water, communicates to it a reddish colour and a salt savour: its solution is not rendered turbid by acids, as it was before being treated with alcohol. Caustic alkalies do not disengage from it ammonia; muriate of barytes forms in it a very abundant depôt, the greater part of which dissolves in water; nitrate of silver occasions in it also a precipitate which partly dissolves in nitric acid. Alcohol precipitates this matter under the form of a mucilage, which is speedily deposited.

Nitrate of iron mixed with the solution of this substance formed in it a brown precipitate, and the liquor at the end of some days furnished a pretty large quantity of nitrate of potash.

The filtered liquor of yolk decomposed by dilute nitric acid blackens by evaporation, exhales vapours of sulphuric acid, and becomes carbonaceous in proportion as the concentration of the sulphuric acid takes place. The residuum being then washed with water, and the solution properly evaporated, furnishes crystals of neutral sulphate of potash; but there remains a great deal in solution in consequence of the superabundant acid, which reduces it to the state of acidulous salt; by longer evaporation this salt crystallizes in needles, and into laminæ of a white pearly colour. During the course of these successive evaporations, another kind of salt presents itself under the form of flattened needles of a satin white colour and without any taste.

This salt, when carefully examined, appeared to me to be nothing but sulphate of lime. It differs, however, from it in several respects: for example, it fuses much sooner in the flame of the blow-pipe into a globule transparent while in a state of fusion, but which becomes opake when fixed: it is also much more soluble in water, and yet does not contain acid in excess, as I fully assured myself. A solution of it in water precipitates abundantly muriate of barytes and oxalate of ammonia: one of these precipitates is sulphate of barytes, and the other oxalate of lime. The solution is rendered turbid neither by lime nor by ammonia. It appears then that it is a modification of the sulphateof lime, which is probably produced by the proportion of the elements. It is possible therefore that this salt may still contain some portions of fat matter, which, by decomposing the sulphate of lime and forming a little sulphuret, might facilitate the fusion. I regret that I had not a sufficient quantity of this salt to examine its properties more in detail.

The yolk of wool dissolved in water, when filtered, thickened, and distilled with weak sulphuric acid, furnished a liquor in which I readily distinguished the presence of the acetic acid by its odour, its savour, and the properties of the salts which it formed with different bases, and particularly with lime and potash. This matter therefore contains acetic acid, which, no doubt, is in part combined in it with the potash. It contains also a little muriate of potash; for it forms with the solution of silver an abundant precipitate which is not entirely soluble in nitric acid, and it gives by distillation with sulphuric acid sensible traces of muriatic acid, which is found mixed with acetic acid.

Yolk, when evaporated to dryness and strongly heated in a silver crucible, swells up, becomes charred, and exhales some fœtid ammoniacal vapours; oily fumes then arise, which inflame, and when the greater part of the oil is dissipated it becomes red and calmly fuses. At this period, if it be poured on marble, a matter is obtained which becomes fixed on cooling, has a grayish colour, and a very caustic alkaline taste: if this substance be then dissolved in water, nothing remains but an infinitely small quantity of carbonaceous matter, and the liquor, by evaporation, gives real potash slightly carbonated.

It results from these experiments that the oil or grease, the presence of which in yolk has been proved by acids, is combined with potash in the state of a real animal soap; that, besides, there is a portion of carbonate of potash in excess, since the acids produce in the solution of yolk, when concentrated, a pretty strong spumous effervescence. Besides

sides the substances already mentioned, yolk contains a certain quantity of animal matter; for it gives by distillation very sensible traces of ammonia, and an oil the fœtid odour of which has a considerable resemblance to that furnished by animal matters.

Yolk then is composed, 1st, of soap with a base of potash, which forms the greater part of it: 2d, a small quantity of the carbonate of potash: 3d, a considerable quantity of acetite of potash: 4th, lime, with the state of the combination of which I am unacquainted: 5th, a small portion of muriate of potash: 6th, a peculiar animal matter, to which I ascribe the particular odour of yolk.

In my opinion, all these matters, which are essential to the nature of yolk, are not found in it accidentally, for I have always found them in a great number of the different kinds of wool both of Spain and of France.

I shall not speak here of the other matters insoluble in water, which are found also on wool, such as the carbonate of lime, sand, filth of every kind,—these being evidently accidental.

It still remains to determine whether all the matters which exist in yolk are the product of cutaneous perspiration accumulated and thickened on the wool, or whether they are contracted in cots or other places where sheep reside. It is very certain that all the elements proper for the formation of the matters contained in yolk are found in the excrements of these animals, and in the vegetables which serve them as litter. I cannot, however, believe that the whole is the effect of beds of dung; on the contrary, I am of opinion that the perspired humour is the principal source.

The analysis of dunghills would give us no certain information on this subject, because the matters found in them might have been deposited by the sheep themselves.

But even if we suppose, what appears to be very probable, that the principles of yolk arise from the humour of perspiration, do these matters issue in this manner from the body of the animal, and do they not experience any change during their remaining on the wool? This is a question to which it would be difficult to give a decisive answer. We can only presume that in wool, as in all very compound substances deprived of movement, there are effected changes, of which, in the present case, we know neither the mode nor the cause.

Yolk being, as already seen, a real soap soluble in water and in alcohol, it appears that there can be no better method of scouring wool than to wash it in running water.

But

But I must observe that there is on wool a small quantity of greasy matter not in combination with the alkali, and which adhering to the wool makes it retain something pitchy, notwithstanding the most careful washing.

But if wool be put into tubs, and the quantity of water necessary for moistening it be poured over it; and if it be suffered to remain in that bath for some time, often treading it down, it will be much better scoured, and become whiter by washing it afterwards in running water.

Scourers are accustomed to macerate their wool in putrefied urine, and it is generally believed that the ammonia which is thus developed effects the scouring; but I have some reasons for thinking that this alkali is of no use. This effect is owing rather to the yolk itself, or to some other principle of the urine, to *urée* for example; and my opinion is founded on the following circumstance:—I put washed wool into a current of water in a mixture of sal-ammoniac and common potash. This mixture had a strong odour of ammonia; and yet the wool was not scoured, because this alkali does not form, or forms only with difficulty, a saponaceous compound with the greasy matter of wool. I am of opinion then, from these observations, that putrid urine is almost useless in scouring wool, at least so far as its ammonia is concerned.

If the utility of putrid urine be at least doubtful, it is on the other hand very certain that fresh urine would be very prejudicial in regard to the proposed end; for the soap contained in yolk would incontestably experience a decomposition by the acid of urine, which would precipitate the grease on the wool.

I suspect that the same effect would be produced by washing wool in water containing earthy salts, which, as is well known, decompose alkaline soaps. For this reason it is always prudent to employ for this purpose the purest water possible to be obtained.

The case is not the same with soapy water; it perfectly completes the scouring of the wool, and at the same time gives them more whiteness. If wool then, after being washed in running water till it gives no more filth, be suffered to macerate for some hours in a twentieth part only of its weight of soap, dissolved by a sufficient quantity of tepid water, often treading it down, it will be entirely freed from the small portion of grease still adhering to it, and then exhibit a softness and a degree of whiteness which it would not have acquired without this operation.

Yolk itself a little concentrated, as I have already an-

 nounced,

nounced, has an efficacious action on the portion of grease which is not in the saponaceous state; for I observed that by pouring over wool no more water than the quantity necessary to cover it completely, it was much better scoured, especially with a slight degree of heat, than when washed in running water. But I observed also that wool which had remained a long time in its own yolk swelled up, split, and lost its strength; effects which take place also in too strong soapy water.

If the water of yolk causes wool to swell and to split in this manner, may it not be possible that this accident often takes place on the backs of the animals, especially during warm damp weather, or when they are shut up in folds the litter of which is not often enough removed? It may not be impossible also that the acridity of yolk may occasion an irritation in their skin, and prove the cause of some of those maladies to which this organ is subject in these animals, and which must occur chiefly during damp warm weather: fortunately, at this season, they are occasionally exposed to rains, which wash them and carry off at least a part of this matter. In this respect I am inclined to adopt the opinion of those who think that the washing of sheep during dry warm weather may be useful to their health and to the quality of the wool.

The loss which wool experiences by scouring is variable. The greatest I ever observed was 45 per cent., and the least 35. The wool, indeed, which I washed was exceedingly dry. This loss does not arise entirely from the yolk it contains: moisture, earth, and filth of every kind contribute to it also.

I have made some attempts to bleach scoured wool; but I confess that I did not carry them so far as they deserved: I observed in general that wool which had been immersed in soapy water bleached much better, by every method, than that which had not been subjected to the same operation. The sulphurous acid dissolved in water bleaches it pretty well; but it does not remove the yellow colour acquired by wool in the groin and under the shoulders of sheep. Wool in liquid sulphurous acid acquires the property of making a noise between the fingers like sulphurated silk, and at the same time contracts a fœtid odour exceedingly strong, which is not dissipated till a long time after.

I have not tried the steam of burnt sulphur; but every body knows that it whitens wool exceedingly well, and that it is employed by all manufacturers of woollen stuffs to give them the last degree of whiteness. Of all the means I tried for

for bleaching wool, I found none better than that of exposing it on the grass, to the dew and the sun, after being well scoured with weak soapy water: the yellow spots, however, observed in that of the flanks are not entirely destroyed; their intensity only decreases.

VII. *Letter to Dr.* THORNTON *from Mr.* ARTHUR AIKIN.

SIR,

YOU have very satisfactorily shown that the author of the critique upon your "New Illustration of the Sexual System of Linnæus," in the Annual Review, is but slenderly acquainted with the science of astronomy: you would also have been perfectly justified in drawing the same conclusion with regard to the editor, who, if he had been aware of it, would not have permitted so grievous an error as that which you have exposed, to pass uncorrected.

I am sorry to find, however, that your otherwise laudable zeal in your own vindication has betrayed you into an ungenerous and unjust allusion to Dr. Rees's Cyclopædia. If you have any authority for believing that I am concerned in that respectable publication, you must know that the only departments in which I have engaged to furnish articles are those of chemistry and mineralogy, sciences which have no more connexion with astronomy than astronomy has with botany.

I have the honour to be, yours, &c.

ARTHUR AIKIN.

Broad-street, Buildings,
June 1, 1804.

VIII. *Letter to the Editor of the Philosophical Magazine, by the Author of the Review of Dr.* THORNTON'S *Illustration of the Sexual System of Linnæus, given in the Annual Review.*

SIR,

YOU are perfectly right in your persuasion that the editor of the Annual Review did not write the criticism on Dr. Thornton's great national work, and that he is not responsible for its mistakes and demerits. The author of that article has long since learnt that no real honour is lost by the ready acknowledgment of an error. He is thankful even to Dr. Thornton for making him acquainted with facts which had escaped his notice, and which are not mentioned in most, if any, of our English professed treatises on astronomy. In his younger years he studied the mathematical principles of that very extensive science, in connection with the other essential parts of what is esteemed a regular education. Professional and other circumstances soon directed his chief attention to other pursuits. But, though occupied in what to him were more important concerns, he did not entirely relinquish what had given him a high pleasure. In subsequent periods of his life he recalled to his memory the knowledge which he had formerly acquired, by carefully reading Rutherford's System of Natural Philosophy and Nicholson's Introduction; and a very little time before he engaged in the very irksome task of reviewing the vaunted Illustration of the Sexual System of Linnæus, he had happened to take a cursory view of professor Vince's Complete System of Astronomy. In these standard works there is not a word concerning a satellite of Venus; and so little credit has its existence obtained with our English astronomers, that Mr. Vince, though he gives a detailed account of Cassini's discoveries, passes it over in silence. The reviewer was not ignorant that, among other advantages expected to be derived from the two transits of Venus over the sun, which, fortunately for the astronomers of the time, happened within eight years of each other, it had been suggested, that if Venus have a moon, it must then be seen. None of the able astronomers who solicitously viewed this interesting phænomenon in different parts of the world, perceived any appearance of a secondary planet. The reviewer, therefore, believed that the question, which in his apprehension had been only a speculative one, was completely decided. But he feels no reluctance to confess, that had he been aware of the observations related in the Encyclopædia Britannica, or if he had happened to consult Dr. Rees's folio edition of Chambers, to which he had readier access, that passage which Dr. Thornton has exclusively selected for animadversion would not have been written. He has made a blot which, he trusts, will not be thought very disgraceful to one who never professed himself a thorough proficient in the game. This blot Dr. Thornton has fairly hit; and he has a right to avail himself of it as far as it will go. But he must make many more such hits, or he will not save his gammon. The moon of Venus, as he himself owns, has only a very remote connection with the object of his work. And he has not attempted to invalidate any of the serious objections which have been made to it as a system of botany, professing to lead the young student, step by step, from the threshold to the inmost recesses of the science. If Dr. Thornton will prove that he has been ignorantly or maliciously misrepresented, and that the work, as far as it has proceeded, has realized the greatness of its promise, the reviewer will take shame to himself, and kiss the rod. Till then he must take the liberty to declare, that his opinion of Dr. Thornton, as a writer, remains unaltered. The work and the review are before the public. Those who understand the subject will decide between them. To their impartial judgment he calmly and respectfully leaves it; and is at the same time, sir, your constant reader and humble servant, Y. Z.

IX. *Experiments to ascertain whether there exists any Affinity betwixt Carbon and Clay, Lime and Silex, separately or as Compounds united with the Oxide of Iron forming Iron Ores and Iron Stones. By* DAVID MUSHET, *Esq. of the Calder Iron-Works* *.

[Continued from our last volume, p. 398.]

To prove that there exists any affinity betwixt clay and carbon, or that the latter unites to the former either by fusion or cementation, the following experiments were made:

I. 100 grains of well dried Sturbridge clay were introduced into a crucible of the same clay, and exposed in the assay-furnace till the pot began to sink and lose shape. When cold, I found the clay resolved into a neat semi-spherical mass firmly connected together, of a pale straw colour, but without any symptoms of fusion. It easily parted from the crucible, and weighed 83 grains.

II. 100 grains of the same clay, reduced to a fine powder and mixed with half a grain of lamp carbon, were exposed to a similar heat as No. I. The result was a mass every way the same in point of shape, but the colour was blueish gray throughout the whole. The carbon had completely disappeared, and seemed now only to exist as the colouring matter in the clay. A few specks of vitrification were evident upon the surface that had been in contact with the crucible. The mass weighed 81 grains, and had therefore lost in water 19 grains.

* Communicated by the Author.

III. 100

III. 100 grains of the same clay were exposed with two grains of lamp carbon. The latter disappeared, and a partially vitrified mass of clay was obtained of a blackish blue colour.

IV. 100 grains of clay and 3 grains of carbon afforded a result similar, though without any symptoms of vitrification. A portion of carbon equal to half a grain remained untaken up.

V. 100 grains of clay were exposed in a Cornwall clay crucible along with 8 grains of carbon, to a heat of 170° of Wedgwood. The result was a mass more friable than any of the former. Its colour was black, and the interior of the crucible was covered with a dark lead blue glaze, which had penetrated a little way into the thickness. As was expected, a considerable quantity of the carbon remained untaken up. It is presumable, therefore, from these experiments, that the addition of charcoal, in quantity not exceeding 1-50th or 1-40th the weight of the clay, hastens its fusibility by uniting with it, but that beyond this proportion the fusibility of the mixture is retarded.

In the fabrication of crucibles the same fact is clearly illustrated. Cast steel pots are frequently made with powdered black lead pots mixed with the Sturbridge clay. This renders them more fusible, but less apt to clink in heating and cooling. An extra dose of either black lead or coke dust in forming smaller crucibles decreases the fusibility, but by impairing the tenacity of the compound in high heats entails an evil of as great importance as that meant to be removed.

VI. A Sturbridge clay crucible filled with charcoal, upon which a lid was accurately fitted, was exposed to a heat of sufficient strength to melt it into a flattish cake. In this state the consistency was soft, and nearly entering into fusion. When cold, I found a great portion of the charcoal still inclosed. The interior of the pot was of a rusty black colour, and honey-combed. The fracture was porous throughout, and exhibited an imperfect glassy appearance of a dirty black colour. The fracture of vitrified Sturbridge clay in general is white, and even when urged to fusion is of a dull yellowish colour. The result now obtained was different from the common appearances, evidently in consequence of the quantity of charcoal inclosed, and readily presented to the clay at a high temperature.

VII. Fifty grains of Sturbridge clay, mixed with 3 grains of chalk, or nearly 1-17th of its weight, were melted into a whitish

whitish yellow porcelain, which had flown freely upon the bottom of the crucible.

VIII. Fifty grains of the same clay, mixed with 5 grains, or 1-10th of chalk, were easily reduced into a blackish glass. The surface was shining; the fracture spotted with whitish brown concretions; but the general appearance was a black incompact semi-glass.

IX. Fifty grains of clay mixed with 3 grains of chalk, to which was added half a grain of carbon, yielded a dense porcelain glass of a dull lead-blue colour. The carbon had totally disappeared. This result, so very different from No. VII, was occasioned simply by the addition of the minute portion of carbon.

X. Fifty grains of the same clay, mixed with 3 grains of chalk and 1 grain of carbon, yielded a mass half glass and half porcelain. The colour a deep black. The charcoal had entirely disappeared.

XI. Fifty grains of clay, 3 grains of chalk, and 1½ grain of carbon, yielded an unshapely mass, composed of very dark glass, and the mixture in a vitrified gritty state. A quarter of a grain of carbon remained untaken up.

XII. Fifty grains of vitrified Sturbridge clay pot, finely pounded, was mixed with 5 grains of chalk, and fused into a beautiful red spotted porcelain very much resembling some varieties of porphyry. The surface was more glassy than the fracture, shining, and covered with wavy and circular impressions. The colour was most probably owing to the oxide of iron contained in the chalk. The great difference betwixt this and the result of No. VIII, wherein the same proportions, but with raw clay, were used, and in which a black glass was obtained, might be owing to the absence of water, which in the former might tend to superoxygenate the iron. In the latter experiment the vitrified clay could contain little or no water; and if the affinity which clay is generally admitted to have for oxygen was exerted, the iron might in the last experiment be considerably deoxidated, and give the singular tinge of red to the whole mass.

XIII. Fifty grains of vitrified clay, 3 grains of chalk, and 1½ grain of carbon, were thoroughly mixed, and subjected to a heat similar to the former. The result was a convex button of glass, of a dirty blueish black colour. Upon breaking the mass I found it hollow, and entirely filled with a beautiful arrangement of a mixture of the carbonaceous matter and the residuum ash. The group was fibrous resembling down, and so extremely light as to ele-

vate

vate itself upon the slightest motion given to the glass. The quantity of carbon thus obtained weighed short of 1-8th of a grain. Upon examining the fracture of the glass I found its colour darken as it approached the cell where the charcoal was found, and neither so dense nor perfect as towards the surface or extremities of the mass.

It will appear, therefore, conclusive from these experiments, that carbon unites to Sturbridge clay either by cementation or fusion, and the quantities will be to the different states of the clay respectively as follows :

Raw Sturbridge clay in cementation causes to disappear $2\frac{1}{2}$ per cent. of carbon, and is thereby changed from a pale straw to a blackish blue colour. Experiments No. I, II, III, and IV.

Raw Sturbridge clay, fused by the assistance of chalk, causes to disappear $2\frac{1}{2}$ per cent. of carbon, and thereby changes its colour from a yellowish porcelain to a heterogeneous mass of black glass and gritty vitrified clay. Experiments No. VII, VIII, IX, X, and XI.

But as this clay was found to contain from 18 to 20 per cent. of water, it was probable that part of the carbon would be carried off by the water in the act of evaporation.

Vitrified clay was used, and a portion of charcoal disappeared in contact with it equal to $2\frac{3}{4}$ per cent., changing the colour from a kind of blood red to a blackish blue colour. Experiments No. XII and XIII.

XIV. One of Wedgwood's rolls, weighing 27 grains, was heated to 163°, and then weighed 20 grains. It was then put into a crucible filled with charcoal, and exposed for two hours to a stronger degree of heat. It was then found to weigh $18\frac{7}{4}$ grains. Its surface was entirely glazed, of a blackish blue colour. Its fracture presented a small ring of the same colour, proceeding from the circumference of the roll. The interior was pure white. The colour in no place exceeded the limits of the circle.

XV. A portion of very pure Cornwall clay was exposed in a crucible made of the same stuff, and, after a heat of 171° of Wedgwood, I found the clay loosely connected together, gritty, and easily pulverized. I returned it with a portion of carbon, and gave it the whole power of the furnace for half an hour. The result was a pulverulent mass of grayish gritty clay, in which the whole of the charcoal employed had disappeared.

XVI. Twenty grains of pure Cornwall clay, 11 grains of water, and 2 grains of lamp carbon, were formed into a small ball, which was dried, and afterwards exposed to a high

high heat. I found the ball vitrified throughout, and possessed of an uniform black fracture, slightly porous from the excessive heat. A fragment of raw clay, weighing 15 grains, was placed at a little distance from the ball in the same pot. It was found perfectly vitrified and glazed, in the same manner as the roll in Experiment XIV. The coloration had penetrated a considerable way further towards the centre of the piece than in the case of the roll, probably owing to the spongy texture of this clay in its native state. The ball weighed, after being exposed, 17 grains; being five less than the weight of the clay and carbon. The mass of clay $12\frac{3}{4}$ grains, being $2\frac{1}{4}$ less than when introduced. The quantity of water in the clay being nearly 15 per cent.

XVII. Fifty grains of raw Cornwall clay were mixed with 5 grains of chalk, and fused into a button of beautiful white porcelain. The colour of the fracture was uniformly pure throughout.

XVIII. Fifty grains of the same clay, mixed with 5 grains of chalk and half a grain of lamp carbon, formed by fusion a very perfect glass of considerable density. The colour was light lead-blue, and possessed considerable transparency.

XIX. Fifty grains of Cornwall clay, 5 grains of chalk, and 1 grain of carbon, afforded by fusion a glass of a darker colour than the former, but not so perfect, arising from an apparent extra dose of carbon. The charcoal, however, had disappeared, and from the increased colour of the glass its combination was obvious.

XX. Fifty grains of Cornwall clay, 5 grains of chalk, and $1\frac{1}{2}$ grain of carbon, yielded a porous mass of porcelain of a very dark rusty black colour. The whole of the carbon disappeared.

XXI. The same experiment repeated with the addition of half a grain, or in all 2 grains of carbon. The result was a semi-fused mass of vitrified matter, the fracture of which resembled porcelain. The colour was darker than in No. XX, and $\frac{1}{4}$ grain of carbon remained untaken up.

XXII. Cornwall clay, vitrified in 168° of Wedgwood: 50 grains of this, finely pounded, were mixed with 5 grains of chalk, and fused into a primrose-coloured porcelain glass. This result differs as much from No. XVII, wherein the same proportion of mixture was used with raw clay, as No. XII did from No. VII, in the experiments with Sturbridge clay. The latter contained from 18 to 20 per cent. of water, the former about 15.

XXIII. Cornwall clay, vitrified, 50 grains, mixed with 5 grains of chalk and 1 grain of carbon, yielded by fusion

a very

a very perfect dark lead-blue glass. The carbon had entirely disappeared.

XXIV. The same proportions of vitrified Cornwall clay and chalk, were exposed in the furnace, intimately mixed with $1\frac{1}{2}$ grain of carbon. The result was a mass of very fine porcelain minutely porous, of a dull blackish lead colour. No remains of carbon were visible.

XXV. Fifty grains of the same clay, mixed with 5 grains of chalk and 2 grains of carbon, were fused into a spongy mass of very black porcelain, somewhat tinged with blue. A few flakes of carbon were found upon the surface of the product, mixed with some snowy white flowers supposed to have come from the residuum ash of the carbon. As soon as the cover was broken from the crucible, they began to elevate themselves, and float lightly about.

The same experiments were performed with a fifth in place of a tenth part of chalk to clay; and similar results, but more fusible products, obtained. One deduction only, different from the others, I was able decidedly to make,—that the addition of from 1-50th to 1-100dth part of carbon, when a fifth of chalk was used, increased the fusibility of the mixture from 168° to 152° of Wedgwood.

It appears therefore generally conclusive, that carbon unites to Cornwall clay either in cementation, (see Experiments No. XIV, XV, and XVI,) or in fusion, and probably in a much greater proportion, changing the colour of the products from milky white, through various shades of lead blues, to black: increasing the fusibility with small portions, and changing porcelain to glass: then again retarding the fusibility when an extra quantity is used, and destroying the perfection of the glass, and producing a spongy porcelain. The greatest quantity united, or which disappeared in the experiments with raw clay, amounted to $1\frac{3}{4}$ grains to 50 of clay, or $3\frac{1}{2}$ per cent., No. XXI. But as Cornwall clay contains nearly 15 parts of water in 100, vitrified clay was used, and the experiments with it indicated an absorption of carbon equal to 4 grains in the 100, or 1-25th part the weight of the clay No. XXV.

XXVI. A portion of pure clay was taken, and, after being introduced into a crucible made of Cornwall clay, was exposed for an hour to the greatest heat of a furnace 8 inches square, with a chimney 48 feet in height. The crucible was found considerably furrowed on the sides, but quite erect. The clay remained pure and unchanged, but much reduced in bulk. It, however, possessed a roughness and asperity which it had not before its introduction.

XXVII.

XXVII. Fifteen grains of pure clay were mixed with $\frac{1}{4}$ of a grain of carbon, and exposed for an hour to a heat of 165° of Wedgwood. I found the clay quite unaltered as to colour. The charcoal had glazed the interior of the crucible in place of uniting to the pure clay. This led me to infer that the combination of carbon was not in the ratio of the absolute temperature, but in the ratio of the fusibility of the mass. In all these experiments I found that carbon united with Sturbridge clay at an inferior temperature to that at which it combined with Cornwall clay, the fusibility of the former being much greater than that of the latter; and I found it quite impossible to colour pure clay by the most minute particle of carbon. In place of 15 grains, I found the product only weighed 7. Lost 8 grains of water.

XXVIII. Twenty grains of pure clay were exposed to 166° of Wedgwood, and then found to weigh only 8 grains. This was mixed with 2 grains of pure lime and half a grain of carbon, and an imperfect reduction obtained. The mass was only partially vitrified.

XXIX. Twenty grains of pure clay and 5 grains of pure lime were intimately mixed and exposed. The result was a very perfect glass arranged in detached irregular columns or crystals upon the bottom of a Cornwall clay pot. The purity of these masses was entire. The colour generally whitish, but in some places tinged with pale yellow.

XXX. Twenty grains of pure clay, 5 grains of pure lime, and 1 grain of carbon, were exposed for an hour; when I obtained a small flat button of earth, hollow in the centre and entirely black upon its upper surface. It, however, contained a portion of the clay and lime, white, and rough as if granulated. In a few places, symptoms of vitrification and glass were evident. The charcoal had disappeared, and the interior of the pot remained unglazed. In point of weight, the whole mass was reduced to a fraction more than ten grains.

XXXI. Twenty grains of pure clay, 5 grains of pure lime, and 2 grains of carbon, formed by fusion a rough half-softened mass of an uniformly black colour. The charcoal was all united to the clay; but a small portion of the mixture, in a pulverulent form, and of a gray colour, remained unfused, which indicated a saturation of the carbonaceous principle, first manifested in excess by retarding the fusibility of the mixture.

It would appear from these experiments, that pure clay causes to disappear a quantity of carbonaceous matter equal to 1-10th part of its weight; but as the clay operated upon contained

contained nearly 6-10ths its weight of water, I deemed it necessary to prepare a few experiments with clay dried in a heat of 165°, and used almost immediately when taken from the crucible.

XXXII. Twenty grains of pure clay thus prepared were mixed with 1-4th its weight of pure lime, and exposed in a Cornwall clay crucible to 170° of Wedgwood. The result was a partially coagulated mass, slightly adhesive, granulated, and resembling very fine silex. The want of fusion in this experiment arose from the extra quantity of real clay introduced by means of depriving it of its water.

XXXIII. Twenty grains of the same clay, mixed with 10 grains of pure lime, were fused into a transparent globule of glass of a milky white colour.

XXXIV. This mixture, fused with 1 grain of carbon, yielded a fine glass of a blueish crystal colour. The charcoal was most evidently united in the mass, which exhibited a cloudy water, as if the glass had inclosed a fine charcoal-coloured vapour. This so completely deceived me, that I broke the glass with a view to liberate it, but found it dense and solid throughout.

XXXV. Twenty grains of pure clay, 10 grains of pure lime, and 2 grains of carbon, were intimately mixed, and fused into a black porcelain mass. The surface was dull and earthy, but the fracture possessed considerable lustre. Half a grain of carbon remained untaken up; so that $1\frac{1}{2}$ grain had united to the mass in fusion. It may therefore be concluded, that pure clay deprived of all moisture, reckoning the calcareous earth to have been neutral, absorbs $7\frac{1}{2}$ per cent. of carbon, or betwixt 1-13th and 1-14th part its own weight.

An abstract of the quantities of carbon united to the different substances now operated upon in one fusion, will stand thus:

Sturbridge clay, vitrified, absorbs of carbon			$2\frac{3}{4}$ per cent.
Cornwall	ditto	ditto -	4
Pure clay dried in a heat of 165° Wedg.			$7\frac{1}{2}$

It is further probable, that were the products thus obtained by single fusion reduced and re-fused, with additional doses of carbon, that a still greater combination of carbon would take place, and a greater alteration upon the results ensue.

I shall conclude this branch of the inquiry with the following remarks:

1st, The combination of carbon with clay uniformly tends to form a black porous porcelain, sometimes resembling

bling the coarsest lavas or cinders that come from the blast-furnace.

2d, From this circumstance I would endeavour to explain in part a chief constituent in the *scouring* cinder of the blast-furnace, not hitherto explicable upon common grounds. When these circumstances unite to produce this cinder at the furnace, it flows copiously of a black spongy texture, frequently igniting sparks resembling the deflagration of carbon. The quantity of iron, which has hitherto been deemed its colouring principle, seldom exceeds 3 per cent., and always appeared to me to be inadequate to explain the uncommon appearance of the cinder. Upon the grounds of clay absorbing carbon, it is easy to suppose, should any circumstance occur in the smelting process to establish an extra share of affinity betwixt the argillaceous matter of the ores and the carbon of the fuel, that a considerable portion of the latter will unite to the former, and change the colour and form of the lava. The crude iron then will become decarbonated, as a consequence of this affinity. It will be deprived of its necessary share of fuel, become inflammable, and oxidate before the blast. The iron thus debased will unite to the general current of lava, and account for the portion of iron which such cinders generally contain. This explanation is the reverse of what could be formerly advanced; for the scouring or running of a black porous cinder could only be attributed to the combustion of the iron by some more remote cause.

3d, The affinity or tendency which carbon has to unite with clay is so great, that 1-300dth part of the former produces the most striking varieties in the result. In many other experiments, not particularized here, I found that even 1-800dth part of carbon produced an effect upon the product, as to density, colour, and transparency. This being the case, may there not exist similar unsuspected affinities betwixt iron and clay, and betwixt oxygen and clay, even in the process of smelting? and may not these be productive of permanent effects upon the quality of the manufactured iron?

4th, I had frequently occasion to notice, in the course of performing these experiments, the strength of affinity existing betwixt carbon and the different clays. In one experiment, wherein pure clay and carbon were exposed in a Cornwall clay crucible with a Sturbridge clay cover, I remarked that the pure clay was equally so as when introduced; but the interior surface of the crucible was covered with a light blue glaze, while the top of Sturbridge clay

was

was of a dark colour inclining to black. The charcoal which was introduced along with the argil had disappeared; but the sides and cover of the pot, being composed of clay which in the same temperature had approached more nearly to fusion, had attracted the carbon, from its simple mixture with the argil, and became united to it by a regular process of cementation.

[To be continued.]

X. *A Case of Typhus Fever cured by the Use of Yeast.*

To Mr. Tilloch.

SIR,

If you think the following history of the cure of a typhus fever by the use of yeast, worth inserting in your Journal, it is at your service.

A young gentleman, about thirteen years of age, was sent home sick from school. The physician who attended the family was sent for immediately; he thought it a trifling complaint, and that the child would be well again in two or three days. The next day, however, he found him worse: the throat began to ulcerate, and his pulse was very quick. He now began to think the disorder was of a serious nature. The third day he declared him to be in imminent danger: his pulse was still quicker, his mouth and fauces so ulcerated that it was with great difficulty he could be made to swallow any fluid; and blood began to exude from his eyes, nose, and ears. On the fourth day the symptoms were all worse, and his neck was swelled to the level of the chin; he had so much anxiety that he had obliged the nurse to remove him continually from one bed to the other, there being two in the room; such a quantity of blood was discharged from his ears, that they were obliged to change the pillow-cases frequently; his pulse was at 140, and the stench of his chamber was intolerable: finally, the physician declared he could not possibly live forty-eight hours, and that it was not probable he would live twenty-four.

At this period, one of the principals of the family recollected having read of the wonderful powers of yeast in curing putrid fevers, and thought he should be perfectly justifiable in superseding the medicines which had no effect, and giving the yeast a trial. Some was immediately procured, and, being diluted with warm water and coarse sugar, was with great difficulty conveyed to the fauces with a spoon: he he presently found himself refreshed, grew calmer, and all the threatening symptoms began to abate.

The next day, when the physician came, expecting to find a corpse, he was struck with astonishment: his pulse was already reduced from 140 to 100 strokes in the minute; the ulcers had put on a more florid appearance; he was perfectly tranquil; and the discharge from his eyes, nose, and ears, considerably diminished. The yeast was continued, and he recovered as rapidly as he had fallen sick—so as, in a few days, to be perfectly well.

I have only further to observe, that, as they got a pail of fermenting wort into his room and skimmed the yeast off occasionally, the precise quantity he took cannot be stated; but it is estimated that he took three or four table spoonsfull of pure yeast in twenty-four hours. It was so far from affecting the bowels, that it was found necessary to administer some opening medicines while he was taking the yeast.

If any persons wish to be further informed, I will give them a reference to the parties, who are people of considerable notoriety in the city.

I am sir, your humble servant,

Grocer's Hall Court, J. Heath.
March 20, 1804.

XI. *On the best hitherto known Methods of purifying Cobalt and Nickel from Bismuth, Arsenic, Iron, and Copper, which in general accompany these Metals; but particularly on the best Methods of separating Cobalt from Nickel, or Nickel from Cobalt, in the large Way. By Dr.* Richter *.

Every practical chemist so well knows how difficult it is to obtain cobalt and nickel free from other metals, that it is not necessary to say any thing concerning it. The author of this paper is well known as an able chemist, and his situation as director of the manufactory of colours for the royal Berlin porcelain manufactory, has enabled him to experiment upon the subject in the large way. Our present object is to give the results, which, no doubt, will be acceptable to those who are concerned in similar undertakings. We shall therefore give an abstract of his paper, which is as follows:

Let the pulverized ore of cobalt be repeatedly roasted

* From Gehlen's *New Journal of Chemistry*, vol. ii. part 1. p. 61.

 with

with charcoal powder until no more arsenic (or at least very little, for it is impossible to free it wholly from arsenic and sulphur,) or sulphur is volatilized. Upon the ore thus partly desulphurated, &c., pour 2-3ds of its weight concentrated sulphuric acid previously diluted with double its quantity of water: heat the mixture in earthen pans placed on a sand-bath nearly to the boiling point, and add to it gradually nitrate of potash till no further action takes place, or till no more red vapours are disengaged. This being done, evaporate the whole to dryness, and heat the dry mass strongly; a new disengagement of red vapours again takes place; keep up the heat till no more red fumes are evolved. The heated mass must then be thrown into water, and its soluble part washed out by the repeated affusion of this fluid. The insoluble residue is to be treated in a similar way till the residue consists of nothing else but part of the matrix of the ore.

The before-obtained solution, after having been suffered to subside, must be decanted or filtered, and mingled with a solution of carbonate of potash. By this means the bismuth and a considerable quantity of iron (frequently also arseniate of iron) become separated; sometimes also copper and nickel, in combination with arsenic acid. The colour of the precipitate cannot be determined, for it differs according to the nature of the ore.

The fluid may now be examined for copper. If a polished cylinder of iron, after having been immersed in the solution, acquires the slightest reddish hue, copper may be suspected. It is, however, not advisable to separate the copper by iron; for part of the cobalt would also be precipitated in combination with the copper, and a loss would thus be occasioned. It is therefore more profitable to decompose the whole solution at once by carbonate of potash. The precipitate obtained must be washed, dried, and sublimed with muriate of ammonia.

If the cobalt is contaminated with a small quantity of copper, that part of the sublimed muriate of ammonia which escapes undecomposed elevates all the copper, and the sublimate has a blueish colour. If a larger quantity of copper be present, the sublimation must be repeated successively until the last sublimed muriate does not show any vestige of copper by the usual tests.

The cobalt thus purified from copper (if it contained any) may again be dissolved, and the solution decomposed by carbonate of potash; taking care to add the alkali in excess. The precipitate obtained is to be digested in a solu-

5 tion

tion of carbonate of potash; or this trouble may be saved by adding to the precipitated solution a considerable quantity of carbonate of potash, and then suffering the whole mixture to boil for some time: we are now sure that the difficultly soluble arseniates, if any were present, are decomposed and got rid of.

In order to know the nature of the precipitate, let a portion of it be neutralized with sulphuric acid; mingle the solution with sulphate of ammonia, evaporate the fluid, and suffer it to crystallize. From the colour of the crystallized salt, the experienced operator may form already some judgment of what his precipitate principally consists: if, namely, the crystals have a greenish colour, he is sure they contain nickel. In that case, it is necessary to redissolve and recrystallize them till they acquire a red colour. Should it, however, happen that during the repeated solution and recrystallization the salt acquires a more lively green colour, and that the noncrystallized fluid or mother-liquor acquires a more lively red colour; in that case his principal object should be directed towards the direct separation of the nickel from the solution. For that purpose, let the whole remaining solution be divided into four equal parts; neutralize one part by sulphuric acid, and note the quantity of acid which was necessary for that purpose, in order to learn the quantity required for the rest.

To save, however, the expense of the direct application of sulphuric acid, it is more œconomical to convert the quantity of sulphuric acid necessary for the saturation of the precipitate into sulphate of ammonia, by making it act on muriate of ammonia. The muriatic acid, though not wanted in the process in view, and the sulphate of ammonia which will thus be obtained, will amply repay the expense incurred.

The sulphate of ammonia must be dissolved in water, and the before-obtained precipitate digested in this solution. If the whole precipitate should not become dissolved, sulphuric acid may be added to effect a solution. This, however, will be seldom found to be the case. Should the solution be turbid, suffer it to stand undisturbed to subside; for it may happen that a minute quantity of arseniate or oxide of iron, or both, becomes deposited, which is in proportion to the care with which the operator has conducted his former processes.

The clear fluid must then be evaporated at a low heat till a considerable pellicle appears, and then suffered to cool:

 green

green crystals of nickel will then be obtained, which prove that this metal was present in a considerable quantity; whereas, on the contrary, the crystals are of a reddish hue. Remove the crystals, and let the fluid be repeatedly evaporated and crystallized till the last crop of crystals are red. The remaining fluid then contains no more nickel; it may therefore be crystallized.

The obtained crops of crystals, which are more or less of a beautiful red, should be put together, redissolved, and recrystallized repeatedly, till a new crystallization does not increase their beauty.

The obtained green crystals of nickel are treated in a similar manner till their green colour does not become more lively by a fresh crystallization. These tedious processes of crystallization may be considerably shortened if the operator picks his crops of crystals, or sorts and dissolves them accordingly.

The cobaltic solution of nickel, or the solution of nickel soiled with cobalt, as it may be called, according to the nature of the solution, may be purified respectively by sulphate of ammonia and subsequent repeated crystallizations; a process which can by far more easily be adhered to in the large way than any of the methods now made use of. I need hardly mention that both the salts may be decomposed by carbonate of potash, and the carbonate of nickel and carbonate of cobalt be reduced in the usual way.

XII. *Fifteenth Communication from Dr.* Thornton, *relative to Pneumatic Medicine.*

To Mr. Tilloch.

May 20, 1804.
No. 1, Hind-street, Manchester-square.

SIR,

The following is an account of the efficacy of the oxygenated marine acid gas in a case of chlorosis or green sickness; and I have not any additional information to add, although the cure was accomplished in the year 1795, because my success in such disorders has been uniform with the simple oxygen gas or vital air, properly diluted, aided by tonic medicines; and this gas has little or no irritating effect upon the lungs, which the other gas, if not properly diluted, undoubtedly has; and it is the part of the prudent physician to apply the mildest means, when these are generally found to answer.

Letter

Letter from JOHN BIGGS, *Esq. to Dr.* THORNTON.

SIR, Iping, near Midhurst.

In answer to your letter I need not inform you that I have a patent for the bleaching of paper, which is accomplished by means of the superoxygenated gas, which has the power of rendering the darkest paper a fine white, taking out all colour. I have had paper which was mildewed in going to India, completely restored by this air; which circumstance has given considerable profit to the traders to the East. Discoloured and mildewed prints are restored by the same means. Mr. Splilsbury, printer, had Milton's Paradise Lost, a fine copy, much mildewed, perfectly recovered. Books discoloured by age are rendered beautifully white by this process. As I make no secret of it, I shall just mention, that the articles are inclosed in a wooden receiver made of deal, dove-tailed, and the inside set with large panes of glass fastened together by filling any interstices with slips of wood. Manganese powdered is then used, with salt and vitriolic acid, and these are placed in an earthen retort in a sand heat, and, communicating by pipes with the boxes, disengage in them the oxygenated gas. When the bleached paper is taken out, after an hour or less, much of the gas, of course, is distributed in the apartment. The persons employed in this process enjoy excellent health; one man and two women have worked four years with me, and have had uninterrupted health. I observe myself, that after breathing this gas diffused in the room, I always experience a greater warmth on that day, with an increased appetite. My work-people make the same observations.

The case you particularly inquired after, was that of a young woman, aged 17, excessively pale, and so delicate a skin that you might see through her fingers; teeth a pearly white, lips the colour of her complexion, breathing very short, a violent cough, and great expectoration; body much reduced; steel, &c. had been used in vain, and the faculty with us supposed she would not recover. When she came to work in my manufactory, my people told her she would soon get well from the steam let out of the boxes: and instead of her breathing getting worse, as some might expect, it was greatly relieved; her appetite came round; her complexion soon was rendered ruddy; nature assumed all her proper functions; the cough left her; and she has continued to work in my manufactory more than a twelvemonth, and enjoys a very excellent state of health.

I have the honour to be, sir, with great respect,

Your obedient humble servant, JOHN BIGGS.

Observations on this Case by Dr. THORNTON.

I. Chlorotic consumption, even oftener than any other, proves fatal from the pernicious treatment of this disease, as considering it a true consumption, and lowering the patient. It arises from a defective oxygenation of the blood.

II. Steel gives the blood more power to abstract oxygen, and form of it one of its component parts: hence the benefit of this remedy. Tonics do the same, but in a less degree.

III. That the superoxygenated marine acid gas imparts oxygen to the blood, or animal fibre, is shown by Girtanner (*vide* Beddoes' translation), who thinks that no substance imparts more of this principle; and hence, when concentrated, as in the superoxygenated muriatic acid, its most powerful effects; when having acted on the animal fibre, it is no longer superoxygenated: hence in the form of gas, probably, the oxygen is in a similar manner, though in a less degree, imparted to the blood or animal fibre.

IV. As this air may require more caution than in accidental admixture with common air in an apartment, much good may hereafter be derived from it under a prudent administration. *Sed ars longa, vita brevis,* as Hippocrates observes, and the strong prejudices against aërial remedies still exist.

XIII. *Description of Mr.* WILLIAM BOWLER'S *improved Churn*.*

FOR this improvement, thirty guineas were voted to the inventor, by the Society for the Encouragement of Arts, Manufactures, and Commerce, which has one of the churns reserved in its repository for the inspection of the public.

The churn itself is of the barrel kind, being a cylinder eighteen inches diameter and nine inches wide, the sides wood, and the rim tin plate, having two openings; the one, eight inches and a half long, by four inches wide, through which the cream is put into the churn, and the hand introduced for cleaning it; the other, a short pipe one inch diameter, by which the butter-milk runs out of the churn when the operation is finished. The first of these openings

* From the *Transactions of the Society for the Encouragement of Arts, Manufactures, and Commerce,* vol. xiii.

openings has a wooden cover, fastened down by two screws, and the other a cork fitted to it, while the butter is churning. There is also, near the larger opening, a small vent-hole with a peg, to allow a passage for any air discharged from the cream at the beginning of the operation. An axle passes through the churn, terminating in two gudgeons on which it hangs, its lower part being immersed in a trough, to occasionally hold hot or cold water according to the season of the year; and on the inside of the rim are four projecting pieces of wood, with holes in them, serving to beat the cream by the motion of the churn: this motion is caused by a pendulum, three feet six inches long, having an iron bob weighing ten pounds, and at its upper end turning a pulley ten inches diameter, from which goes a rope twice round another pulley, about three inches diameter, fixed on the axis of the churn, and causing it to make a partial revolution by each vibration of the pendulum. There are sliding covers to the machinery, and also a cover to the water-trough, in order, when the hot water is used, to secure the steam, and keep the cream in a due and necessary degree of warmth. The motion of the pendulum is given and kept up by a wooden rod, about three feet nine inches long, turning on a pin about three inches above the bob of the pendulum.

A Front and Side View of this Churn is given on Plate I.

A, A, the body of the churn.

B, an opening, by which the cream is put in.

C, the cover of the large opening. *c*, the small hole on the opposite side of the churn, by which the butter-milk is poured out.

D, the gudgeon on which the body of the churn hangs.

E, E, the upper or larger pulley. The screw *e* tightens the band which goes round

F, F, the smaller pulley, fixed on the axis or gudgeon of the churn.

G, G, the rod of the pendulum hanging from the upper pulley E.

H, H, the bob of the pendulum.

I, the handle, moveable on a pin at *a*, by which the pendulum is moved to and fro, making a traverse, in form of the dotted line K, K.

L, L, L, the trough for the hot or cold water.

M, a rest for the handle when the churn is not at work.

XIV. *Re-*

XIV. *Report made to the Class of the Physical and Mathematical Sciences of the French National Institute, by* C. Ramon, *respecting a Memoir of* C. Daubuisson *on the Basaltes of Saxony**.

C. Haüy and myself have been charged to give an account to the class of a very long and circumstantial memoir of Daubuisson on the basaltes of Saxony, accompanied with observations on the origin of basaltes in general. It is well known that the question respecting the origin of basaltes has excited many disputes and discussions among naturalists. It is, however, among the small number of substances which it is impossible to mistake in the antient mineralogy. Pliny and Ptolemy give this name to the *lapis Æthiopicus* of Herodotus and Strabo; a stone which was found in Upper Egypt, on the frontiers of Ethiopia, and which, according to the latter author, appeared always under a regular form. According to their description, it was of the colour and hardness of iron; it was employed in different works of sculpture, and particularly for making mortars. No object of natural history has been described with more precision by the antients; and a great number of works of this basaltes, still preserved, afford us the means of fully examining the nature of it.

Dolomieu, to whom we are indebted for these details, examined the antique basaltes with great care. He found in it what is called schorl *en masse*, hornblend, trapp, petrosilex, granitella composed of feld-spar with grains more or less perceptible, and scales of schorl: he found the component parts vary in their volume and proportions, and in the same masses veins and spots of granite on the smooth black ground of the stone: he therefore declares, with every assurance of conviction, that basaltes is not of volcanic origin.

Twenty years before, our fellow-labourer, Desmarets, made similar observations; and he deduced exactly the same consequences, describing under the name of *gabbo* the amphibolic stones which Dolomieu calls hornblende and schorl *en masse*.

The idea of the volcanic origin of the antient basaltes, continues Dolomieu, arose from the physical constitution of Italy, where people must have been gradually accustomed to consider all stones not calcareous, and of a black-

* From the *Annales de Chimie*, No. 137.

ish

ish colour, as produced by fire. In the time of Adrian the Egyptian statues were repaired and imitated with certain kinds of compact lava, which had nearly the colour, the grain, and hardness, of basaltes. Basaltes, then, was considered as compact and prismatic lava; and foreign mineralogists received this opinion on vague analogies, and at first without examination. Let us therefore do justice to Dolomieu, who from fragments of a rock, the position of which is unknown, conjectured in part what could have scarcely been determined by thirty years discussion in regard to the basaltes of Germany; and let these abuses of analogy, inseparable from the progress of the human mind, explain better the errors into which respectable naturalists may have fallen, than a fondness for the marvellous, of which the author of the memoir accuses those who do not participitate in his sentiments; as before him, and in similar circumstances, M. Noze was not afraid of making the same accusation against the celebrated and judicious Saussure.

From these considerations, Dolomieu wished that a more precise nomenclature might put an end to the numerous ambiguities which the word *basaltes* had occasioned. He confined this denomination within its antient meaning, and extended the name of *lava* to that even which affected prismatic and globular forms, when the fire had imprinted on it the character of its action. Being at length convinced, by long observation of the principal volcanoes in Europe, that a stone may have been in a state of fusion without experiencing in its contexture any sensible alteration, he was of opinion that nothing but actual inspection could dissipate the doubts on this subject; and by readily allowing that the black prismatic trapp of Saxony, as well as that of Sweden and Scotland, are products of the moist way, he asserted that those of the Vivarais and Sicily were productions of fire.

Such, thirteen years ago, was the opinion of the ablest of our geologists; a naturalist who spent a part of his life amidst volcanoes. He published it in the *Journal de Physique* for the year 1790, in consequence of the accounts transmitted to him of the labours and ideas of the most celebrated mineralogists of Germany. If it be true that this grand observer, brought up, in some manner, in the domain of fire, extended the limits of it too far, even when he imagined that he had confined them within too narrow a compass, can we believe that his adversaries, placed in a quite opposite situation, should have been less carried away by the

the seductions of analogy, and that their general conclusions should never show any traces of the influence of the places which have been the principal object of their study?

The basaltes of the north was unanimously considered as of volcanic origin, when Bergman, having made a comparative analysis of the basaltes of Staffa and the trapp of Hunneberg, found them to be composed of the same principles*. From the result of this analysis he was led to doubt that the former was the immediate product of fire. This fact, which, in the opinion of Dolomieu, would prove nothing, had a strong influence on that of the German mineralogists; and the basaltes of their country was examined under a new point of view. Several of the most illustrious, at the head of whom was the celebrated Werner, were soon persuaded that the basaltes of Saxony, Hesse, and Bohemia, were of aqueous origin. Among the motives which determined their opinion, two observations, to which it was impossible to make any objection, have long been remarked: 1st, The position of an immense stratum of basaltes on a stratum of coal, which is not altered; 2dly, The gradual transition of wacke into basaltes, and of the latter into granitella, which is known to the Germans under the name of *grunstein*. The last observation, though in other terms, is exactly that which determined Dolomieu to consider the basaltes of Ethiopia as the production of water. In a word, however decisive these observations may appear, they are far from having terminated the dispute. The learned in Germany were divided into two very animated parties, *Volcanists* and *Neptunians*; and these denominations, which may appear a little more pompous than the subject requires, did they not refer to the importance of the contested ground, prove at least the value which each attached to victory. It is on this ground, even, on which the Neptunians defied their adversaries, that the Volcanists thought they should be able to retort their proofs against themselves. The wackes, according to them, belong to muddy eruptions; cellular basaltes is porous lithoid lava; they point out the craters and cavities from which these currents have issued: and lately, M. Voigt, in examining the stratum of coal which the flowing of the basaltes has covered, analysed it with a great deal of address and ingenuity, to prove the different alterations produced in it by heat †. We shall not speak here of the German mineralogists mentioned by Dau-

* Haüy Traité de Minéralogie, tom. iv. p. 479.

† Mineralogische Reise, Weimar 1802.

buisson;

buisson; but we must add that C. Faujas visited also the Meissner, and persists in his opinion of the volcanity of its basaltes.

It must, however, be confessed, that the longer this discussion is continued, the less the proofs of the Volcanists seem to prevail over those of their adversaries; at least in what concerns the basaltes of Saxony. Several distinguished mineralogists have successively appeared in the field of the Neptunians: they reckon Klaproth, Kirwan, and many others among their conquests; and it is at this moment, when the balance inclines in their favour, that C. Daubuisson, a distinguished pupil of M. Werner, and educated in the sentiments of his school, presents the motives of an opinion become very general in Germany and England, and supported by the result of his own observations.

The memoir of C. Daubuisson is divided into five very long articles or chapters, accompanied by a great number of notes, and considerably enlarged by observations on mount Meissner, which he considers as the most interesting of the basaltic mountains he ever saw.

The author employs the first chapter to determine with precision what he understands by the word *basaltes*, and by the expression *volcanic productions*.

He describes then the basaltes, and justly remarks that this stone highly characterized, and always similar to itself, whatever may be the region from which it comes, is exactly that to which the antients gave this name. Its most striking properties are, a grayish black colour, a dull and generally fine-grained fracture, a specific gravity about triple that of water, and a manifest action on the magnetic needle. Its masses, for the most part, are divided into prisms, sometimes into plates, and sometimes, but more rarely, into balls with concentric strata. Certain varieties present cavities more or less numerous, as if produced by bubbles: when subjected to the action of fire, it is converted into glass of a brownish or greenish black colour; but this glass, when again fused and slowly cooled, reassumes a stony appearance, according to the results of the ingenious experiments of Sir James Hall. The author then mentions and compares two analyses made by Klaproth and Kennedy, which correspond very well. Silex, alumine, and iron, predominate among the constituent principles. There are found also a little muriatic acid, soda, and a small portion of water. Klaproth discovered also carbon.

The author then proceeds to a definition of volcanic productions. He confesses that he never saw a volcano, but he he declares that he will comprehend among their productions those substances only *which have been completely fused and altered by subterranean fires, and which a volcanic eruption has afterwards conveyed to those places where they are found at present*; that is to say, substances similar to those thrown up in our days by Ætna and Vesuvius. In regard to the testimonies which might be deduced from the real or supposed existence of extinguished volcanoes, he rejects them, because their existence, he says, is a matter of dispute. C. Daubuisson, therefore, will not easily be convinced by the experiments of Sir James Hall, which prove that gradual cooling may restore a stony appearance to fused and vitrified rocks: consequently he will be under no embarrassment from that lithoid lava, which, according to Dolomieu, cannot be distinguished, but by its position, from analogous stones which have not been subjected to the action of fire: to explain the latter, therefore, he will have no need of recurring to another mode of fusion, another degree of heat, than that which has given its form to common lava. He rejects all these suppositions, as so many hypotheses, invented without any foundation, to explain facts which are themselves hypotheses. It may be readily perceived that to lay down the question in this manner is to determine it beforehand, since the whole is then reduced to basaltes, and that it would be sufficient to prove that this basaltes has none of the characters which distinguish lava, whose origin is beyond dispute. It will, however, be found that the author does not always adhere to this negative kind of proof.

In the second chapter, C. Daubuisson proceeds to a general and particular description of the basaltic chain of Saxony. This part of his labour deserves great praise, on account of the method which prevails in it, and which it is much to be wished were to be found in the works of other geologists.

The chain which he describes, remarkable for the great number of veins it contains, is called the *Erz-Gebirge*, or metalliferous chain. It separates the electorate of Saxony from Bohemia, and runs north-east for the extent of about 130 miles. The maximum of its elevation is about a thousand yards above the plains of Saxony, or from eleven to twelve hundred above the level of the sea. Its nucleus is granite; but this rock is almost entirely covered with strata of gneiss, micaceous and argillaceous schist. There are found in it also serpentine quartz, calcareous strata, coals, and clay. The whole of the eastern part is covered towards the north with an immense bed, no less extensive, of free-stone.

It is on the ridge of this chain thus constituted that the basaltes is placed in the form of cones, domes, and plateaux. It forms about twenty summits, sometimes insulated and sometimes connected by their sides to the neighbouring mountains. All these basaltic summits, however, taken together, do not form the sixteenth part of the whole chain crowned by them.

C. Daubuisson describes separately about a dozen of summits.

1st, The *Scheibenberg* rises under the form of a very irregular truncated cone. The body of the mountain consists of gneiss, having above it micaceous and argillaceous schist, covered by horizontal strata of gravel, fine sand, and clay. The basaltic bed, which is about 250 yards in length, and from 80 to 100 in thickness, rests upon the latter strata. The basaltes is divided into vertical irregular prisms with blunt angles. It is of moderate hardness; contains a great number of small crystals of amphibolite, and some grains of peridot, or the olivin of Werner. Several galleries have been cut out under this bed. Fifteen years ago, M. Werner found here a stratum of wacke, on which the basaltes was immediately placed; and he asserts that these two rocks formed a transition into each other by gradual shades. It was on occasion of this discovery that the celebrated professor of Freyberg published for the first time his ideas on the origin of basaltes.

2d, The *Pochlberg* is also a truncated cone, and the body of the mountain consists of gneiss. It is covered in the same manner towards the top with gravel, fine sand, and clay, above which arises a large bed of basaltes. The latter is 540 yards in length, and about 54 in thickness. It is divided into irregular prisms, and in its nature differs very little from the preceding.

3d, The *Baerenstein* is also composed of gneiss, and covered with a thin stratum which supports the mass of basaltes. This mass is from 87 to 108 yards at least in thickness. It is divided into large irregular pillars of considerable length. The basaltes is of the same nature as the preceding.

4th, The *Heidelberg* is to the top formed of gneiss, which passes to the state of micaceous schist. But in one of the flanks there are two groups of prismatic basaltes a little divergent. This basaltes is black, compact, contains some grains of olivin, and in its cavities a kind of marly earth.

5th,

5th, The *Lichtewalde* is the object of more important considerations. The body of this mountain is composed of large-grained reddish granite. It is terminated by a mass of basaltes not less perhaps than 200 yards in thickness, and about 1000 in diameter. It is not easy to determine whether it be divided into prisms. It is of a grayish black colour; some blocks of it are entirely pierced with tortuous cavities. These are lighter, and have less hardness than common basaltes. But what in particular distinguishes the basaltes of this mountain is the quantity of beautiful olivin which it contains. It appears in irregular morsels sometimes larger than the fist.

6th, The *Steinkopf*, an oblong mountain the base of which is of gneiss, and the upper part of porphyry, a *pâte argilleuse rouge*. On the back of the porphyritic part is found a basaltic summit divided into prisms, which contains a cavity two or three yards in depth and about four in diameter, the sides of which are composed of prisms, that proceed diverging like the radii of a hemisphere the centre of which is in the middle of the depression. The basaltes here is very hard, and of a dark colour. It contains a little olivin, and grains of magnetic iron ore.

7th, The *Landberg* is gneiss, covered on the side with argillaceous schist and porphyry, having a base of compact feldspar: over this porphyry is extended a stratum of gres which supports the basaltes. The latter is divided into plates; but this division ought not to be considered as the work of stratification. On the eastern declivity of the mountain is a small cavity three yards in depth and two and a half in breadth. This has been considered as the crater of a volcano. This hole exhibits only fragments of basaltes, and an earth somewhat rough to the touch, which results from the imperfect decomposition of some parts of the same rock.

8th, *Ascher-hugel* is a small eminence of gres, the ridge of which is formed by a thin stratum of basaltes divided into irregular vertical prisms. In some of this basaltes the author found fragments of gres.

9th, *Geissingenberg* is a large mountain where tin ore, disseminated throughout a quartzy substance impregnated with chlorite, is worked in the mines known by the name of Altenberg. Above this substance, towards the west, is a large mass of porphyry with a base of hornstein; but towards the east it is gneiss covered by sienite of a porphyritic structure. On the back of the mountain rests a basaltic excrescence the circumference of which is nearly a thousand yards

yards and the height about fifty. This basaltes is divided into prisms, most of them dismembered. It is of a grayish black colour, very hard, and contains a large quantity of olivin, which, being rapidly decomposed on the surfaces exposed to the air, leaves a multitude of irregular or angular cavities. This basaltes contains also some grains of carbonated lime.

10th, The *Luchauerberg* has the form of a cone, almost insulated on every side, and terminating in a basaltic summit about fifty yards in height. The body of the mountain is gneiss covered by porphyry. The basaltes is of the same nature as the preceding; but it contains only few grains of olivin and amphibolite. At the summit of the cone is a small cavity or depression two yards in depth.

11th, The *Heulenberg*, situated near the frontiers of Bohemia, consists of gres, of which almost the whole region around is composed. The basaltic summit consists of two groups of prisms, very regular. The basaltes is black, and exceedingly compact. It contains a great many grains of magnetic iron ore, and a mineral which has a close relation to the pyroxen (augite of Werner), and which is found here in considerable quantity.

12th, The *Stolpen* is the most remarkable of all the basaltic mountains of Saxony, on account of the beauty and regularity of the basaltes. The body of the mountain is of granite. C. Daubuisson does not venture to assert that the basaltes rests immediately upon it; he observed on the granite a sort of wacke, which, perhaps, is extended between both. The basaltic summit appeared to him a kind of inverted cone, the point of which is sunk into a depression which existed in the top of the mountain when these matters were deposited. This basaltes is an assemblage of beautiful prisms, most of them regular hexagons, standing in a position almost vertical, and traversed by horizontal and parallel fissures which divide them into stories. They are of a black colour, with a blueish tint. They are sonorous, and as hard as iron. Small round cavities, the sides of which are covered with a stratum of chalcedony, lined itself with crystals of quartz, or filled with green steatites, are often remarked in them. At other times these cavities contain balls of calcareous spar, zeolite, and lithomarga, having the appearance of semi-opal. This basaltes contains besides, small grains of olivin and black shining points of amphibolite,—if it be not, perhaps, the substance mentioned in the preceding article.

After having thus described the principal basaltic summits of Saxony, the author observes that the same country presents also some veins the mass of which has a greater or less affinity to basaltes, and particularly the *wacke* and *grunstein*. Those who know the opinion of Werner on the origin of these veins, may readily conceive the advantage which partisans of the aqueous origin of basaltes must derive from this arrangement.

C. Daubuisson terminates this article with a review of the basaltes of Lusatia. Here it is still the same substance, containing the same heterogeneous principles, exhibiting the same peculiarities of arrangement and structure. The only difference between them consists in this, that in Saxony the basaltic mountains are nearest to the ridge of the chain, and that in Lusatia they are nearer the bottom: some even are seen at a considerable distance in the plain, and completely insulated.

[To be continued.]

XV. *Curious Extracts from old English Books, with Remarks which prove, that the Telescope, &c. were known in England much earlier than in any other Country.*

To Mr. Tilloch.—(Letter II.)

[Concluded from our last volume, p. 256.]

18. If this be granted, and if it be also proved, by our quotations from the *Pantometria* and the *Stratioticos*, that Digges, the father and son, actually constructed telescopes, then it will follow, that *that instrument was known in England long before the period of its reputed invention*; which was all that I proposed to prove.

19. But it is so natural to ask how those ingenious men came by that knowledge, that I find it impossible to quit the subject, without looking somewhat more particularly into the source from whence such knowledge was probably derived. And here we have little else to do, than to follow the lights held out to us by the authors, whose works we have cited. Dr. Recorde, as we have seen (§ 16), though he does not expressly mention Roger Bacon as his instructor in this subject, gives us reason to infer from his own words, that he acquired what he knew of it, either from the writings of that philosopher, or from rules traditionally transmitted from his time, along with the maxim, that such knowledge was "more meet for princes than for other men." Bacon has

has a whole chapter (the eighth of his tract *De Nullitate Magiæ*) "on the Concealment of the Secrets of Nature and Art *:" and the free-masons adhere to this maxim at the present hour. Digges the son, however, makes no mention of tradition; for he expressly affirms, that his father's knowledge of optics "*partly* grew by the aid he had by one old written booke of Bakon's experiments, that by strange adventure, or rather destinie, came to his hands; though chiefly by conioyning continuall laborious practise with his mathematicall studies" (§ 9). But surely *we* should not think it more "strange" that a MS. of Roger Bacon should fall into the hands of Digges, than that a writing 300 years old should come into the possession of an antiquary of the present day (and many much older writings are yet extant); nor nearly so strange as that you should now have in your hands the MS. of Raymond Lully, mentioned in the foot note. And that Digges, "chiefly by conioyning continuall laborious practise with mathematicall studies," should discover the construction of the telescope, is by no means *so* strange as that Porta, Jansen, and Metius, should hit upon the same thing, as they appear to have done, without either labour or mathematics; especially if it be true that "the optical principles whereon telescopes are founded, were well known to the antient geometricians, being contained in Euclid †, and that it was for want of attention thereto that the world was so long without that admirable invention ‡." I say, *if* this be true; but I must

* I have just seen an old MS. dated 1319, with a similar title, namely, *Liber Secretorum Naturæ*, "A Book on the Secrets of Nature," by the famous Raymond Lully, a cotemporary of Roger Bacon. The philosophers of the middle ages did no more than continue the *exoteric* and *esoteric* rules of the antients. For example, the Dionysians of Ionia monopolized the building of temples, &c. as the freemasons did the erection of cathedrals; and both kept their science *secret:* for much science the builders of our cathedrals certainly possessed. Nay, the learned compiler of the article *Arch*, in the Supp. to the Encycl. Britann. does not scruple to affirm that "there is *infinitely more* scientific skill displayed in a Gothic cathedral than in all the buildings of Greece and Rome:" and he appeals to the nice balancing of the arches in the open spires at Brussels, &c.; to which he might have added those of St. Giles's, Edinburgh; St. Nicholas's, Newcastle; and King's College, Aberdeen. Sir C. Wren was one of the few moderns who *could* imitate such structures; as he has successfully done in the elegant spire of St. Dunstan's in the East. If the cotemporaries of Bacon possessed such *consummate* skill in *architecture*, why not *some* skill in *optics?* But this I merely ask, without pressing it as an argument.

† Not Euclid the compiler of the Elements. See the Note, vol. xviii. p. 54, of this Magazine.

‡ Harris's *Lexicon Technicum*, article *Telescope*.

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confess that this exaltation of the antient geometricians, on such grounds, reminds me of the folly of those fanatical pedants, who maintain that the elements of all the arts and sciences are to be found in Homer. No worse a judge than Huygens was of a very different opinion. "If any particular person (says that great man) had been so diligent and sagacious as to invent this instrument from the principles of nature and geometry; for my own part, I should have thought his abilities were more than human. But the case is so far from this, that *the most learned men have not yet been able sufficiently to explain the reasons of this casual invention.*" These are the words of Huygens, as translated from his *Dioptrica* by Dr. S.*, who seems to have forgotten them when, merely from some *errors in theory*, he concludes that Roger Bacon was unacquainted both with spectacles and telescopes. Nor does he seem to have recollected that a "*casual* invention" might as well have been made by Bacon, or some other *philosopher*, in a dark age, as by Jansen and other *ignorant* men in an age more enlightened; an argument which would no doubt be equally strong in favour of the antients, if they had left us as strong proofs of optical knowledge, as Bacon has.

20. Dr. S. being, as far as I know, the only respectable author † who has seriously disputed Bacon's pretensions, against the judgment of Dr. Plott, the two Molyneuxes, Dr. Jebb, Dr. Friend, Muschenbroek, and other learned men ‡, I should here hazard a few pretty close remarks on his arguments, if I were in possession of the *Opus Majus*, whence he quotes the passages from which he endeavours to justify this singular opinion. That work of Bacon cannot be very scarce, as it was published among that philosopher's works, by Dr. Jebb, in 1733 §; but it is probably *immured* in our public libraries, to which ordinary men cannot have any easy or useful access ||; for I have never seen it, or met with any one

* Compleat System of Optics, Remark 103, *et seqq.*

† See Mr. Bonnycastle's excellent translation of Bossut's *Hist. de Mathématiques*, p. 189, and Dr. Hutton's valuable Dictionary, art. *Telescope.*

‡ Among whom we may reckon Dr. Campbell, who (as appears from an advertisement by his amanuensis, cut out of a newspaper and pasted into the first volume of the *Biographia Britannica*, first edition, 1747, now before me) drew up all the articles marked E and X in that work. The article *Bacon* (*Roger*), on which the learned compiler has bestowed great labour, is marked E.

§ See Biog. Britann., article *Bacon* (*Roger*).

|| For example, a few months ago, an advertisement appeared in the public prints, stating that papers were to be delivered at the porter's lodge of the British Museum, showing the manner of applying for admission to the

one who has. The doctor's quotations by no means satisfy my mind; as he has left us quite in the dark as to the context, which is commonly of the utmost importance in determining the general scope of old writers, and the manner in which it may affect the sense of particular passages. Hence, being afraid of doing injustice to the commentator or his author by random remarks, I must confine myself to such as the few authorities before me will fairly justify.

21. In the first place, I beg leave to lay before you and other scholars, the doctor's translation* of these words of Bacon:—"*Si vero homo aspiciat literas, et alias res minutas, per medium crystalli, vel vitri, vel alterius perspicui, suppositi,* [i. e. as the doctor interpolates, *superimpositi*] *literis; et sit portio minor spheræ, cujus convexitas sit versus oculum; et oculus sit in aëre; longe melius videbit literas, et apparebunt ei majores:*" that is, says Dr. S., "if the letters of a book, or any minute objects, be viewed through a lesser segment of a sphere of glass or crystal, whose plane base is laid upon them, they will appear far better and larger." Now I appeal to any competent judge, whether the literal translation be not: "But if a man look at letters and other minute things through a medium of crystal, or glass or other transparent (substance) *set or put before* the letters, and it be the smaller portion of a sphere whose convexity is towards the eye, and the eye be in the air, he will see the letters far better, and they will appear to him larger." The doctor justifies the liberty he has taken with the word *suppositi*, by alleging that it is a contraction; and so it appears to be; but whether of *superimpositi*, "laid upon," or of *suprapositi*, "set or put before†," (as a reading-glass is before a book,) it would not be easy to determine; especially as the doctor has not given us Bacon's fifth canon, to which he refers. But, for aught I can see at present, my interpretation seems to be as allowable as his. At any rate, Bacon has no word for a "plane base;" though, no doubt, this is implied in the glass being the portion of a sphere. The doctor lays some stress on Bacon's figures; more, indeed, than they will fairly bear; for, even in the most accurate modern books, we daily meet with figures

the libraries in that great national repository. I called twice at the porter's lodge, as advertised, and was told first by a girl, and the second time by a middle-aged woman, that no such papers had ever come to the lodge. Similar anecdotes might be mentioned respecting some other public institutions, particularly Gresham College.

* Complete System of Optics, Remark 84.

† See Ainsworth's Dictionary.

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which contradict the rules not of perspective only, but even of common sense and probability*. And, considering the imperfection, both of optics and of the graphical art, in the days of Bacon, together with the errors of transcribers, would it not be extremely unjust not to make *proportionably greater* allowances for the faults of his diagrams? Thus, it does not appear to me, that the doctor had any satisfactory authority for substituting *superimpositi* for *suppositi*, or for drawing any unfavourable inference from the faults of Bacon's figures.

22. I may add, that Bacon says, in the sequel of the same passage, that "this instrument is useful to old men, and to those who have weak eyes; for they may see the letters, however small, in sufficient magnitude." Now what man would have said "*this* instrument *is* useful to old men, &c. (*hoc instrumentum est utile senibus*, &c.), unless he had witnessed its effects? This would have been to talk of a thing as real, which had no existence. If he had only thought of it, without having seen or made it, he would have said, *such* an instrument *would be* useful to old men, &c. And, had this been Bacon's language, it would surely have been a proof that he knew something of the theory, contrary to what Dr. S. would allege in his observations on this and other passages of his great author. But do not Bacon's very excuseable errors *in theory* only make it the more probable that he is accurate as to *the fact*; and that he either invented reading-glasses or spectacles, or had at least experienced their effects?

23. Dr. S., before he proceeds to examine the pretensions of Bacon to an acquaintance with the dioptric telescope, translates from the *Opus Majus*† a whole chapter as follows:—*De visione fracta majora sunt*, &c. "Greater

* In fig. 67. tab. vii. of Wolfius's excellent *Elem. Diopt.* the engraver has represented a lens as in absolute contact with an eye. Mr. Gibson, a very ingenious mechanician at Hampstead, whose late brother at Kelso was one of the first opticians in Great Britain, and who has himself paid particular attention to optics, complains, that, except Dr. Brook Taylor, he scarcely knows a writer on perspective free from gross errors. *You*, Mr. Tilloch, know to your cost, that, except Mr. Lowry, there are few artists who engrave figures in ordinary books, which are always correct in point of perspective. Even the diagrams in Agnesi's Analytical Institutions are not entirely free from the errors of the wood-cutter. Yet I believe it would be hard to say, whether that work does most credit to the fair author; to Mr. Colson, the translator; to Mr. Hellins, the editor; to Mr. Taylor, the printer; or to Mr. Baron Maseres, to whose munificence the mathematicians of this country are indebted for its publication.

† Dr. Jebb's edition, London 1733, p. 357, as quoted in the Compleat System of Optics, Remarks, 112, 113.

5 things

things than these may be performed by refracted vision. For it is easy to understand, by the canons above mentioned, that the greatest things may appear exceeding small, and on the contrary. For we can give such figures to transparent bodies, and dispose them in such order, with respect to the eye and the objects, that the rays shall be refracted and bent towards any place we please; so that we shall see the object near at hand, or at a distance, under any angle we please. And thus, from an incredible distance we may read the smallest letters, and may number the smallest particles of dust and sand, by reason of the greatness of the angle under which we may see them; and, on the contrary, we may not be able to see the greatest bodies just by us, by reason of the smallness of the angle under which they may appear. For distance does not affect this kind of vision, excepting by accident, but the quantity of the angle. And thus a boy may appear to be a giant, and a man as big as a mountain; forasmuch as we may see the man under as great an angle as the mountain, and as near as we please. And thus a small army may appear a very great one, and, though very far off, yet very near us; and on the contrary. Thus also the sun, moon, and stars may be made to descend hither in appearance, and to appear over the heads of our enemies; and many things of the like sort, which would astonish unskilful persons."

24. No great fault, I think, can reasonably be found with this translation, of which Dr. S. also gives us the original. But I must say, that his reasonings upon it appear to me to be even more inconclusive than those we have been considering. "It seems then, (says the doctor, Remark 116,) as if he did not think of performing these problems by a single portable instrument like a telescope; but by fixing up several glasses in proper places at large intervals from one another, which would certainly prove ineffectual." But how does this *seem to be* the sense of Bacon? Certainly not from "making the sun, moon, and stars to appear over the heads of our enemies," who being in continual and uncertain motion over the face of the country, any optical instrument employed to watch those motions must also be movable or portable.

25. "What he mentions (continues the doctor, Remark 117,) of Julius Cæsar, that he raised up speculums to a great height upon the coast of France, to discover the disposition of the cities and camps in England, is therefore impracticable, and probably a fiction, if there be not a mistake in the interpretation of the word *specula* for glasses,

instead of a watch-tower. The same is to be understood of the story mentioned by *Porta**, That Ptolomy, by speculums, could discern ships at the distance of 600 miles, which could not possibly be done by our best telescopes." The doctor here refers to the 357th page of the *Opus Majus*; but, as he does not give us his author's express words, I beg leave to cite a parallel passage from the 5th chapter of Bacon's piece *De Secretis*, &c. "Of the secret Works of Nature and Art, and of the Nullity of Magic†." *Possunt enim sic figurari perspicua*, &c. "For transparent (bodies) may be so figured, that things at the greatest distance may appear to be the nearest, and the contrary; so that, from an incredible distance, we may read the smallest letters, and number things however minute: for thus it is thought that Julius Cæsar, on the coast of Gaul, discerned *(per ingentia specula)* by, or through, very large glasses, the disposition and situation of the camps and cities of Britannia Major." Now, I can answer for it, that there is not in this chapter, or in the whole of this very rational account of what is vulgarly called magic, which I have perused with great pleasure and admiration, a single syllable about raising up speculums to a great height. And I add, without any fear of contradiction, that in this quotation there *can* be no mistake about the word *specula*, which, happily for my argument, stands in such a connection that it evidently is, and can only be, the accusative plural of *speculum* (a mirror, or looking-glass); but, as the author is talking of *perspicua* (transparent things, bodies, or substances), I am fully authorized to render it simply "glasses." It is not, indeed, very probable that Bacon would have left it uncertain what *specula* he meant: for he was an accurate grammarian; and, as Dr. Campbell observes‡, his Latin style, though perhaps not always classical, is "neat, strong, and remarkably expresssive; leaving nothing perplexed or obscure, either from a want or from a redundancy of words."

26. Dr. S. next proceeds (Remark 118.) to show that Bacon "was not qualified to invent a telescope by theory" —"considering the false notions he had from the antients about distinct and confused vision; the false principle he maintains, that the apparent magnitude of an object is as the angle subtended at the eye, by its image, and recipro-

* In his *Magia Naturalis*, lib. xvii. cap. 11. as quoted by Dr. S.

† See tom. v. p. 851. of the Theatrum Chemicum, *Argentorati* (Strasburgh) 1660, in which this little work of Bacon is inserted entire, and illustrated with notes.

‡ *Biog. Brit.* art. *Bacon* (*Roger*) note K.

cally

cally as the distance of the image too; and, lastly, the false conclusions he has drawn, and must always draw, from these principles; as I (says the doctor) have shown in his attempt upon making spectacles." The theory of vision is very difficult. I believe it now exercises the genius of those excellent philosophers and mathematicians Dr. Young, and your correspondent Dr. Wollaston, and therefore cannot, even at this hour, be considered as completely unfolded and established in all its parts. With respect to "the false principle Bacon maintains, that the apparent magnitude of an object," &c. it is observable that, when the angles are small, the two ratios he gives are nearly equal, and therefore that the ratio compounded of both is nearly the duplicate of either. Not having the *Opus Majus*, I cannot say whether Bacon means the apparent magnitude of the surface of an object, or of its height or breadth only. But whether he mean the one or the other, and whether the principle, as he applies it, be true or false, it seems rather too much to expect from Bacon an accuracy which, in several instances, modern philosophers have yet to seek. For example, it is not yet entirely settled, whether the forces of bodies in motion be as the masses and the velocities simply, or as the masses and the squares of the velocities. And Dr. S. should have remembered that, in his 107th remark, he had said that the "great Descartes is quite mistaken in his method of demonstrating the effects of telescopes;" that his demonstration "can never be made sense of; and that, though many others have since been labouring at the same problem, which is the chief of all, yet none of them have been able to solve it." From these failures, however, Dr. S. does not infer an utter ignorance of the telescope. Why are different measures of criticism to be thus applied to Roger Bacon and to some of the greatest of the moderns? It may be said, that it was necessary for Dr. S. to expose his author's faults in order to prove, that "he was not qualified to invent a telescope by theory," this being the subject of this (118th) remark. But where was the necessity of showing that Bacon was not qualified to do that which, by the account of Huygens, acquiesced in by Dr. S. (in his 103d remark) required "abilities more than human?" No one affirms that Bacon had theory sufficient to conduct him to the invention of the telescope. But had Porta, Jansen, Metius, Lippersheim, or even Galileo, such a sufficiency of this refined theory? Surely Dr. S. would not have asserted this. Yet it is *a fact* that one or more of these men invented, or rather re-invented, the

refracting

refracting telescope, though, Galileo excepted, not one of them had any correct ideas of the theory; and therefore Bacon's mistakes in that theory, or in any other part of his subject, can have no weight against *the fact*, proved by many parts of his writings, that he was acquainted with the dioptric or refracting telescope. This argument applies to every branch of science. Kepler's total ignorance of the theory of the laws which bear his name, can have no weight against *the fact* that he discovered those laws, and knew that they prevailed in the solar system. Dr. S. himself submits to the force of this argument on another occasion. In his 93d remark, he expresses his surprise that "the ancients could not account for burning by reflection from a concave metal:" yet he acknowledges that "they knew and cultivated catoptrics:" and (Remark 121.) that they had burning mirrors.

27. In his 119th remark, the doctor asserts that Bacon "was not qualified to invent a telescope, by experiments, for want of lenses."—"I have shown above," says he, "that he never had handled a convex spectacle-glass."—With what force the doctor has shown this, I must leave to the reader of his 88th remark. But is it probable that *such* a man as Bacon, *without theory*, would make an "*attempt upon making spectacles*," as the doctor owns he did (Rem. 118), and yet not be able to produce some sort of a spectacle-glass?—In this same remark Dr. S. quotes a passage adduced by Dr. Jebb, to show that Bacon was no stranger to the astronomical use of the telescope. It is this: *Sed longe magis quam hæc: oporteret homines haberi, qui bene, immo optime, scirent perspectivam et instrumenta ejus,—quia instrumenta astronomiæ non vadunt nisi per visionem secundum leges istius scientiæ.* Dr. S. gives no translation of this passage. It may, however, be rendered thus: "But what is much more (important) than these things; men ought to be had who understand perspective* and its instruments well, yea exquisitely well;—because the instruments of astronomy only proceed by vision, according to the laws of that science." Dr. Campbell tells us that this passage is in the *Opus Tertium*, and he very naturally considers it as a proof, "that he (Roger Bacon) made use of the telescope in his astronomical observations." And certainly, a great force of reasoning would be ne-

* In Bacon's time, and long after it, by the word Perspective was meant Optics in general, as is evident from the quotations in the former part of this letter.

cessary

cessary to prove, that Bacon here talks of having men who understand optical and astronomical instruments which did not exist! How Dr. S. *gets over* this argument, the reader shall judge. "To this," says he, "it may be answered, that the ancients had some occasion for perspective in plain instruments before the invention of telescopic ones."—What! Did the ancients pretend that, with their "plain instruments," they could, "from an incredible distance, read the smallest letters, number (the smallest particles of) dust and sand, and make the sun, moon, and stars to descend hither in appearance?"—"But," continues the doctor, "as this passage stands alone, it is not easy to know the intent of it: however, had there been any more to the like purpose, no doubt this gentleman (Dr. Jebb), so much versed in the author's works, would have found them out and obliged us with them." But is it not fair and natural to ask, why Dr. S. himself has not obliged us with those passages? He cites the number of Bacon's MS. in the Cottonian library (Lib. c. v. fol. 6.) which was as accessible to him, or his friends, as to Dr. Jebb; for we cannot suppose that that famous Oxonian repository would have been shut against a Cambridge-man, when employed in recording the renown of the greatest of Oxford-men*. Dr. S. it would seem, had even a better opportunity of searching for, and inserting such passages, when he had yet to write 150 pages of his book, than Dr. Jebb, who, by Dr. S.'s own account, appears not to have discovered the above striking passage, till his edition of Bacon was printed off; so that he was obliged to insert it in the *dedication*, the part of a book which, though first in order, is generally the last in execution. As to the passage itself, it appears to me strongly to imply that Bacon had been proposing to pope Clement IV., "a wise and worthy man," (as Dr. Campbell calls him) to whom he addresses the *Opus Tertium*, as well as the *Opus Majus*, some expedients for promoting optics and astronomy.—"But," continues he, "what is much more" (important or requisite) "than *these* things"—an expression which seems necessarily to imply *other* things which he had been mentioning. But, leaving this to be decided by those who have access to the

* The philosophy of Newton (the greatest of all Cambridge-men) was taught not only in Scotland, (where it was first introduced into the schools; see Hutton's Dict. art. *Gregory*) but in France and Holland, before it was taught at Oxford, by Keill or Gregory, both Scotchmen. Is it possible that some remains of the old prejudice could have reached the year 1738, when Dr. S. published the Remarks we are considering?

MS.

MS. of the *Opus Tertium* in the Cottonian library, I must observe that the passage can by no means be said to "stand alone," while it so admirably corresponds with the chapter which Dr. S. himself has translated, and which we have above transcribed (§ 23), unless Roger Bacon be the only old author who is to have his meaning elucidated, or, where necessary (as in this instance it scarcely is), ascertained and supported by collating different parts of his writings.

28. Dr. S.'s next remark (the 120th) is, that "this author speaks only hypothetically, saying that glasses may be figured, and objects may be magnified, so and so; but never asserts one single trial or observation upon the sun or moon (or any thing else), though he mentions them both." And, where is the mystery in this? Bacon, who was represented as a magician, and bitterly persecuted* by his ignorant brethren of the church, was now writing to the pope, and might naturally wish that his holiness would send for him to explain his meaning more fully, which might have led to a settlement under the protection of that excellent pontiff. Besides, the inventor, who rashly imparts his discoveries to *any* man, will generally have cause to regret his communicative disposition. But would it be fair to say, that because lord Napier, or the marquis of Worcester †, or any other inventor, (and Bacon certainly was at least in part the inventor of the optical knowledge he possessed,) did not at once explain the whole of their discoveries, that therefore they made "no experiments, trials, or observations ‡" on the subjects which they professedly treated? It is true, that I cannot back this question with any original document; but I read in respectable modern works, founded on such documents, that Bacon himself states, that "in *experiments*, instruments and scarce books, he spent in 20 years no less than 2000l., an amazing sum in those days;" also that "he had great numbers of burning-glasses §;" that "the first burning-glass he *made* cost him 20l. sterling ||;" and that, in his inquiries into chemistry

* Hutton's Dict. art. *Bacon (Roger)*.

† See my first letter, in vol. xviii. p. 53, &c. of this Magazine.

‡ See Dr. S.'s 88th and 120th remarks.

§ Dr. Hutton's Dictionary, art. *Bacon* (*Roger*).

|| Equal to 60l. Paris money; so that, at that time (about the year 1250) the French *livre* was worth 6s. 8d. sterling (See *Biog. Britann.* art. *Bacon* (*Roger*), note B.) For the pound in money of France, England, and Scotland, was, originally, a Troy (*Troise*) pound in weight of fine silver, and hence the name. But the pound in England has since dwindled to 6s. 8d.; in Scotland, at the time of the Union, to about 1s. 8d.

mistry and other subjects, he called in the aid of "*experimental* perspective and *practical* astronomy*."—"On the other hand," continues Dr. S. in this same 120th remark, "he conceives some effects of telescopes which cannot possibly be performed by them." The best answer to this is, that, as is above observed, Dr. S. himself mentions, in his 117th remark, Porta's folly in believing that Ptolomy could see ships 600 miles off; yet the doctor, in his 104th remark, allows Porta's pretensions as an inventor (or, as I should say, a re-inventor) of the telescope, to pass without animadversion. The truth is, that the ardent spirit of inventors is but too apt to deal in prodigies; and I see no reason to exempt either Bacon or Porta from the common infirmity of their brethren. What wonders and "exuberances" were to be, and still are *to be* performed, in our own times, by air-balloons, and galvanism, and the gases!

29. Dr. S. sums up the evidence on Roger Bacon's pretensions to a knowledge of the telescope in his 121st remark, which is as follows: "If it be asked, How Bacon came by these notions? I answer, From the common doctrine of refractions in his canons, and from common appearances by refraction and reflection; especially from concave speculums, whose effects were well known to him, both by the accounts of them in antient authors, and by his own experience. And this I take to be a sufficient ground for a man of good sense and fancy to produce all that he has said. I conclude then that the time of the invention of telescopes was not earlier than the beginning of the 17th century."—After what has been stated (though not so perfect as could be wished) the reader will probably be inclined, as I am, to substitute for this conclusion of Dr. S.

1s. 8d. and in France, before the revolution, to about 10½d. all estimated in parts of the Troy pound weight of fine silver. (See Henry's Hist. of G. Britain.) By Sir Geo. Shuckburgh Evelyn's excellent table in the Philosophical Transactions for 1798, 60l. in the year 1250 was about equivalent to 562l. in 1800; so that Bacon's first burning-glass may be said to have cost him about 187l. and that he laid out on his experiments, &c. in 20 years, about 18733l. of our present money.

* *Cum adjutorio scientiæ experimentalis perspectivæ, et astronomiæ operativæ,* &c. p. 9. *Excerpta ex Libro Sexto Scientiarum, quem fecit Frater Rogerus Bacon,* prefixed to *Sanioris Medicinæ Magistri. D. Rogeri Baconis Angli, Thesaurus Chemicus, Francofurti,* 1620. Bacon's connecting perspective (optics) with practical astronomy, as he does on other occasions also, is very remarkable, and will no doubt be regarded by some as a strong presumption that sciences, which he thus connected in his language, he also united in his practice; for practical astronomy can no more exist without optics than navigation can without them both.

that of the "learned Dr. Plott, who," says Campbell, "considers the invention of the telescope at large, and declares, that without wresting of words, or begging favourable constructions, it is very possible to prove, that friar Bacon was *either the inventor or improver* of that useful instrument."—"This learned Franciscan," says Dr. Plott, "did so far excel the ancient magicians, that whereas they represented the moon's approach by their magical charms, he brought her lower with greater innocence, and with his glasses did that in truth which the ancient poets always put in a fable. All which put together, it must necessarily be confessed, that he had some such instrument, though not so trimly made, it is like, as our telescopes are now; in favour of which truth much more might be alleged, did I not think this sufficient to evince it to the unprejudiced reader*."

30. But I must not dismiss the latter part of Dr. S.'s summation of the historical evidence on this question, without expressing my wonder that he has taken no notice either of Recorde or of the Diggeses. It is indeed surprising that a private individual like myself, led casually to take a transient view of this subject, should presently procure the *Stratioticos*, the *Pantometria*, and the Path-way to Knowledge; and that a gentleman publicly known and esteemed, who had all the libraries in one, if not both, of the English universities at his command, should employ many years in writing a very large quarto volume on the principles and the history of Optics, without once mentioning, as far as I can see, any of those respectable testimonials of English ingenuity. Had he consulted them, he would have been constrained to place *the invention of the telescope in his own country, and many years "earlier than the beginning of the seventeenth century;"* and this even without going so far back as the days of Roger Bacon. My opinion on this subject is of little consequence; but, after attentively considering all the evidence which I could procure, I must say, that I can no more doubt that the refracting telescope originated in the southern part of this island, than that the reflecting (commonly called the Gregorian) telescope was invented in the northern.

31. What may be the fate of these last remarks I know not; nor do I much care, while I am conscious of having done all the justice to the subject which my limited time and

* Plott's Natural History of Oxfordshire, as quoted by Campbell, in the *Biog. Britann.* art. *Bacon (Roger)* note M.

authorities,

authorities, and more limited abilities, would permit. I wish to excite no controversy, neither will I enter into any on this subject. But *nullius in verba:* I *will* hold such opinions as I have reason to think well founded. I have shown all the deference which plain dealing would allow, to the deservedly respected author from whom I dissent—only because I really do not think he has treated one of the greatest men whom this island or the world ever produced, with all that candour (for Roger Bacon needs no indulgence) which is always attached to the name of Dr. S. I have, in short, endeavoured to observe the happy mean which Sir Richard Steele recommends, when he says, that zeal and candour are two very good things, if we can but contrive to keep fire out of the one and frost out of the other. Yours, &c.

* D.

XVI. *On the supposed Chemical Affinity of the Elements of Atmospheric Air: with Remarks upon Dr. Thomson's Observations on this Subject.*

To Mr. Tilloch.

SIR,

In a former letter inserted in your Magazine (vol. xiv. p. 169.), I endeavoured to show the absurdity of the notion of atmospherical air being a chemical compound of azotic and oxygenous gases. Besides the difficulty, or rather impossibility, on the one hand, of conceiving how two elementary particles, constantly repelling each other, should, notwithstanding, be held together by a principle of cohesion or chemical affinity;—or, on the other hand, supposing the two atoms to combine and form one centre of repulsion, how atmospheric air should differ from nitrous gas, &c. there are a variety of facts which oppose the doctrine so forcibly, that I have for some time wondered on what grounds those who are still its adherents defended it. Dr. Thomson, in the 2d edition of his Chemistry, vol. iii. page 316, after reviewing the opinions of different philosophers on this head, and amongst others my own, concludes that air is a chemical compound: he assigns the four following reasons for the conclusion, which, from his extensive acquaintance with authorities, may fairly, it is presumed, be deemed the most cogent that have been offered on that side of the question. It is the object of this communication to show their insufficiency.

1. The

1. The constant proportion of azot and oxygen in the atmosphere is considered as an argument for their being held by affinity. So indeed it may; but it is equally in favour of my hypothesis, and, therefore, nothing tending to decide the question can be obtained from it. For, let part of the oxygen be abstracted any where from the atmosphere, then the azot may be supposed to attract the oxygen from the vicinity, and thus the equilibrium be restored; but it is certainly equally satisfactory to suppose that, the oxygen in the vicinity meeting with less repulsive power from the deficient quarter, nothing prevents its diffusion into that quarter but the azot previously there, which, by hypothesis, can only *retard*, but by no means *prevent*, the effect. Thus, then, whether the azot attract the oxygen, or the oxygen *repel* itself, the effect is precisely the same. From this fact simply it is impossible, therefore, to decide the merits of either theory; but if it be found that any one gas diffuses itself in any other with nearly the same celerity, it will be a presumption in favour of my hypothesis; if otherwise, it may be urged that the quicker diffusion is owing to the stronger affinity. I have made a great number of experiments on this head, but could not find any remarkable difference in the time and circumstances of diffusion of the same gas.

2. The experiments of Morozzo and Humboldt show that air possesses different properties, from a mere mixture of its two component parts. I do not credit the experiments. Humboldt finds a *variable* quantity of oxygen, from 25 to 30, or more, per cent. in the air; whereas others, who are more accurate, find but 21, or at most 22, and that *constant*. It is no wonder then, if he mix 28 oxygen and 72 azot, that the mixture diminishes nitrous gas more than air, and supports combustion and animal life for a longer time.

3. "Different combustibles are capable of absorbing different portions of oxygen from a given quantity of air: phosphorus 22 per cent. sulphur 8, &c." The only inferences I draw from these facts are, that phosphorus will burn in oxygen of any density; that sulphur will not burn in oxygen, unless it be of $\frac{1}{7}$ of atmospheric density, or more. The difference in the phænomena of combustion in air and in oxygen is not to be ascribed to the combination of azot and oxygen, but to the less density of the latter, $\frac{1}{5}$ of what a pure atmosphere of the same gas would be. From an incidental, but imperfect, trial I made, in conjunction with Mr. Davy last winter, I have no doubt but iron wire would burn in common air of five times the density with brilliancy,

ancy, as in an atmosphere of pure oxygen of common density. At any rate, it is notorious that, as the density of common air is increased, combustion in it becomes more vigorous. Though I have never attempted combustion in an atmosphere of pure oxygen of $\frac{1}{5}$th the common density, I can scarcely doubt that the appearances would be much the same as in open air. It is probable, then, that the facts under this head, if duly investigated, would turn out in favour of the hypothesis of air being a mixture.

4. "A gas, no way distinguishable from common air, frequently makes its appearance during the preparation of nitric acid; and Mr. Davy decomposed nitrous oxide by passing it through a red-hot tube, and converted it into nitric acid and a gas which possessed the properties of common air. Now, if air were a mere mixture, it is infinitely improbable that its two constituent parts should be evolved during such processes exactly in the proportion that exists in common air." Granted: but as the force of this argument rests upon the *exact proportion* of oxygen and azot in the gases so evolved, that is, upon their being constituted always of 21 per cent. oxygen and 79 azot, the facts should be made out accordingly. Dr. Priestley is the only one I know of who has particularly examined the gas produced in the preparation of nitric acid; and he found it to have *much more* oxygen than common air. Mr. Davy, in his analysis of nitrous oxide, found the gas analogous to atmospheric air always to contain *less* oxygen, though it was nearly of the atmospheric standard.

The quick ascent of hydrogen, and the descent of carbonic acid, have been objected to my hypothesis, as facts that prove the operation of the laws of specific gravities on elastic fluids. No doubt can exist that a portion of elastic fluid completely insulated, as a balloon, or bubble of carbonic acid or hydrogen surrounded by a film of water, is subject to the laws of gravitation, and rises or falls in elastic fluids on the same principle as it rises in water: the same must be allowed whenever a vessel containing a considerable portion of elastic fluid is suddenly exposed at some surface to the atmosphere: in this case the fluids *must operate upon each other* for a few moments in a collected capacity, as in elastic bodies; because the diffusive or repulsive force, by which they constantly tend to dispersion, is comparatively slow in producing the ultimate effect, being in this respect exactly similar to chemical affinity, the operation gradually diminishing as the effect draws towards a conclusion. Nothing

thing more, therefore, can be inferred from the facts above mentioned, than that gravity overpowers, and for a moment obliterates, the effect of that cause, which in other cases slowly produces the dispersion of the fluid, whether it be attraction, as is commonly supposed, or repulsion, as I suppose. Chemical philosophers have not inquired sufficiently into the effects of exposing gases in different circumstances to the atmosphere: all that we are usually told is, that a jar filled with hydrogen, and uncovered, loses its gas in a few seconds; but, if inverted, it remains nearly pure for a considerable time, &c. I find that a cylindric jar of 7 inches depth, and $2\frac{1}{4}$ diameter, being filled with hydrogen, and inverted, loses more than half of its gas in two minutes; and there is so little left as scarely to explode in five minutes. If a tube 12 inches long, and $\frac{1}{4}$ inch in diameter, be filled with hydrogen, and exposed in like manner to the atmosphere, it will lose half its gas in five minutes; and that the same, whether it is held up, or down, or horizontal. Here we see effects that cannot be caused by gravity, that are produced in opposition to its agency, and where, indeed, it is almost obliterated by the action of some more powerful cause. Let the advocates for the atmosphere being a chemical compound attend to such facts as these, and they will soon find themselves reduced to acknowledge that *all gases have the same affinity for one another*, a position which their doctrine ultimately tends to establish. Indeed, it is the same with regard to air, and vapour of water, æther, or any other kind; that is, all kinds of gas, or mixtures of gases, have the same affinity for the same vapour; and even a torricellian vacuum possesses just the same affinity as any of them, judging from the quantity evaporated and force of the vapour in a given volume. If any one doubt it, he may easily satisfy himself by throwing up a drop or two of æther into the vacuum of a common barometer: if the temperature be 68°, the mercury will fall 15 inches nearly: at the same time, if æther be admitted to a given bulk of any kind of gas, subject to the pressure of the atmosphere, its volume will be doubled; clearly showing that the elastic vapour from the æther is the same in both cases, namely, an independent fluid of 15 inches force.

I cannot dismiss this subject without observing, in justice to Dr. Thomson, that he has entered more clearly into my views of these subjects than any other of our own country who has animadverted upon them. There are certain principles, however, which he, with most chemists of the present day, embraces,

embraces, which are, according to my experience, decidedly erroneous. One of these is, *that water dissolves air.* An excellent paper of Mr. W. Henry, on the absorption of gases by water, in the Philosophical Transactions for 1803, has shown us sufficiently in what light we should view the supposed solution of air in water. Certainly air that is retained in water by mechanical force, and which always escapes when that force is withdrawn, cannot, with any propriety, be said to be held by chemical affinity.

Dr. Thomson has been misinformed respecting my opinions on the expansion of liquids. In vol. i. page 343, he gives it as my suggestion, that all liquids expand the same quantity from their freezing to their boiling temperatures. I never entertained such an opinion; and it is certainly erroneous. My idea is, that pure and homogeneous liquids, such as water and mercury, expand according to the square of the temperature from the points at which they congeal; but I have not yet found a law to regulate the *relative* expansions of these and other liquids.

I am, yours, &c.
J. DALTON.

Manchester,
June 19, 1804.

XVII. *On a distinguishing Property between the Galvanic and Electric Fluids. By Mr.* JOHN CUTHBERTSON.

To Mr. Tilloch.

DEAR SIR,

SINCE my letter to Dr. Pearson appeared in your Philosophical Magazine for last month, I thought the following additional experiments necessary:

The two experiments last mentioned in the above letter were compared with common electrical discharges, with a view to prove what quantity of coated glass would be required to take a charge sufficient to ignite the same lengths of wire.

Two jars, each containing about 170 square inches of coating, were set to the conductor of a 24-inch single-plate electrical machine, with my universal electrometer loaded with 31 grains, (see Nicholson's 4to Journal, pl. xxiii. vol. xi.). 8 inches of the same sort of wire were laid in the circuit:—57 revolutions of the plate caused the electrometer to discharge the jars, which ignited the wire perfectly, as in the 9th experiment. In the next place, 6 inches of the wire being laid in the circuit, the same number of revolutions caused the discharge, and the wire was deflagrated and fused into balls in the same manner as in the 8th experiment. Hence I conclude, that 340 square inches of coated glass, properly constructed, will bear a charge equal to a galvanic battery of 1080 square inches surface.

I compared the above experiments with others gone before, particularly Mr. Wilkinson's, in Nicholson's Journal, vol. vii. p. 297, wherein he says that one trough of 100 pairs of plates ignited one half-inch of wire of *one-seventeenth* of an inch in diameter. If this is not a mistake (as I am inclined to think), it is well worthy of notice; because, to ignite one half-inch of steel-wire of the above diameter would require a power sufficient to ignite 120 inches of wire of $\frac{1}{150}$th part of an inch in diameter by common electrical discharges, which is a power equal to two of my common electrical batteries. See Nicholson's 4to Journal, vol. p. 525.

The greatest power of 60 pairs of 6-inch square plates that has ever been hitherto known, is that of igniting 16 inches of wire of $\frac{1}{150}$th part of an inch in diameter. Mr. Wilkinson's trough of 100 pairs of plates of 4 inches square is of much less surface, and, as he says, it is a less favourable size; from which, and from the above experiments, I conclude, that such a battery has not the power of igniting one half-inch of wire of one-seventeenth of an inch in diameter, unless galvanic discharges act upon metals in some manner different from common electrical discharges, but with which I am unacquainted: perhaps Mr. Wilkinson will be kind enough to clear up this remark.

From the experiments mentioned in the above letter, and others since made with the same result, I concluded, that double quantities of galvanic fluid only burn double lengths of wire; but on examining some of my notes of experiments, I find that, on the 6th of June 1803, I had made a Volta's pile of 16 pairs of plates of 10 inches diameter, 8 of which laid upon each other in the usual manner, with cloths wetted with diluted muriatic acid, burned one half-inch of wire of $\frac{1}{105}$th part of an inch in diameter; and when the other 8 were added they burned 4 inches of the same wire. This was repeated with the 8 in pairs with the same result, with respect to burning of metals; but it gave strong and loud sparks from metal to metal, sufficient to be heard at 300 yards distance; which result, I believe, has never been obtained from troughs, to be heard at any distance. For this

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last experiment the cloths were wetted in a strong solution of muriate of ammonia; so that I am of opinion there is at present some defect either in the arrangement or construction of galvanic troughs.

I am, dear sir,
Your very humble servant,
JOHN CUTHBERTSON.

Poland-street, Soho,
June 21, 1804.

XVIII. *Proceedings of Learned Societies.*

BRITISH MINERALOGICAL SOCIETY*.

FOUR years have now nearly elapsed since the establishment of this society, a review of their labours during which period will, it is thought, not be displeasing to their members. It is a satisfaction to the minds of persons engaged in philosophical pursuits, that they have added some truths to a science like mineralogy, where the researches of every one help to remove the veil in which nature is enveloped.

In the first formation of this society its institutors were guided by motives of regard for their country, possessing mines and subterranean riches little inferior to the proudest empire on the continent, but without any college or school of scientific mineralogy. In their public declaration they were not arrogating to themselves the entire possession of all mineralogical knowledge; but, as far as their abilities as philosophical chemists enabled them, they wished to assist both the miner and the mine-owner in the analysis and reduction of substances, either of a new or unknown nature, or in a state of peculiar mineralization.

Time, and their labours, it is also hoped, will add one more great pillar to British mineralogy, in furnishing specimens, with their provincial names, as well as their scientific, of each county in this kingdom, arranged in cabinets which will be of easy access to the mineralogist.

To our corresponding members we shall consider ourselves much indebted in forwarding this branch of inquiry; and, at the same time, we must take this opportunity to thank several of them for their valuable communications and specimens.

The first analysis undertaken by the society was an ore of iron from Shetland, found equal with the level of the sea, on the south-west side of the island. The surface is a smooth, black mendic, of a metallic appearance, hard to

* Communicated by the Secretary.

 penetrate,

penetrate, and about two feet thick. The vein runs north-east, and the specimen was taken four fathoms from the surface.

The analysis, by Mr. W. H. Pepys, jun. gives in 200 parts,

Iron - -	50·9
Silex - - -	92
Argil - -	28·5
Sulphur and oxygen -	27·6

Specific gravity 2·94.

The proprietor is Mr. Crighton, of the island of Shetland.

The second specimen was from Carnarvonshire, a sulphate of barytes found equal with the level of the earth near the foot of a hill in that county.

The analysis, by Mr. Knight, yielded in 400 parts,

Sulphate of barytes -	352
Silex - -	17
Loss - -	30

Specific gravity 4·028.

The proprietor Mr. S. Holland.

The third specimen was an iron pyrites found near the same spot with the last.

The analysis, by Messrs. Tilloch and Pepys, gave in 100 parts,

Iron - -	47
Sulphur - -	34
Argil - -	8
Loss - -	10

Specific gravity 4·512.

Proprietor Mr. S. Holland.

The fourth specimen is from Hawes, near Winsly Dale, Yorkshire, above the earth, forming for some way a path or road.

Mr. Charles Aikin's experiment proved it to contain 4 per cent. of copper in sulphate of barytes. It may, therefore, be considered nearly a pure sulphate of barytes.

Specific gravity 4·20.

The proprietor Mr. J. Hillary, of Yorkshire.

The fifth specimen is a silver from the Herland mine in Cornwall, in the parish of Gonnear, about seven miles west of Redruth, and near the direct road from thence to Penzance.

The first discovery of silver was made at 100 fathoms from the surface in a cross-course which angles the copper lodes. The silver is found about eight feet in length on each side of the latter, and it continues in depth as they sink the mine, which is now 145 fathoms.

It

It was an abandoned copper mine about 67 years back. It had lain unwrought from 1762 till that time, and had turned up great profit to the former adventurers.

Specific gravity 4·464.

The analysis, by Mr. William Allen, gives in 100 parts,

Silver - -	2·152
Iron - - -	27·500
Sulphur and arsenic,	26·600
Silex - -	32·400
Loss - - -	11·348
	100·000

The specimen we received was from one of the proprietors, Mr. William Phillips.

The sixth specimen was a green carbonate of copper diffused through an ochrey clay in compact quartz from a mine in the parish of St. Neots, in the county of Cornwall, at the depth of 30 fathoms from grass.

Specific gravity 3·078.

The seventh specimen is from the same mine.

Specific gravity 2·985.

Specimens 6 and 7, being already worked, are not subjects for the investigation of the society.

Their value is reckoned by the proprietors at 12l. per ton, when copper in the metallic state sells at 135l. per ton.

The eighth specimen is a copper and iron pyrites in quartz, found on the surface of the earth, county of Cumberland: the specimen obtained by pick-axe.

Spec. gravity 3·788.

The analysis by Mr. T. Cox in 400 parts of the ores,

Copper - - -	125
Iron - - -	139
Silex - - -	68
Sulphur - - -	40
Loss - - -	28

The proprietor is Mr. W. Monkhouse of Cumberland.

The ninth specimen is a peculiar arrangement of pyrites found on the coast of Africa among the stones on the beach.

On analysis by Mr. R. Phillips it was found to contain in 100,

Iron - - -	43
Alumine - -	12
Silex - - -	9
Sulphur and oxygen -	36

The proprietor Mr. J. Bolts.

Specimen 10 is a lead ore (from a mine called Hoxley, at Carleton, Derbyshire) in lime stone.

Spec. gravity 6·578.

The examination by Mr. R. A. Cox gave

From 1 ton of ore 15 cwt. of lead.

From 1 ton of lead 23 oz. 6 dwts. silver.

Specimen 11 is another lead (from a mine called Dirtlow in the same county) in fluat of lime.

Spec. gravity 3·068.

By the analysis of Mr. R. A. Cox it appears that

1 ton of ore contains 16½ cwt. of lead;

and 1 ton of lead 15 oz. of silver.

These specimens were from one of the proprietors, Mr. Mawe.

Specimen 12 is a beautiful micaceous glittering iron ore from Moreton-Hampstead, in Devonshire. The vein rises from 2 inches to 3 feet wide, and its direction is from S. E. to N. W. and about 4 feet from the surface of the earth; hard gravel on each side.

The analysis, by Mr. R. Knight, gave in 100 parts,

Iron - - -	72
Oxygen and loss -	28
	100

The proprietor Mr. J. Pinsent.

Specimens 13 and 14 were from the high grounds called Scotland, in Barbadoes. Specimen 14 has a large extent of ground slid over it on an inclined plane. They were analysed by Mr. Sandman.

No. 13 contained

Carbonate of lime -	77
Silex - - - - - -	10
Alumine - - -	7
Water - - - - -	3
Iron, muriate of soda, and loss	3

No. 14 contained

Alumine - -	31
Silex - - -	62
Iron - - -	4
Magnesia - -	2
Water - -	4

Proprietor, Mr. Wood, Barbadoes.

Specimens 15 and 16 were brought from the same situation as the last.—15 is the earth supposed to furnish the petroleum of Barbadoes.—16 is found in large nodules in a white loamy earth.

Specimen

Specimen 15, on a very attentive examination by Mr. Bingley, was found to contain

Silex - - -	72
Alumine - -	8
Oxide of iron - -	4
Maltha - -	16

Specimen 16, examined also by Mr. Bingley, yielded

Maltha - -	60
Carbon - - -	37·10
Ashes - - -	2·10

The proprietor Mr. Wood of Barbadoes.

Specimen 17. We have not yet the place from which this specimen was obtained. It was analysed, without this information, at the particular request of the proprietor, Barker Chifney, esq.

Mr. R. Phillips found it to contain, on analysis,

Antimony - -	2·75
Lead - - -	8·21
Copper - - -	a trace
Oxide of iron - -	4
Silex - - -	68
Sulphur and oxygen -	7·4
Loss - - -	10

Spec. gravity 2·976.

Specimen 18. A red micaceous substance from Shropshire. As the analysis was for the metallic contents, which were found to be inconsiderable by Mr. R. Phillips, it was not deemed of sufficient importance for a humid analysis. Proprietor Sir Corbett Corbett.

Specimen 19, a carbonat of copper from Cheshire.

The analysis, by Mr. A. Aikin, gave 11½ per cent. of copper, 6 and $\frac{3}{10}$ths of which may be obtained by simple fusion. Proprietor Mr. Latham.

Specimen 20. A lead ore from the parish of Llandegfar in the isle of Anglesea.

Mr. R. Knight's analysis of this ore gave

125 grains of lead in 672 of the ore;

and Mr. Bingley's examination gave

1 grain of silver in 166 of the lead.

Proprietor Barker Chifney, esq.

The 21st specimen is under examination.

Besides these regular specimens, the society have determined to analyse all such substances as a committee appointed for that purpose shall determine worthy of examination.

Agreeably to that resolution, W. H. Pepys has analysed the

the satin spar*; Messrs. Aikin and Allen, wolfram, from which they have obtained the regulus of tungsten, of an equal specific gravity with D'Elhuyars †; Mr. R. Phillips the schiefer spar, and a variety of carbonates of lime‡.

During the meetings of the society a series of experiments on the substances which Klaproth treated in the porcelain furnace of Berlin, have been exposed to the action of oxygen gas on charcoal; from which, when completed, very interesting results to the mineralogist and chemist will be obtained.

Our cabinets, the great object of which is to complete the provincial mineralogy, have received large additions from correspondents and members. We should let no opportunity be lost in completing this useful collection.

I cannot conclude without mentioning the valuable present of the mineralogical map of Cornwall, so attentively drawn out, and presented by Mr. Wm. Phillips to the society.

The committee are at present employed in making a catalogue of the specimens we have, which, when printed, will be forwarded to each of the members.—Duplicates of specimens they have, and which are not in possession of the society, will assist much in completing our plan.

SOCIETY OF THE FRIENDLY SEARCHERS INTO NATURE AT BERLIN.

This society has proposed the following prize question:

The disputes in regard to basaltes are terminated; but the nature of it seems not yet to be ascertained, and therefore a diversity of opinions still prevail respecting it. Since the period when a prize question was proposed on this subject at Berne, geognosia has made considerable progress; but the geognostic relation of this kind of stone has remained partly a problem, and partly a subject of difference, among our best geologists.

It is very remarkable that all the geognosts, both foreigners and others, formed in Germany, and particularly under the direction of Werner, never entertain any doubt of the Neptunian origin of basaltes; but, on the other hand, the French and Italian mineralogists, who have never been

* A description of the satin spar by Mr. A. Aikin, and Mr. Pepys's analysis, were published in the xiith volume of the Philosophical Magazine, p. 364.

† Philosophical Magazine, vol. xiii. p. 407.

‡ Philosophical Magazine, vol. xiv. p. 289.

beyond

beyond the boundaries of their own country, though desirous of giving up their opinions when they do not coincide with nature, cannot abandon their volcanic ideas. Of this Breislac, Fortis, Fabroni, and, in particular, the acute-sighted Dolomieu, are striking examples. Does this arise from the different appearance assumed by the various kinds of trapp in these countries, and in Germany and England?

But there is even a great difference of opinion among those who defend the Neptunian origin of basaltes. In general they consider the formation of basaltes as belonging to the class of the alluvial kinds of substances, but assert that they are formed at different periods. On the other hand, Karsten, in his mineralogical tables, unites all the stones belonging to basaltes in *one peculiar class*, and other geologues entertain other opinions of this species of stone.

As more data can now be obtained than at the period when the former question was proposed, the object may be more fully obtained by a repetition of it, especially as many experiments on this subject are to be found in a variety of works; as a new component part has been discovered in basaltes by Klaproth and Kennedy, and as many essential observations not yet published have been since made.

The society has therefore resolved to give a prize of thirty ducats, transmitted to us by one of our foreign members, to be employed in improving the study of the sciences, for a paper which shall contain the best account of the nature of basaltes; the most satisfactory conclusions on that subject; and the best exposition of the errors in the different opinions hitherto offered respecting it.

The candidates must readily conceive that all partial conclusions, where the geognostic nature of one country only is taken into consideration, will be foreign to the proposed end: a comparison therefore of the most striking varieties of this singular production, found in different countries, is expected; such for example as the basaltes in Bohemia and on the Rhine; that of Auvergne with the basaltes of the middle part of Italy; the basaltes of Scotland with that of Ireland, &c.

An exposition of the peculiar character of its formation in different lands, and a clear account of the principal results in regard to the general formation, corresponding with the acknowledged principles of geology, will answer the views of the society.

The answers, written either in German, French, or Latin, must be transmitted in the usual manner, with a motto and a sealed a sealed note, containing the author's name, addressed to the society before the 1st of October 1805.

IMPERIAL ACADEMY OF SCIENCES AT ST. PETERSBURGH.

In the sitting of February the 11th, the president, M. von Novosilzof, presented to the academy a stone which about eight years ago fell from the atmosphere in the neighbourhood of Karkof, and which is perfectly similar to that which fell last year in Normandy, on the appearance of a fire-ball. As a particular account of the circumstances by which the fall of this stone was accompanied is expected, the president requested that it might be subjected to chemical analysis, as well as the piece of native iron sent to the academy by the celebrated professor Pallas, which is also considered as an atmospherical production.

XIX. *Intelligence and Miscellaneous Articles.*

VACCINE INOCULATION.

The following letter from Dr. de Carro to the editors of the *Bibliothèque Britannique*, dated Vienna, March 27, 1804, contains the latest account of the success of the vaccine inoculation in the East:

"You have seen by my preceding letters, and my work on the oriental vaccination, what rapid progress this happy discovery is making in Asia. We had never before heard that it had been extended beyond the peninsula of India. A letter from Bombay states that the vaccine inoculation is practised every where from Cape Comorin to Delhi. I have experienced a new pleasure,—that of having laid the foundation for vaccination in Persia.

"Dr. Milne, physician to the English factory at Bassora, having vaccinated a great number of children in that place, experienced an interruption in vaccinating immediately from arm to arm; and had recourse to threads, lancets, and pieces of glass containing vaccine matter. Being vexed to find that all these means failed, he wrote to me, in the month of May last year, earnestly begging me to send him vaccine matter by the first opportunity. I took every care possible to collect matter on ivory lancets, and to impregnate lint with it, according to the excellent method of Messrs. Ballhora and Stromeyer: but Dr. Milne, in the mean time, was obliged to quit Bassora and to retire to Bashire or Abusheher, in Persia. As my packet, which was dispatched from Vienna

Vienna in the beginning of the month of August, did not find him at Bassora, it was dispatched to Bashire, where he received it at the end of November. Dr. Milne, and Mr. Jukes an English surgeon, who for four months had despaired of seeing vaccination succeed, were agreeably surprised to find lint impregnated with matter still moist, which produced its effect on the first trial. The ivory lancets produced no effect whatever.

"I do not know in the whole history of the vaccine any instances more satisfactory of what may be done, by care, in the manner of preserving the matter, than the success of that which I some time ago sent to Bagdad, and lately to Bashire. We have witnessed the incalculable good produced by the first of these drops; and I have reason to hope that what has been so happily introduced into Persia, will be attended with as salutary effects in that immense and celebrated empire.

"Dr. Milne and Mr. Jukes inform me from Bashire, of date the 11th and 15th of January, that their first success made a great sensation in that town, which at present is one of the most commercial in the whole empire. They announce also that a mission is about to set out for Tehran, the seat of government; and Mr. Jukes, who is to accompany it in the quality of surgeon, has taken the most efficacious measures to put vaccination under the protection of the governors of the provinces, and even to explain the history and utility of it to the sovereign, to whom they will be presented.

"I am very impatient to receive the further details of this expedition. Mr. Jukes has promised to enter into a regular correspondence with me. Dr. Milne, who has been invited to Bombay, is succeeded at Bassora by Mr. Donald, who proposes to do every thing in his power to favour the propagation of the vaccine. The East India company have taken into consideration my exertions for introducing vaccination into the British settlements; and the secretary has made known to Mr. Paget, the English envoy at the court of Vienna, by a letter dated December 9, 1803, that the directors have voted me the sum of two hundred guineas to purchase a piece of plate.

"I have received also from the hospodar of Wallachia a magnificent India shawl, accompanied by a very flattering letter which his serene highness condescended to write to me, and in which he gives an account of the efficacious measures he has taken to diffuse vaccination throughout that principality. J. DE CARRO."

NOTICE

NOTICE FROM THE VACCINE POCK INSTITUTION,
No. 44, Broad-Street, Golden-Square.

25 June, 1804.

The public mind being of late much disturbed in consequence of successive reports during the whole of the last year, and especially of late by publications of cases esteemed to be instances of the small-pox two or three years subsequently to the cow-pock, the medical establishment of this institution have thought it their duty, whatever may be their own opinions, not to be inactive and silent.

Accordingly, I am directed to state that, in the last fortnight, a number of subjects who had undergone vaccination in the year 1800 (the *first* year of the new practice at any professed institution) have been submitted to the test or counter-proof, variolation, in circumstances the most favourable for exciting the small-pox. Besides these trials, additional ones have been instituted on subjects who were vaccinated in Dr. Pearson's early practice in 1799. Further, Reports have been already received at the Institution from several provincial correspondents who were witnesses to whole parishes of subjects vaccinated under Dr. Pearson's and Mr. Keate's inspection, or with matter furnished by them, early in the year 1799 *.

A very brief, but it is presumed conclusive statement of evidence, collected from these sources, on the question with which some persons have agitated the minds of so many families, is intended to be laid before the public in a week or ten days. This statement, it is apprehended, will be the most proper return to the respectable author, who has lately addressed his pamphlet "*To the Directors of the Vaccine Institution,*" very justly conceiving "that the point at issue is within the power of this Institution, if they will give directions for a number of persons to be inoculated with small-pox matter, and exposed strongly to infection, who were vaccinated early in the practice."—As no other professed vaccine institution but this has been established long enough to answer the demand, it has been determined to comply. W. SANCHO, Secretary.

* It may be very important information to affirm, that the matter now used at this Institution was *that* originally taken in January and February 1799, by one of the physicians, from cows in Marylebone-fields and Gray's-inn-lane; with the addition, about three years ago, of matter from the Milanese, by Dr. Sacco. But it does not appear that this extensive succession has at all altered the properties, nor that there is any difference of properties among these different sources of matter. The experience of this Institution does not justify the conclusions, that the failure of the cow-pock in preventing the small-pox depends in general upon the selection of matter on a particular day.

NEW EARTH.

Klaproth has discovered a new earth in an ore which has hitherto been supposed to contain tungsten. He has given it the name of *ochroït* earth. It seems to form the connecting link between the earths and the metallic oxides. It produces, like yttria, a reddish-coloured salt with sulphuric acid, and is precipitable by all the prussiates; but it differs from yttria in not forming sweet salts, in not being soluble in carbonate of ammonia (or but little so), and in acquiring, when ignited, a light brown colour. It also differs from yttria by not being fusible either by borax or by phosphates, with which yttria fuses into a colourless transparent globule.

THE PRINCESS DASHKOFF.

We intended to have given the life of this lady, lately directress of the Imperial Academy of Russia, along with the portrait that appears in the present number of our work; but not having been able yet to meet with sufficient materials, we must defer it.

DEATHS.

At Madagascar, the meritorious botanist André Michaux, author of the History of the American Oaks, and of an American Flora. According to an account of him published by De Leuze, he was bred a gardener, and, notwithstanding the many vicissitudes he experienced, had the satisfaction of enriching several parts of the earth with plantations. Before the revolution he was sent to New York in order to establish a botanical garden, in which all the plants he had collected in his excursions were to be preserved till he could return to France. In the course of the revolution he expended the greater part of his property to maintain this garden; but at length he was obliged to return, and on his voyage home he lost the remainder of it by shipwreck, but saved his plants, for the preservation of which he sacrificed the former. Through a desire of travelling he accompanied captain Baudin, but left him at the Isle of France in order to explore Madagascar, and to establish a garden on the coast for the preservation of plants brought from the interior parts of the island. The great fatigue to which he exposed himself hastened his dissolution.

Letters received at Hamburgh announce the death of that ingenious philosopher and indefatigable traveller M. von Humboldt, who is said to have fallen a sacrifice to the yellow fever at Acapulco.

METEOR-

METEOROLOGICAL TABLE *

For June 1804.

Days of the Month.	Thermometer. 8 o'Clock, Morning.	Noon.	11 o'Clock, Night.	Height of the Barom. Inches.	Weather.
1804. May 27	56°	64°	51°	29·94	Fair
28	58	63	50	·86	Cloudy, and rain at night
29	54	62	49	·92	Cloudy
30	55	60	56	30·00	Cloudy
31	57	61	55	·09	Fair
June 1	59	70	56	·17	Fair
2	58	74	60	·11	Fair
3	66	81	67	·02	Fair
4	68	83	64	29·98	Fair
5	66	75	64	30·05	Cloudy
6	64	71	57	29·95	Fair
7	57	68	54	·84	Fair and windy
8	57	64	56	·70	Fair
9	53	66	52	30·01	Fair
10	55	63	48	·10	Showery
11	50	65	56	·35	Fair
12	56	67	57	·41	Fair
13	61	69	61	·38	Hazy
14	63	60	57	·28	Rain
15	60	69	56	29·97	Fair
16	58	66	58	·76	Cloudy
17	60	68	61	·91	Fair
18	61	72	58	30·20	Fair
19	60	76	62	·37	Fair
20	63	76	60	·35	Fair
21	62	78	69	·31	Fair
22	68	76	59	·32	Fair
23	59	70	55	·30	Fair
24	63	80	62	·23	Thunder, with remarkable vivid lightning, and very little rain
25	66	82	66	20	Fair
26	58	70	59	18	Fair

* By Mr. Carey, of the Strand.

PREMIUMS offered by the SOCIETY, *instituted at* London, *for the Encouragement of Arts, Manufactures, and Commerce, for the Year* 1804.

TO THE PUBLIC.

THE chief objects of the SOCIETY are to promote the Arts, Manufactures, and Commerce of this kingdom, by giving rewards for all such useful Inventions, Discoveries, and Improvements, (though not mentioned in this book), as tend to that purpose; and, in pursuance of this plan, the SOCIETY have already expended FIFTY THOUSAND POUNDS, advanced by voluntary subscriptions of their members, and legacies bequeathed.

The manner in which this money has been distributed may be seen by applying to the Secretary or other officers of the SOCIETY, at their house in the *Adelphi*. The Register of the Premiums and Bounties they have given will show the very great advantages which the Public have derived from this Institution.

The meetings of the SOCIETY are held every *Wednesday*, at seven o'clock in the evening, from the fourth *Wednesday* in *October* to the first *Wednesday* in *June*. The several Committees meet on other evenings in the week during the session.

In order still farther to promote the laudable views of this SOCIETY, it may be necessary to explain the mode by which its members continue to be elected.

Each member has the privilege, at any weekly meeting of the SOCIETY, of proposing any person who is desirous to become a member, provided such proposal is signed by three members of the SOCIETY.

Peers of the Realm or Lords of Parliament are, on their being proposed, immediately ballotted for; and the name, with the addition and place of abode, of every other person proposing to become a member, is to be delivered to the Secretary, who is to read the same, and properly insert the name in a list, which is to be hung up in the SOCIETY's room until the next meeting; at which time such person shall be ballotted for; and, if two-thirds of the members, then voting, ballot in his favour, he shall be deemed a *perpetual member*, upon payment of *Twenty Guineas* at one payment; or a *subscribing member*, upon payment of any sum not less than *Two Guineas* annually.

Every member is entitled to vote and be concerned in all the transactions of the SOCIETY, and to attend and vote at the several Committees. He has also the privilege of recommending two persons as Auditors, at the weekly meeting of the SOCIETY; and, by addressing a note to the Housekeeper, of introducing his friends to examine the various models, machines, and productions, in different branches of arts, manufactures, and commerce, for which rewards have been bestowed; and to inspect the magnificent series of moral and historical paintings, so happily contrived and completed by JAMES BARRY, Esq. which, with some valuable busts and statues, decorate the Great Room. He has likewise the use of a valuable Library; and is entitled to the annual Volume of the SOCIETY's Transactions.

The time appointed for admission to the paintings or models, is from ten to two o'clock, *Sundays* and *Wednesdays* excepted.

PREMIUMS IN AGRICULTURE.

Class 1. ACORNS.

FOR having set, between the first of October, 1802, and the first of April, 1803, the greatest quantity of land, not less than ten acres, with acorns, with or without seeds, cuttings, or plants of other trees, at the option of the candidate; and for effectually fencing and preserving the same, in order to raise timber; the gold medal.

2. For the second greatest quantity of land, not less than five acres, set agreeably to the above conditions, the silver medal.

Certificates of setting agreeably to the above conditions, and that there are not fewer than three hundred young oaks on each acre, to be delivered to the Society on or before the first Tuesday in December, 1804.

3. RAISING OAKS. To the person who shall have raised, since the year 1800, the greatest number of oaks, not fewer than five thousand, either from young plants or acorns, in order to secure a succession of oak timber in this kingdom; the gold medal.

4. For the next greatest number, not fewer than three thousand; the silver medal.

Certificates that there were on the land, at least the number of young oak-trees required, in a thriving condition, two years after the planting, with an *account* of the methods pursued in making and managing the plantation, to be produced to the Society on or before the first Tuesday in January, 1805.

5. Ascertaining the best Method of raising Oaks. To the person who shall ascertain in the best manner, by actual experiments, the comparative merits of the different modes of raising oaks for timber, either from acorns set on land properly dug or tilled, from acorns set by the spade or dibble, without digging or tillage, either on a smooth surface, or among bushes, fern, or other cover; or from young plants previously raised in nurseries, and transplanted; regard being had to the expense, growth, and other respective advantages of the several methods; the gold medal.

The *accounts*, and proper *certificates* that not less than one acre has been cultivated in each mode, to be produced to the Society on or before the first Tuesday in November, 1804.

6. Chesnuts. For having sown or set, between the first of October, 1802, and the first of April, 1803, the greatest quantity of dry loamy land, not less than six acres, with Spanish chesnuts, with or without seeds, cuttings, or plants of other trees, adapted to such soil, at the option of the candidate; and for effectually fencing and preserving the same, in order to raise timber; the gold medal.

7. For the second greatest quantity, not less than four acres, the silver medal.

Certificates of sowing or setting, agreeably to the above conditions, and that there are not fewer than three hundred chesnut plants, in a thriving state, on each acre, to be delivered to the Society on or before the first Tuesday in January, 1805.

8. Elm. For having planted the greatest number of the English elm, not less than eight thousand, between the twenty-fourth of June, 1802, and the twenty-fourth of June, 1803; and for having effectually fenced and preserved the same, in order to raise timber; the gold medal.

9. For the second greatest number, not less than five thousand, the silver medal.

Certificates of having planted, agreeably to the above conditions, that the plants were in a healthy and thriving state two years at least after making the plantation, and specifying the distance of the plants, to be delivered to the Society on or before the first Tuesday in April, 1805.

10. Larch. For having planted out, between the twenty-fourth of June 1801, and the twenty-fourth of June, 1802, the greatest number of larch-trees, not fewer than five thousand; and for having effectually fenced and preserved the same, in order to raise timber; the gold medal.

11. For the next greatest number, not fewer than three thousand, the silver medal.

Certificates of the number of plants, that they were in a healthy and thriving state two years at least after they were planted out, with a general account of the methods used in making the plantation, to be delivered to the Society on or before the last Tuesday in December, 1804.

12, 13. The same premiums are extended one year farther.

Certificates to be produced on or before the last Tuesday in December, 1805.

N. B. The larch-trees may be either planted, mixed with other trees, or by themselves, as may best suit the convenience of the planter.

14. Osiers. To the person who shall have planted, between the first of October, 1803, and the first of May, 1804, the greatest quantity of land, not less than five acres, with those kinds of willows, commonly known by the names of osier, Spaniard, new kind, or French, fit for the purpose of basket-makers, not fewer than twelve thousand plants on each acre; the gold medal, or thirty guineas.

15. For the second greatest quantity of land, not less than three acres, the silver medal, or ten guineas. *Certificates* of the planting, and that the plants were in a thriving state five months at least after the planting, to be produced to the Society on or before the last Tuesday in November, 1804.

16. Alder. For having planted, in the year 1801, the greatest number of alders, not less than three thousand; the gold medal.

Certificates of the number of plants, and that they were in a thriving state two years at least after being planted, to be delivered to the Society on or before the last Tuesday in December, 1804.

17. Ash. For having sown or set, in the year 1801, the greatest quantity of land, not less than six acres, with ash for timber, with or without seeds, cuttings, or plants, of such other trees as are adapted to the soil; the gold medal.

18. For the next greatest quantity, not less than four acres, the silver medal.

Certificates of the sowing or setting, agreeably to the above conditions, that there are not fewer than one hundred ash plants on each acre, in a thriving and healthy condition, two years at least after the sowing or setting, with a general account of the methods used in making the plantation; to be delivered to the Society on or before the last Tuesday in December, 1804.

19, 20. The same premiums are extended one year farther.

Certificates to be delivered on or before the last Tuesday in December, 1805.

N. B. It is the particular wish of the Society, that such lands only as are not calculated for growing corn, should be employed for the purposes specified in these advertisements.

21. Forest-trees. To the person who shall have inclosed and planted, or set, the greatest number of acres (not less than ten) of land, that is incapable of being ploughed, such as the borders of rivers, the sides of precipices, and any land that has too many rocks, or that is not calculated to repay the expense of tillage, owing to the stiffness or poverty of the soil, the surface being too hilly, mountainous, or otherwise unfit for tillage, with the best sorts of forest-trees, namely, oak, Spanish chesnuts, ash, elm, beech, alder, willow, larch, spruce and silver fir, with or without screens of Scotch fir, adapted to the soil, and intended for timber-trees, between the first of October, 1801, and the first of April, 1802; the gold medal.

22. For the second greatest quantity of land, not less than seven acres; the silver medal, or ten guineas.

23. For the third greatest quantity of land, not less than five acres, the silver medal. A particular *account* of the methods used in making and managing the plantations, the nature of the soil, the probable number of each sort of plants, together with proper *certificates* that they were in a healthy and thriving state two years at least after making the plantation, to be delivered to the Society on or before the first Tuesday in November, 1804.

24, 25, 26. The same premiums are extended one year farther. *Certificates* to be produced on or before the first Tuesday in November, 1805.

N. B. With the above forest-trees, the seeds, cuttings, or plants, of such other trees as are adapted to the soil, and proper for underwood, may or may not be intermixed.

N. B. *The candidates for planting all kinds of trees are to produce certificates that the respective plantations are properly fenced and secured, and particularly to state the condition of the plants at the time of signing such certificates. Any information which the candidates for the foregoing premiums may choose to communicate, relative to the methods made use of in forming the plantations, or promoting the growth of the several trees, or any other observations that may have occurred on the subject, will be thankfully received.*

27. Securing Plantations of Timber-trees, and Hedge-rows. To the person who shall give to the Society the most satisfactory account, founded on experience, of the most effectual and least expensive method of securing young plantations of timber-trees, and hedge-rows, from hares and rabbits, as well as sheep and larger cattle, which at the same time shall be least subject to the depredations of wood-stealers, the silver medal, or ten guineas. The *accounts*, and *certificates* of the efficacy of the method, to be produced to the Society on or before the first Tuesday in November, 1804.

28. The same premium is extended one year farther. The *accounts* and *certificates* to be produced on or before the first Tuesday in November, 1805.

29. Comparative Tillage. For the most satisfactory set of experiments, made on not less than eight acres of land, four of which to be trench-ploughed,* and four to be ploughed in the usual manner, in order to ascertain in what cases it may be advisable to shorten the operations of tillage, by adopting one trench-ploughing, for the purpose of burying the weeds, instead of the method, now in common use, of ploughing and harrowing the land three or four times, and raking the weeds together and burning them; the gold medal. It is required that every operation and expense attending each mode of culture be fully and accurately described, and that proper *certificates* of the nature and condition of the land on which the experiments are made, together with a circumstantial account of the appearance of the subsequent crops during their growth; and also of the quantity and weight of the corn and straw under each mode of culture, or, in case of a green crop, the weight of an average sixteen perches, be produced to the Society on or before the first Tuesday in February, 1805.

30. Comparative Culture of Wheat, broad-cast, drilled, and dibbled. For the best set of experiments, made on not less than twelve acres, four of which to be sown broad-cast, four drilled, and four dibbled, the two latter in equidistant rows, in order fully to ascertain which is the most advantageous mode of cultivating wheat; the gold medal, or thirty guineas. It is required that every operation and expense of each mode of culture be fully described; and that proper *certificates* of the nature and condition of the land on which the experiments are made, together with an *account* of the produce of the corn, the weight per bushel, and also of the straw, be produced to the Society on or before the first Tuesday in February, 1805.

31. Spring Wheat. To the person who, between the 10th of January and the 10th of April, 1804, shall cultivate the greatest quantity of wheat, not less than ten acres; the gold medal. It is required, that the time of sowing and reaping be noticed; also a particular *account* of the species, cultivation, and expense attending it, with proper *certificates* of the nature and condition of the land on which the experiments were made, and the name of the crop, if any, which the same land bore the preceding

* It is a common practice among gardeners, when they have a piece of very foul land, to dig it two spits, or about eighteen inches deep, shovelling the weeds to the bottom. This they call trenching.

year; together with an *account* of the produce, the weight per Winchester bushel; and a sample, not less than a quart, be produced to the Society on or before the second Tuesday in February, 1805.

It is supposed that sowing wheat early in the spring will not only allow more time to till the land, but less for the growth of weeds; thus rendering the wheat as clean as a barley crop, and exhausting the soil much less than autumnal sowing. It may be seen in the 19th volume, that the wheat usually sown in autumn may be put into the ground, with great success, so late as February or March, thus giving time to clear the ground from turnips, or to avoid a bad season.

32. Beans and Wheat. To the person who shall have dibbled or drilled, between the 1st of December, 1803, and the 1st of April, 1804, the greatest quantity of land, not less than ten acres, with beans, in equidistant rows, and hoed the intervals twice or oftener, and shall have sown the same land with wheat in the autumn of the year 1804; the gold medal. It is required that an *account* of the sort and quantity of beans, the time of dibbling or drilling, and of reaping or mowing them, the produce per acre thrashed, the expense of dibbling or drilling, hand or horse hoeing, the distance of the rows, and the quality of the soil, together with *certificates* of the number of acres, and that the land was afterwards actually sown with wheat, be produced on or before the second Tuesday in March, 1805.

33. Beans. To the person who, in the year 1803, shall discover and cultivate, either by the drill or dibbling method, on not less than five acres, a species of horse-beans or tick-beans, that will ripen their seeds before the 21st of August; the silver medal, or ten guineas. It is required that a particular account of the bean, the cultivation, and the expense attending it, with proper *certificates* of the nature and condition of the land on which the experiments are made, together with an *account* of the produce, the weight per Winchester bushel, and a sample of not less than a quart, be produced to the Society on or before the first Tuesday in December, 1804. It is apprehended that, if a bean should be brought into cultivation with the habits of the hotspur, or other early peas, that it would, in a great measure, escape the danger arising from the collier-insect, or other insects, and allow more time for the farmers to till the land for the subsequent crop of wheat. The *accounts* and *certificates* to be delivered on or before the first Tuesday in December, 1804.

34. The same premium is extended one year farther. The *accounts* and *certificates* to be delivered on or before the first Tuesday in December, 1805.

35. Comparative Culture of Turnips. For the best set of experiments made on not less than eight acres of land, four of which to be sown broad-cast, and four drilled, to ascertain whether it is most advantageous to cultivate turnips by sowing them broadcast and hand-hoeing them, or by drilling them in equidistant rows, and hand or horse hoeing the intervals; the silver medal, or ten guineas. It is required, that every operation and expense of each mode of culture be fully described, and that proper *certificates* of the nature and condition of the land on which the experiments were made, together with the weight of the turnips grown, on a fair average sixteen perches of land, under each mode of culture, be produced to the Society on or before the first Tuesday in March, 1805. The object which the Society have in view in offering this premium is experimentally to ascertain the most advantageous method of growing turnips. To do this in a satisfactory manner, both the drilled and broad-cast crops should have the advantage of the most perfect cultivation, consequently the drilled crops should have the intervals between the rows worked by the horse or hand hoe, or by both these implements; and the rows should be either weeded or hand-hoed, or both weeded and hand-hoed. The broadcast crop should have every advantage which weeding and hand-hoeing can give it, consistently with leaving the soil a flat surface.

36. The same premium is extended one year farther. *Certificates* to be produced on or before the first Tuesday in March, 1806.

37. Parsnips. To the person who, in the year 1804, shall cultivate the greatest quantity of land, not less than five acres, with parsnips, for the sole purpose of feeding cattle or sheep; the gold medal. *Certificates* of the quantity of land so cultivated, with a particular *account* of the nature of the soil and weight of the produce on sixteen perches, and also of the condition of the cattle or sheep fed with the parsnips, and the advantages resulting from the practice, to be produced to the Society on or before the second day in February, 1805.

38. Buck Wheat. To the person who shall cultivate the greatest quantity of land with buck wheat, not less than thirty acres; the gold medal. It is required that the time of sowing and reaping be noticed; also a particular *account* of the species, cultivation, and expense attending it, the manner of reaping it, thrashing it, and housing the grain; with proper *certificates* of the nature and condition of the land on which the experiments were made, and the name of the crop, if any, which the same land bore the preceding year, together with an *account* of the produce, and a sample of the seed, not less than a quart, be produced to the Society on or before the second Tuesday in January, 1805.

39. For the next greatest quantity, not less than fifteen acres, on similar conditions; the silver medal. Information respecting its application to the feeding of cattle, hogs, and

poultry, and other of its uses, is also desired. It is known to be particularly serviceable in furnishing honey to bees.

40. RAISING GRASS SEEDS. To the person who shall raise the greatest quantity of each or any of the following named grass seeds, *viz.* —Meadow fox-tail (alopecurus pratensis), sweet-scented vernal grass (anthoxanthum odoratum), Timothy grass, meadow Fescue grass, smooth-stalked meadow grass (poa pratensis), rough-stalked meadow grass (poa trivialis); the silver medal, or ten guineas. It is required that *certificates* from persons who have viewed them in a proper state, to identify that they are one or other of the seeds above mentioned, indicating clearly the particular species, and noticing the quantity produced of such seeds, free from weeds or mixture of other grasses, together with proper samples of the seeds, be produced to the Society on or before the first day of February, 1805.

41. The same premium is extended one year farther. *Certificates* to be produced on or before the first day of February, 1806.

42. ROTATION OF CROPS. To the person who shall, between the 10th of August, 1801, and the 10th of September, 1803, cultivate the greatest quantity of land, not less than forty acres, in the following rotation, *viz.* 1st, winter tares; 2d, turnips; and 3d, wheat; and apply the two former crops in the best and most farmer-like manner, to the rearing, supporting, and fattening horses, cattle, sheep, or hogs, on the land which produced the crops; the gold medal, or one hundred guineas.

43. For the next in quantity and merit, on not less than thirty acres, the silver medal, or fifty guineas.

44. For the next in quantity and merit, on not less than twenty acres, the silver medal. It is required, that every operation and expense be fully described, and that satisfactory *certificates* of the nature and condition of the soil on which the crops have grown, together with an *account* of their appearance, the number of horses and cattle, sheep or hogs, fed by the two green crops, and, as near as possible, the improved value of the live stock by the consumption of those crops, and also the quantity of wheat per acre, and its weight per bushel, be produced to the Society on or before the first day of November, 1804.

It is presumed that very great advantages will arise to such agriculturists as shall adopt this rotation of crops on a dry soil. They will be enabled, with the addition of a few acres of turnip-rooted cabbage for spring-food, to keep such large flocks of sheep and herds of neat cattle as may secure a sufficient quantity of manure to fertilize their land in the highest degree, and in every situation. It is farther conceived, that wheats which will bear sowing in the spring will be particularly suitable for this premium.

45, 46, 47. The same premiums are extended one year farther. *Certificates* to be delivered on or before the first day of November, 1805.

48. PRESERVING TURNIPS. To the person who shall discover to the Society the best and cheapest method of preserving turnips perfectly sound, and in every respect fit for the purpose of supporting and fattening sheep and neat cattle, during the months of February, March, and April; the silver medal, or ten guineas. It is required that a full and accurate *account* of the method employed, and the expense attending the process, together with *certificates* that the produce of four acres at the least have been preserved according to the method described, and applied to the feeding of sheep and neat cattle; that the whole were drawn out of the ground before the first day of February, in order to clear the greater part of it previous to its being prepared for corn, and to save the soil from being exhausted by the turnips; and also of the weight of an average sixteen perches of the crop; be produced to the Society on or before the first Tuesday in November, 1804.

N.B. *It is recommended to those who may be induced to try the necessary experiments for obtaining this and the following four premiums, to consider the method employed for the preservation of potatoes in ridges (which the growers call pies), and also the propriety of adopting a similar method in cases where they are previously frozen. It is supposed that, in the latter instance, the addition of ice or snow, and the construction of the ridges upon a large scale, may be sufficient to preserve the freezing temperature till the vegetables are wanted for the use of cattle or sheep, at which time they may be thawed by immersion in cold water, and the* rot *which a sudden thaw produces may be prevented.*

49. For the next in quantity and merit, on not less than two acres, the silver medal.

50. PRESERVING CABBAGES. To the person who shall discover to the Society the best and cheapest method of preserving drum-headed cabbages perfectly sound, and in every respect fit for the purpose of supporting and fattening sheep and neat cattle during the months of February, March, and April; the gold medal, or thirty guineas.

51. For the next in quantity and merit, on not less than two acres, the silver medal or fifteen guineas. Conditions the same as for preserving turnips, *Cl.* 48. And the *accounts* to be produced on or before the first Tuesday in November, 1805.

52. PRESERVING CARROTS, PARSNIPS, OR BEETS. To the person who shall discover to the Society the best and cheapest method of

preserving carrots, parsnips, or beets, perfectly sound, and in every respect fit for the purpose of supporting horses, and fattening sheep and neat cattle, during the months of February, March, and April; the silver medal, or fifteen guineas. Conditions the same as for preserving turnips, *Cl.* 48. And the *accounts* to be delivered in on or before the first day in November, 1805.

53. Preserving Potatoes. To the person who shall discover to the Society the best and cheapest method of preserving potatoes, two or more years, perfectly sound, without vegetating, and in every other respect fit for the purpose of sets and the use of the table, and, consequently, of supporting and fattening cattle; the gold medal, or thirty guineas. It is required, that a full and accurate *account* of the method employed, and the expense attending the process, with *certificates* that one hundred bushels at the least have been preserved according to the method described, and that one or more bushels of the same potatoes have been set, and produced a crop without any apparent diminution of their vegetative power, and also that they have been used at table, with entire satisfaction to the person who ate of them, together with a sample of one bushel, be sent to the Society on or before the first Tuesday in November, 1805.

54. Making Meadow-Hay in wet Weather. To the person who shall discover to the Society the best and cheapest method, superior to any hitherto practised, of making meadow-hay in wet weather; the gold medal, or thirty guineas. A full *account* of the method employed, and of the expense attending the process, with not less than fifty-six pounds of the hay; and *certificates* that at least the produce of six acres of land has been made according to the method described, and that the whole is of equal quality with the sample; to be produced on or before the first Tuesday in January, 1805.

55. Harvesting Corn in wet Weather. To the person who shall discover to the Society the best and cheapest method, superior to any hitherto practised, of harvesting corn in wet weather; the gold medal, or thirty guineas. A full *account* of the method employed, and of the expense attending the process, with not less than two sheaves of the corn, and *certificates* that at least the produce of ten acres has been harvested according to the method described, and that the whole is of equal quality with the samples, to be produced on or before the first Tuesday in January, 1805.

56. Ascertaining the component Parts of arable Land. To the person who shall produce to the Society the most satisfactory set of experiments to ascertain the due proportion of the several component parts of rich arable land, in one or more counties in Great Britain, by an accurate analysis of it; and who having made a like analysis of some poor arable land, shall, by comparing the component parts of each, and thereby ascertaining the deficiencies of the poor soil, improve a quantity of it, not less than one acre, by the addition of such parts as the former experiments shall have discovered to be wanting therein, and therefore probably the cause of its sterility; the gold medal, or forty guineas. It is required, that the manurings, ploughings, and crops, of the improved land, be the same after the improvement as before; and that a minute *account* of the produce in each state, of the weather, and of the various influencing circumstances, together with the method made use of in analysing the soils, be produced, with proper *certificates* and the chemical results of the analysis, which are to remain the property of the Society, on or before the last Tuesday in February, 1805.

It is expected that a quantity, not less than six pounds, of the rich, of the poor, and of the improved soils, be produced with the *certificates.*

57. Gaining Land from the Sea. To the person who shall produce to the Society an account, verified by actual experiment, of his having gained the greatest quantity of land from the sea, not less than fifty acres, on the coast of Great Britain or Ireland; the gold medal. *Certificates* of the quantity of land, and that the experiments were begun after the 1st of January, 1798, to be produced to the Society on or before the last Tuesday in October, 1804.

58. The same premium is extended one year farther. *Certificates* to be produced on or before the last Tuesday in October, 1805.

59. The same premium is extended one year farther. *Certificates* to be produced on or before the last Tuesday in October, 1806.

60. Improving Land lying waste. For the most satisfactory *account* of the best method of improving any of the following soils, being land lying waste or uncultivated, *viz.* clay, gravel, sand, chalk, peat-earth and bog, verified by experiments on not less than fifty acres of land; the gold medal, or thirty guineas.

61. For the next greatest quantity, not less than thirty acres, the silver medal, or twenty guineas. It is required, that the land before such improvement be absolutely uncultivated, and in a great measure useless, and that, in its improved state, it be enclosed, cultivated, and divided into closes. *Certificates* of the number of acres, of the quality of the land so improved, with a full *account* of every operation and expense attending such improvement, the state it is in as to the proportion of grass to arable; and the average value thereof, to be produced on or before the first Tuesday in February, 1805.

62. Manures. For the most satisfactory set of experiments, to ascertain the comparative

advantages of the following manures, used as top-dressings on grass or corn land, viz. soot, coal-ashes, wood-ashes, lime, gypsum, night-soil, or any other fit article; the gold medal, or the silver medal and ten guineas. It is required that the above experiments be made between two or more of the above-mentioned manures, and that not less than two acres of land be dressed with each manure. An *account* of the nature of the soil, quantity and expense of the manure and crops, with *certificates*, to be produced on or before the last Tuesday in February, 1805.

63. The same premium is extended one year farther. The *accounts* and *certificates* to be produced on or before the last Tuesday in February, 1806.

64. Raising Water for the Irrigation of Land. To the person who shall discover to the Society the cheapest and most effectual method of raising water in quantities sufficient to be beneficially employed for the purpose of irrigating land, superior to and cheaper than any other method now in use; the gold medal, or fifty guineas. A model on a scale of one inch to a foot, with *certificates* that a machine at large, on the same construction, has been used, specifying the quantity of water delivered in gallons per hour, and the height to which it was raised, to be produced to the Society on or before the first of March, 1805.

65. The same premium is extended one year farther. *Certificates* to be produced on or before the first of March, 1806.

66. Paring Plough. To the person who shall invent and produce to the Society, a machine or plough for the purpose of paring land preparatory to burning, superior to any hitherto known, or in use for such purpose, and to be worked by not more than one man and two horses; the silver medal, or twenty guineas. The machine, and *certificates* that at least three acres have been pared by it in a proper manner, to be produced to the Society on or before the first of January, 1805.

67. Machine for Dibbling Wheat. To the person who shall invent a machine, superior to any hitherto known or in use, to answer the purpose of dibbling wheat, by which the holes for receiving the grain may be made at equal distances and proper depths; the silver medal and ten guineas. The *machine*, with *certificates* that at least three acres have been dibbled by it, to be produced to the Society on or before the second Tuesday in January, 1805. Simplicity and cheapness in the construction will be considered as principal parts of its merit.

68. Machine for Reaping or Mowing Corn. For inventing a machine to answer the purpose of mowing or reaping wheat, rye, barley, oats, or beans, by which it may be done more expeditiously and cheaper than by any method now practised, provided it does not shed the corn or pulse more than the methods in common practice, and that it lays the straw in such a manner that it may be easily gathered up for binding; the gold medal, or thirty guineas. The *machine*, with *certificates* that at least three acres have been cut by it, to be produced to the Society on or before the second Tuesday in December, 1804. Simplicity and cheapness in the construction will be considered as principal parts of its merit.

69. Thrashing Machine. To the person who shall invent a machine by which corn of all sorts may be thrashed more expeditiously, effectually, and at a less expense, than by any method now in use; the gold medal, or thirty guineas. The *machine*, or a model, with proper *certificates* that such a machine has been usefully applied, that at least thirty quarters have been thrashed by it, and of the time employed in the operation, to be produced to the Society on or before the last Tuesday in February, 1805.

70. Destroying the Grub of the Cockchafer. To the person who shall discover to the Society an effectual method, verified by repeated and satisfactory trials, of destroying the grub of the cockchafer, or of preventing or checking the destructive effects which always attend corn, peas, beans, and turnips, when attacked by those insects; the gold medal, or thirty guineas. The *accounts*, with proper *certificates*, to be produced on or before the first Tuesday in January, 1805.

71. Destroying Worms. To the person who shall discover to the Society an effectual method, verified by repeated and satisfactory trials, of destroying worms, or of preventing the destructive effects they occasion on corn, beans, peas, or other pulse; the gold medal, or thirty guineas. The *accounts*, with proper *certificates*, to be produced to the Society on or before the first Tuesday in January, 1805.

72. Destroying the Fly on Hops. To the person who shall discover to the Society an easy and efficacious method of destroying the fly on hops, superior to any hitherto known or practised, on not less than four acres of hop-ground; the gold medal, or thirty guineas. *Accounts* and *certificates* to be delivered to the Society on or before the first Tuesday in February, 1805.

73. Preventing the Blight, or Ravages of Insects, on Fruit-Trees and Culinary Plants. To the person who shall discover to the Society the most effectual method of preventing the blight, or ravages of insects on fruit-trees and culinary plants, superior to any hitherto known or practised, and verified by actual and comparative experiments; the gold medal, or thirty guineas. The *accounts*, with proper *certificates*, to be delivered to the Society on or before the second Tuesday in November, 1804.

74. The same premium is extended one year farther. The *accounts* and *certificates* to be delivered on or before the second Tuesday in November, 1805.

75. Removing the ill Effects of Blights, or Insects. To the person who shall discover to the Society the most effectual method of removing the ill effects of blights, or insects, on fruit-trees and culinary plants, superior to any hitherto known or practised, and verified by actual and comparative experiments; the gold medal, or thirty guineas. The *accounts* and *certificates* to be delivered to the Society on or before the first Tuesday in February, 1805.

76. Cure of the Rot in Sheep. To the person who shall discover to the Society the best and most effectual method of curing the rot in sheep, verified by repeated and satisfactory experiments; the gold medal, or fifty guineas. It is expected that the candidates furnish accurate *accounts* of the symptoms and cure of the disease, together with the imputed cause thereof, and the actual or probable means of prevention, which, with proper *certificates*, must be delivered to the Society on or before the first Tuesday in February, 1805.

77. Cure of the Foot-Rot in Sheep. To the person who shall discover to the Society the best and most effectual method of curing the foot-rot in sheep; the silver medal, or ten guineas. It is required, that the cure be ascertained by repeated and satisfactory experiments, and the method of performing it be verified by proper *certificates* delivered to the Society on or before the first Tuesday in February, 1805.

78. Preventing the ill Effects of Flies on Sheep. To the person who shall discover to the Society the most effectual method of protecting sheep from being disturbed and injured by flies; the silver medal, or ten guineas. It is required, that the method be ascertained by repeated experiments, and that a *certificate* of its efficacy be delivered to the Society on or before the first Tuesday in December, 1804.

79. Protecting Sheep. To the person who, in the year 1803, shall protect the greatest number of sheep, not fewer than one hundred, by hovels, sheds, or any other means, and give the most satisfactory account, verified by experiment, of the advantages arising from the practice of protecting sheep from the inclemency of the weather, by hovels, sheds, or any other means; the silver medal, or twenty guineas. A particular *account* of the experiments made, with the advantages arising therefrom, together with the expense, and *certificates* of its utility, to be produced to the Society on or before the first Tuesday in March, 1805.

80. The same premium is extended one year farther. The *accounts* and *certificates* to be delivered on or before the first Tuesday in March, 1806.

N.B. It is required that the *certificates* shall specify the length of time the sheep were so protected, and the manner in which they were maintained during that time; together with the general method of managing them.

81. Improving the Condition of the labouring Poor, by erecting Cottages, and apportioning Land. To the person who, in the year 1803, shall erect the greatest number of cottages for the accommodation of the labouring poor, and apportion not less than two acres of land to each cottage; the gold medal. The *accounts* and *certificates* to be delivered to the Society on or before the first Tuesday in February, 1805.

82. The same premium is extended one year farther. The *accounts* and *certificates* to be delivered to the Society on or before the first Tuesday in February, 1806.

83. Improving the Condition of the labouring Poor by apportioning Land to Cottages. To the person who, in the year 1803, shall apportion to the greatest number of cottages already built upon his or her estate, any quantity of land, not less than two acres to each cottage, for the better accommodation of the respective inhabitants; the gold medal. The *accounts* of the number of cottages, and of the quantity of land apportioned to each, to be delivered to the Society, with proper *certificates*, on or before the first Tuesday in February, 1805.

84. The same premium is extended one year farther. The *accounts* and *certificates* to be delivered on or before the first Tuesday in February, 1806.

85. Culture of Hemp in certain parts of Scotland. The Society for the Encouragement of Arts, Manufactures, and Commerce, wishing to encourage the growth of hemp for the use of the navy in certain parts of Scotland, comprehending the whole county of Argyle, that part of Perthshire situated to the north of the river Tay, and west of the Military Road (see Ainslie's Map of Scotland) leading from Logierait to the county of Inverness, and such other parts of Scotland as lie north of Inverness-shire, offers to the person who shall sow with hemp, in drills at least eighteen inches asunder, the greatest quantity of land in the above-mentioned district, not less than fifty acres statute measure, in the year 1804, and shall at the proper season cause to be plucked the summer hemp (or male hemp bearing no seed), and continue the winter hemp (or female hemp bearing seed) on the ground until the seed is ripe, the gold medal, or fifty guineas.

86. To the person who shall sow with hemp, in drills at least eighteen inches asunder, the

next greatest quantity of land in the same above-mentioned district, not less than twenty-five acres, statute measure, in the year 1804, and shall at the proper season cause the same to be plucked as above mentioned; the silver medal, or twenty-five guineas. *Certificates* of the number of acres, of the distance of the drills, of the plucking of the hemp, with a general *account* of the soil, cultivation, and produce, to be delivered to the Society, along with fourteen pounds of the hemp, and two quarts of the seed, on or before the second Tuesday in January, 1805.

PREMIUMS FOR DISCOVERIES AND IMPROVEMENTS IN CHEMISTRY, DYING, AND MINERALOGY.

87. Preserving Seeds of Vegetables. For the best methods of preserving the seeds of plants in a state fit for vegetation a longer time than has hitherto been practised, such method being superior to any known to the public, and verified by sufficient trial, to be communicated to the Society on or before the first Tuesday in December, 1804; the gold medal, or thirty guineas.

88. Preventing the Dry-rot in Timber. To the person who shall discover to the Society the cause of the dry-rot in timber, and disclose a certain method of prevention superior to any hitherto known; the gold medal, or thirty guineas. The *accounts* of the cause, and method of prevention, confirmed by repeated experiments, to be produced to the Society on or before the second Tuesday in December, 1804.

89. Preserving salted Provisions from becoming rancid or rusty. To the person who shall discover to the Society the best, cheapest, and most efficacious method of preserving salted provisions from growing rancid or rusty; the gold medal, or thirty guineas. A full *description* of the method, with proper *certificates* that it has been found, on repeated trials, to answer the purpose intended, to be produced to the Society on or before the first Tuesday in February, 1805.

90. Clearing Feathers from their animal Oil. To the person who shall discover to the Society the best and most expeditious method, superior to any hitherto practised, of clearing goose-feathers from their offensive animal oil, for the use of upholders, in making beds, cushions, &c. the silver medal, or twenty guineas. A quantity of such feathers unstripped and so cleared, not less than forty pounds weight, with a full *account* of the process, to be produced to the Society on or before the first Tuesday in February, 1805.

91. Refining Whale or Seal Oil. For disclosing to the Society an effectual method of purifying whale or seal oil from the glutinous matter that incrusts the wicks of lamps and extinguishes the light, though fully supplied with oil; the gold medal, or fifty guineas. It is required, that the whole of the process be fully and fairly disclosed, in order that satisfactory experiments may be made by the Society to determine the validity of the claim; and *certificates* that not less than twenty gallons have been purified according to the process delivered in, together with two gallons of the oil, in its unpurified state, and two gallons so refined, be produced to the Society on or before the second Tuesday in February, 1805.

92. Manufacturing Tallow Candles. To the person who shall discover to the Society a method of hardening or otherwise preparing tallow, so that candles may be made of it which will burn as clear and with as small a wick as wax candles, without running, and may be afforded at a less expense than any at present made with spermaceti; the gold medal, or thirty guineas. *Certificates* that 112lb. of such tallow have been made into candles, and 12lb. of the candles made thereof, to be produced to the Society on or before the second Tuesday in January, 1805.

93. Candles from Resin or other Substances. To the person who shall discover to the Society the best method of making candles of resin, or any other substance, fit for common use, at a price much inferior to those made of tallow only; the gold medal, or thirty guineas. Six pounds at least of the candles so prepared, with an *account* of the process, to be delivered to the Society on or before the first Tuesday in December, 1804.

94. Method of separating Sugar in a solid Form from Treacle. To the person who shall discover to the Society the best method of separating sugar from treacle, in a solid form, at such an expense as will render it advantageous to the public; the gold medal, or fifty guineas. A quantity of the sugar so prepared, in a solid form, not less than thirty pounds weight, with an *account* of the process, and *certificates* that not less than one hundred weight has been prepared, to be produced to the Society on or before the first Tuesday in February, 1805.

95. PROOF-SPIRIT. To the distiller who, in the year 1804, shall make the greatest quantity, not less than one hundred gallons, of a clean marketable spirit, from articles not the food of man or cattle, equal in strength or quality to the proof-spirit now in use, and at a rate not higher than the spirit produced from corn or melasses; the gold medal, or one hundred guineas. Ten gallons of the spirit, together with proper *certificates*, and a full *account* of the expense and mode of making it, to be produced to the Society on or before the first Tuesday in January, 1805.

96. Increasing Steam. To the person

who shall invent and discover to the Society a method, verified by actual experiments, of increasing the quantity or force of steam, in steam-engines, with less fuel than has hitherto been employed, provided that in general the whole amount of the expenses in using steam-engines may be considerably lessened; the gold medal, or thirty guineas. To be communicated to the Society on or before the first Tuesday in January, 1805.

97. SUBSTITUTE FOR TAR. To the person who shall invent and discover to the Society the best substitute for Stockholm tar, equal in all its properties to the best of that kind, and prepared from materials the produce of Great-Britain; the gold medal, or one hundred guineas. A quantity of the substitute, not less than one hundred weight, with *certificates* that at least one ton has been manufactured, and that it can be afforded at a price not exceeding that of the best foreign tar, together with an *account* of the process, to be delivered to the Society on or before the first Tuesday in March, 1805.

98. PREPARATION OF TAN. To the person who shall prepare in the most concentrated form, so as to be easily portable, and at a price applicable to the purposes of manufactures, the largest quantity, not less than one hundred weight, of the principle called by the French *tannin,* which abounds in oak-bark and many other vegetable substances; the gold medal, or fifty guineas. *Certificates* of the superior quality of the quantity so prepared, and a sample of not less than 28lb. to be produced to the Society on or before the last Tuesday in January, 1805.

99. INDELIBLE INK. To the person who shall discover to the Society, a method of making a black ink proper for writing, superior to any at present known, indestructible by chemical applications, and not dearer than that which is now in common use; the silver medal or fifteen guineas. *Certificates* that not less than two gallons of such ink have been actually prepared and found to possess the qualities above mentioned, with a full detail of the process of making it, and two quarts of the ink, to be delivered to the Society on or before the second Tuesday in January, 1805.

100. PREPARATION OF A RED STAIN FOR COTTON CLOTH. To the person who shall communicate to the Society, the cheapest and most effectual method of printing or staining cotton cloths with a red colour, by an immediate application of the colouring-matter to the cloth, equally beautiful and durable with the red colours now generally procured from decoctions of madder; the gold medal, or thirty guineas. *Certificates* that the above process has been advantageously used on ten pieces of calico, each twenty-one yards or upwards in length, one piece of the calico so printed, a quart of the colour in a liquid state, and a full *account* of the preparation and application, to be produced to the Society on or before the second Tuesday in January, 1805.

101. PREPARATION OF A GREEN COLOUR FOR PRINTING COTTON CLOTH. To the person who shall communicate to the Society the best and cheapest method of printing with a full green colour on cotton cloth, by an immediate application of the colouring matter from a wooden block to the cloth, equally beautiful and durable as the colours now formed from the complicated process of the decoction of weld on alumine and the solutions of indigo by earths or alkaline salts; the gold medal, or thirty guineas. *Certificates* and conditions as for premium 100.

102. SUBSTITUTE FOR THE BASIS OF PAINT. To the person who shall produce to the Society the best substitute, superior to any hitherto known, for the basis of paint, equally proper for the purpose as the white lead now employed; such substitute not to be of a noxious quality, and to be afforded at a price not materially higher than that of white lead; the gold medal, or one hundred guineas. A quantity of the substitute, not less than 50lb. weight, with an *account* of the process used in preparing it, and *certificates* that at least one hundred weight has been manufactured, to be produced to the Society on or before the first Tuesday in January, 1805.

103. RED PIGMENT. To the person who shall discover to the Society a full and satisfactory process for preparing a red pigment, fit for use, in oil and water, equal in tone and brilliancy to the best carmines and lakes now known or in use, and perfectly durable; the gold medal, or thirty guineas. One pound weight of such colour, and a full disclosure of its preparation, to be produced to the Society on or before the first Tuesday in Feb. 1805.

N. B. It is not required that the colour should resist the action of fire or chemical applications, but remain unaltered by the common exposure to strong light, damps, and noisome vapours.

104. ULTRAMARINE. To the person who shall prepare an artificial ultramarine, equal in colour, brilliancy, or durability, to the best prepared from lapis lazuli, and which may be afforded at a cheap rate; the gold medal, or thirty guineas. The conditions are the same as in the preceding premium for the red pigment.

105. ANALYSIS OF BRITISH MINERALS. To the person who shall communicate to the Society, the most correct analysis of any mineral production of Great-Britain, hitherto either unexamined, or not examined with accuracy; the gold medal. The analysis and sufficient specimens to be produced to the Society on or before the first Tuesday in Jan. 1805.

106. STATUARY MARBLE. To the person

who shall discover, within Great-Britain or Ireland, a quarry of white marble fit for the purposes of statuary, and equal in all respects to those kinds now imported from Italy; the gold medal, or one hundred pounds. A block of at least three feet in length, two in height, and two in width, with an account of the situation of the quarry, and *certificates* of its possessing considerable extent, to be produced to the Society on or before the first Tuesday in February, 1805.

N. B. In order to prevent useless expense or trouble to the claimant in forwarding so large a block, the Society will be ready to examine any smaller specimen of the marble, and express their opinion of its value to the candidate before the block required by the above premium is produced.

107. PREPARATION OF SULPHURIC ACID FROM SULPHUR WITHOUT THE USE OF ANY NITRIC SALT. To the person who shall prepare the largest quantity (not less than one ton) of sulphuric acid from sulphur, without any nitric salt, of a specific gravity, not inferior to the best sulphuric acid of commerce; the gold medal, or fifty guineas. *Certificates* that not less than the above quantity of such an acid has been prepared, together with a sample, to be produced to the Society on or before the first Tuesday in January, 1805.

108. PREPARATION OF ANY ALKALINE OR EARTHY NITRATE. To the person who shall prepare, in Great-Britain, the largest quantity, not less than one hundred weight, of any salt of nitric acid, with either earths or alkalies, by a method superior to and as cheap as those hitherto practised; the gold medal, or one hundred guineas. *Certificates* of the above quantity having been prepared, and a sample of not less than 28lb. to be produced to the Society on or before the last Tuesday in January, 1805.

109. FINE BAR-IRON. To the person, in Great-Britain, who shall make the greatest quantity of bar-iron, not less than ten tons, with coak, from coak-pigs, equal in quality to the best iron imported from Sweden or Russia, and as fit for converting into steel; the gold medal, or fifty guineas. Samples, not less than one hundred weight, with *certificates* that the whole quantity is of equal quality, to be produced to the Society on or before the first Tuesday in January, 1805.

110. PRESERVING IRON FROM RUST. To the person who shall invent and discover to the Society a cheap composition, superior to any now in use, which shall effectually preserve wrought iron from rust, the gold medal, or fifty guineas. A full description of the method of preparing the composition, with *certificates* that it has stood at least two years unimpaired, being exposed to the atmosphere during the whole time, to be produced to the Society, with ten pounds weight of the composition, on or before the first Tuesday in January, 1805.

111. REFINING BLOCK-TIN. To the person who shall discover to the Society the best method of purifying or refining block-tin, so as to render it fit for the finest purposes to which grain-tin is now applied, and not higher in price; the gold medal, or fifty guineas. *Certificates* that not less than three tons have been so refined or purified, with a full detail of the process, and a quantity, not less than one hundred weight, of the tin so refined, to be produced to the Society on or before the first Tuesday in January, 1805.

112. GLAZING EARTHEN-WARE WITHOUT LEAD. To the person who shall discover to the Society the cheapest, safest, most durable, and most easily fusible, composition, fit for the purpose of glazing the ordinary kinds of earthen-ware, without any preparation of lead, and superior to any hitherto in use; the gold medal, or thirty guineas. Specimens of the ware so glazed, with proper *certificates* of its having succeeded, and a sample of the materials made use of, to be produced to the Society on or before the first Tuesday in Feb. 1805.

113. REFINING COPPER FROM THE ORE. To the person who shall discover to the Society the best method of separating, purifying, and refining copper from the ore, so as to render it fit for the finest purposes to which fine copper is now applied, and by a process superior to any hitherto known or in use, and not higher in price; the gold medal, or fifty guineas. *Certificates* that not less than three tons have been so prepared or refined, and a quantity not less than one hundred weight of the copper so refined, to be produced to the Society on or before the first Tuesday in Feb. 1805.

114. MINERALOGICAL MAP OF ENGLAND AND WALES. To the person who shall complete and publish an accurate mineralogical map of England and Wales, on a scale of not less than ten miles to an inch, containing an account of the situation of the different mines therein, and describing the kinds of minerals thence produced; the gold medal, or fifty guineas. *Certificates* of the accuracy of such map, together with the map, to be produced to the Society on or before the first Tuesday in February, 1805. The map to remain the property of the Society.

115. MINERALOGICAL MAP OF IRELAND. The same premium is offered for a mineralogical map of Ireland, on similar conditions.

116. MINERALOGICAL MAP OF SCOTLAND. The same premium is offered for a mineralogical map of Scotland, on similar conditions.

117. NATURAL HISTORY. To the author who shall publish, in the year 1804, the natural history of any county in England or Wales; the gold medal, or fifty guineas. It is required that the several natural productions,

whether animal, or vegetable, or mineral, peculiar to the county, or found therein, be carefully and specifically arranged and described, in order that the public may be enabled to judge what arts or manufactures are most likely to succeed in such county. The work to be delivered to the Society on or before the last Tuesday in January, 1805.

PREMIUMS IN POLITE ARTS.

118. Honorary Premiums for Drawing, by Nobility. For the best original drawing, of any kind, by young gentlemen under the age of twenty-one, sons or grandsons of peers, or peeresses in their own right, of Great-Britain or Ireland, to be produced on or before the first Tuesday in March, 1805; the honorary medal of the Society in gold.

119. The same in silver for the best copy.

120, 121. The same premiums will be given, on the like conditions, to young ladies, daughters or grand-daughters of peers, or peeresses in their own right, of Great-Britain or Ireland.

122. Honorary Premiums for Drawing, by Gentlemen. For the best original drawing, of any kind, by young gentlemen under the age of twenty-one; to be produced on or before the first Tuesday in March, 1805; the gold medal.

123. For the best copy, the silver medal.

124, 125. The same premiums will be given for drawings by young ladies.

N. B. As the foregoing honorary premiums are intended only for such of the nobility and gentry as may hereafter become patrons or patronesses of the arts; persons professing any branch of the polite arts, or any business dependent on the arts of design, or the sons or daughters of such persons, will not be admitted candidates in these classes.

126. Drawings of Outlines. For the best outline, after a cast, in plaster, of the Venus de Medicis, by persons of either sex, under the age of sixteen, the figure not less than eighteen inches; to be produced on or before the last Tuesday in February, 1805; the greater silver pallet.

127. For the next in merit; the lesser silver pallet.

128. Drawings of Landscapes. For the best drawing in water-colours of a landscape after nature, not less than eighteen inches by twelve, by persons of either sex, under twenty-one years of age, to be produced on or before the last Tuesday in February, 1805; the gold pallet.

129. For the next in merit, the greater silver pallet. Each candidate must mention, on the front of the drawing, whence the view was taken.

130. Historical Drawings. For the best historical drawing, being an original composition, of five or more human figures; the height of the principal figure not less than eight inches; to be produced on or before the third Tuesday in Feb. 1805; the gold pallet.

131. For the next in merit; the greater silver pallet.

132. Drawing and Engraving. To the person who shall complete the best original drawing and engraving. The design and engraving to be executed by the same artist, and produced to the Society on or before the first Tuesday in February, 1805; the gold medal. It is required that the drawing and two impressions of the engraving be produced, and remain the property of the Society.

133. Line Engravings of Landscapes. For the best line engraving of a landscape, published in the year 1804, the size of the engraving not less than eighteen inches by fourteen; the gold medal. To be produced to the Society on or before the last Tuesday in January, 1805; and the impression to which the premium is adjudged to remain the property of the Society.

134. For the next in merit; the silver medal, on similar conditions.

135. Line Engravings of Historical Subjects. For the best line engraving published in the year 1804, of an historical subject, the size of the engraving not less than eighteen inches by fourteen; the gold medal.

136. For the next in merit; the silver medal. Conditions, &c. the same as in classes 133 and 134.

137, 138, 139, 140. The same premiums are extended one year farther.

N. B. It is not necessary in the classes of line engravings, for the artist's name to be concealed. The first aquafortis proof of the above plates are required to be sent in with the finished impression, and *certificates* that the etchings are the entire work of the candidate. The aquafortis proof also to remain the property of the Society.

141. Model in Clay or Plaster. For the best model in clay or plaster of an ornamental design for the purpose of embellishing works of architecture; the silver medal or twenty guineas. To be produced to the Society on or before the last Tuesday in January, 1805. The model not to be less than thirty inches by twelve.

142. Perspective Drawings of Machines. For the best perspective drawing of machines by persons under twenty-one years of age; the greater silver pallet. To be produced to the Society on or before the last Tuesday in January, 1805.

143. For the next in merit; the lesser silver pallet, on similar conditions.

144. Engraving on Wood, or Metal Blocks, &c. For the best engraving on wood or metal blocks, or any other material,

so that the same be rendered capable of composition with the letter-press, of any allegorical or other subject suited to the embellishment of letter-press, the gold pallet.

145. For the next in merit, the greater silver pallet. Two or more impressions along with the block to be produced to the Society on or before the first Tuesday in February, 1805. The impressions, but not the block, to remain the property of the Society.

146. Bronzes. For the best drapery figure or group cast in bronze; if a single figure, not less than twelve inches high; and, if a group, not less than nine inches; and which will require the least additional labour to repair; the gold medal, or the silver medal and twenty guineas. The cast to be exhibited to the Society before it is begun to be repaired, with the original figure or group, on or before the first Tuesday in February, 1805, together with a full explanation of the whole process.

147. Ornamental Drawings for Architectural Designs. For the best ornamental drawing for the purpose of embellishing architectural designs; a silver medallion with the following engraved inscription: *The Premium given by the Society for the Encouragement of Arts, Manufactures, and Commerce, in conformity to the Will of John Stock, of Hampstead, Esq.* The drawing to which the premium is adjudged to remain the property of the Society; and to be produced to the Society on or before the second Tuesday in February, 1805.

PREMIUMS FOR ENCOURAGING AND IMPROVING MANUFACTURES.

148. Machine for carding Silk. For the best machine, superior to any now in use, for carding waste silk equally well as by hand; to be produced, together with a specimen of the cardings, on or before the first Tuesday in November, 1804; the silver medal, or twenty guineas.

149. Cloth from Hop-stalks, &c. To the person who shall produce to the Society the greatest quantity, not less than thirty yards of cloth at least twenty-seven inches wide, made in Great-Britain, of hop-stalks or bines, or other raw vegetable substances, the produce of Great-Britain or Ireland, superior to any hitherto manufactured from such substances, and which can be generally afforded as cheap as cloth of equal quality and appearance now made from hemp, flax, or cotton, and much finer in quality than any hitherto manufactured in England from hop-stalks, &c. the gold medal, or thirty guineas. One pound of the thread of which the cloth is made, and thirty yards of the cloth, together with proper *certificates* that the whole is manufactured from hop-stalks or bines, &c. to be produced to the Society on or before the first Tuesday in December, 1804.

N.B. The Society is already in the possession of cloth made in England from hop-stalks or bines, which may be inspected by application to the Housekeeper.

150. Wicks for Candles or Lamps. To the person who shall discover to the Society a method of manufacturing hop-stalks or bines, or any other cheap material, the growth of Great-Britain, so as to render them equally fit for the purpose of supplying the place of cotton, for wicks of candles or lamps; twenty guineas. Samples, not less than five pounds weight, of the wick so prepared, to be produced to the Society, with *certificates* that the whole quantity is equal in quality to the sample, on or before the second Tuesday in Jan. 1805.

151. Paper from raw vegetable Substances. To the person, in Great-Britain, who shall, between the first of January, 1804, and the first of January, 1805, make the greatest quantity, and of the best quality (not less than ten reams), of good and useful paper, from raw vegetable substances, the produce of Great-Britain or Ireland, of which one hundred weight has not been used in manufacturing paper previous to January, 1803, superior to any hitherto manufactured from such substances, and which can be generally afforded as cheap as paper of equal quality and appearance now made from rags; twenty guineas.

N.B. The object of the Society being to add to the number and quantity of raw materials used in this manufacture, it is their wish to include every useful sort of paper, and to introduce such natural products as can be easily and cheaply procured in great quantities. The Society are in possession of two volumes containing a great variety of specimens of paper made from raw vegetable substances, *viz.*—nettles, potatoe-haum, poplar, hop-bines, &c. which volumes may be inspected by any person on application to the Housekeeper. *Certificates* of the making such paper, and one ream of the paper, to be produced on or before the last Tuesday in January, 1805.

152. Transparent Paper. To the person who shall discover to the Society a method of making paper from the pulp that shall be perfectly transparent, and of a substance and body equal to foolscap, that shall take and bear common writing ink with the same facility and correctness as writing-paper generally in use; the silver medal, or twenty guineas. *Certificates* of the making such paper, an *account* of the process, and one ream of the paper, to be produced on or before the second Tuesday in January, 1805.

153. Chints Patterns for Calico-Printers. For the best original pattern in a new taste, of light or dark-ground chints for garment-work, fit for the purposes of calico-

printers, by persons of either sex; the gold medal. To be produced to the Society on or before the second Tuesday in January, 1805; the pattern to which the premium is adjudged to remain the property of the Society.

154. For the next in merit; the silver medal, on similar conditions.

155. Copper-plate Patterns for Calico-Printers. For the best pattern, in a new style, fit for the purposes of calico-printers for garment-work; the silver medal. To be produced to the Society on or before the second Tuesday in January, 1805. The pattern to which the premium is adjudged to remain the property of the Society.

PREMIUMS IN MECHANICS.

156. Gunpowder-Mills. To the person who, in the year 1804, shall invent and bring to perfection the most effectual method of so conducting the works of gunpowder-mills, in the business of making gunpowder, as to prevent explosion; the gold medal, or one hundred guineas. *Certificates* and *accounts* of the method having been put in practice in one or more gunpowder-mills in this kingdom, and that it promises, in the opinion of the best judges concerned in such works, to answer the purpose intended, to be produced to the Society on or before the first Tuesday in Feb. 1805.

N.B. As an encouragement to persons to turn their thoughts to improvements of this nature, if any should be made on the present method of conducting the business of gunpowder making, which fall short of the total prevention of explosion, and they are sent to the Society for the sake of humanity, the papers so sent in will receive due consideration, and such bounty or reward will be bestowed thereon as they appear to merit.

157. Transit-Instrument. To the person who shall invent and produce to the Society a cheap and portable transit-instrument, which may easily be converted into a zenith-sector, capable of being accurately and expeditiously adjusted, for the purpose of finding the latitudes and longitudes of places, and superior to any portable transit-instrument now in use; the gold medal, or forty guineas. To be produced on or before the last Tuesday in Jan. 1805.

158. Taking Whales by the Gun-Harpoon. To the person who, in the year 1804, shall strike the greatest number of whales, not fewer than three, with the gun-harpoon; ten guineas. Proper *certificates* of the striking such whales, and that they were actually taken in the year 1804, signed by the master, or by the mate when the claim is made by the master, to be produced to the Society on or before the last Tuesday in December, 1804.

159. Family Mill. To the person who shall invent and produce to the Society the best-constructed mill for grinding corn for the use of private families, or parish-poor; the construction to be such as to render the working of the mill easy and expeditious, and superior to any hitherto in use; the gold medal, or thirty guineas. The mill, and *certificates* of its having been used to good effect, to be produced to the Society on or before the first Tuesday in Feb. 1805. Cheapness and simplicity will be considered as essential parts of its merit; and the mill, or the model, to remain with the Society.

160. Machine for raising Coals, Ore, &c. &c. To the person who shall invent a machine for raising coals, ore, &c. from mines, superior to any hitherto known or in use, and which shall produce the effect at a less expense than those already known or in use; the gold medal, or fifty guineas. A model of the machine, made on a scale of not less than one inch to a foot, with a *certificate* that a machine at large on the same construction has been advantageously used, to be produced to the Society on or before the second Tuesday in Feb. 1805.

161. Improved Walking-Wheel or Crane. To the person who shall invent an improved walking-wheel or crane, on which the weight and power of any person or persons shall be applied with the greatest safety and effect, and so contrived that the power can be varied according to the greater or lesser weight to be raised or lowered; the gold medal, or thirty guineas. The model, on a scale of not less than one inch to a foot, with a proper *certificate* that the machine at large has been employed to good effect, to be produced to the Society on or before the second Tuesday in February, 1805.

162. Machine for Raising Water. To the person who shall invent a machine on a better, cheaper, and more simple construction than any hitherto known or in use, for raising water out of wells, &c. from a depth of not less than fifty feet; the gold medal, or forty guineas. *Certificates* of the performance of the machine, and a model of it, on a scale of not less than one inch to a foot, to be produced to the Society on or before the first Tuesday in February, 1805.

163. Elm Pipes. To the person who shall invent and discover to the Society a substitute for the elm pipes now in common use for the conveyance of water, which shall be cheaper, equally effectual, and more durable than any heretofore employed; the gold medal, or thirty guineas. It is required that one of the pipes so employed, an accurate *account* of the method used, and every expense attending it, together with satisfactory accounts of its being effectual, be delivered to the Society on or before the second Tuesday in January, 1805.

164. Extinguishing Fires. To the person who shall produce to the Society the best and most effectual method of procuring an imme-

diate supply of water in case of fire, or for the means best calculated to prevent or extinguish accidental fires in buildings, superior to any now in use; the gold medal, or thirty guineas. *Certificates* of the method having been practised with success, with a full description thereof, to be delivered to the Society on or before the second Tuesday in Jan. 1805.

165. Boring and Blasting Rocks. To the person who shall discover to the Society a more simple, cheap, and expeditious method than any hitherto known or in use of boring and blasting rocks in mines, shafts, wells, &c.; the gold medal, or thirty guineas. *Certificates* of the method having been practised with success, with a full description thereof, to be delivered to the Society on or before the first Tuesday in January, 1805.

166. Heating Rooms for the purposes of Manufacturers. To the person who shall invent and discover to the Society a method of heating rooms, superior to any hitherto known or in use, and at a moderate expense, for the purposes of painters, japanners, and other manufacturers, so as to avoid the necessity of iron or copper tunnels going through the rooms to convey the smoke, whereby the danger from such tunnels may be prevented; the gold medal, or forty guineas. A model, or complete drawing and description of the method, with *certificates* that it has been successfully practised, to be delivered to the Society on or before the last Tuesday in March, 1805.

167. Improved Ventilation. To the person who shall invent and produce to the Society a mode of permanently ventilating the apartments in hospitals, workhouses, and other crowded places, superior to any now known or used; the gold medal, or fifty guineas. A model of the apparatus, and a full account of the means by which the effect has been produced, with proper *certificates*, to be delivered to the Society on or before the last Tuesday in February, 1805.

168. Preventing Accidents from Horses falling with two-wheeled Carriages. To the person who shall invent and produce to the Society a method superior to any hitherto known or in use, to prevent accidents from the falling of horses with two-wheeled carriages, especially on steep declivities; the silver medal, or fifteen guineas. A model of the apparatus, and a full account of the means by which the effect has been produced, with proper *certificates* that the same has been used with success, to be delivered to the Society on or before the second Tuesday in January, 1805.

169. Improving Turnpike and other Roads. To the person who shall discover to the Society the most effectual and cheapest method, verified by actual experiments, of combining the materials ordinarily employed in making or repairing roads, so as to form them of the hardest consistence by their cementing properties, or by an artificial mixture of earth, stones, &c. altered by heat or any other mode, so as to form an even, hard, and durable carriage-road, not liable to be injured by heat or rain; the gold medal, or fifty guineas. It is required that an accurate *account* of the method used, and every expense attending it, together with satisfactory *certificates* of its being effectual, be delivered to the Society on or before the first Tuesday in March, 1805.

170. Cleansing Chimnies. To the person who shall invent and produce to the Society the most effectual mechanical or other means for cleansing chimnies from soot, and obviating the necessity of children being employed within the flues; the gold medal.

171. For the next in merit; the silver medal. The mechanical, or other means, with *certificates* of their having been used with proper effect, to be produced to the Society on or before the first Tuesday in January, 1805.

172. Chimnies Cleansed. To the person who shall during the year 1804 cleanse, or cause to be cleansed, the greatest number of chimnies, at least two stories high, not fewer than three hundred, by any mechanical or other process, which does not require the employment of boys within the flues; the gold medal. *Certificates*, signed by not less than two-thirds of those housekeepers on whose premises the said means have been employed, and an account of the process, to be produced to the Society on or before the first Tuesday in February, 1805.

173. To the person who shall cleanse, or cause to be cleansed, the next greatest number of chimnies, not fewer than one hundred and fifty, upon similar conditions to the above; the silver medal.

174. Raising the Bodies of Persons who have sunk under Water. To the person who shall invent and produce to the Society a cheap and portable drag, or other machine, superior to those now in use, for the purpose of taking up in the best and most expeditious manner, and with the least injury, the bodies of persons who have sunk under water; the gold medal, or thirty guineas. The drag, or machine to answer the purpose intended, to be produced to the Society, on or before the first Tuesday in March, 1805.

PREMIUMS OFFERED FOR THE ADVANTAGE OF THE COMMERCE OF THE UNITED EMPIRE.

175. Taking Porpoises. To the people in any boat or vessel, who, in the year 1804, shall take the greatest number of porpoises on the coast of Great-Britain or Ireland, by gun,

harpoon, or any other method, not fewer than thirty, for the purpose of extracting oil from them; the gold medal, or thirty pounds. *Certificates* of the number, signed by the persons to whom they have been sold or delivered for the purpose of extracting the oil, to be produced to the Society on or before the last Tuesday in January, 1805.

176. OIL FROM PORPOISES. To the person who shall manufacture the greatest quantity of oil from porpoises taken on the coast of Great-Britain or Ireland, in the year 1804, not less than twenty tons; the gold medal, or thirty pounds. *Certificates* of the oil having been made from porpoises actually caught on the coast of Great-Britain or Ireland, and two gallons of the oil as a sample, to be produced to the Society on or before the last Tuesday in February, 1805.

177. CURING HERRINGS BY THE DUTCH METHOD. To the person or persons who shall, before January, 1805, cure the greatest quantity of white herrings, not less than thirty barrels, according to the method practised by the Dutch, and equal in all respects to the best Dutch herrings, the same being caught in the British or Irish Seas, and cured in a British or Irish vessel or port; the gold medal, or fifty guineas.

178. For the next greatest quantity, not less than fifteen barrels; the silver medal, or twenty guineas. A sixteen-gallon barrel of the herrings to be produced to the Society on or before the first Tuesday in February, 1805, with *certificates* that the conditions of the premium have been completely fulfilled, and that the whole were cured in the same manner as the specimen, together with a full description of the process employed, in order that the Society may judge how far the Dutch method has been adopted.

PREMIUMS OFFERED FOR THE ADVANTAGE OF THE BRITISH COLONIES.

179. NUTMEGS. For the greatest quantity of merchantable nutmegs, not less than ten pounds weight, being the growth of his Majesty's dominions in the West Indies, or any of the British settlements on the coast of Africa, or the several Islands adjacent thereto, and equal to those imported from the islands of the East Indies; the gold medal, or one hundred guineas. Satisfactory *certificates*, from the governor, or commander in chief, of the place of growth, with an account of the number of trees, their age, nearly the quantity of fruit on each tree, and the manner of culture, to be produced on or before the first Tuesday in December, 1804.

180. The same premium is extended one year farther. *Certificates* to be produced on or before the first Tuesday in December, 1805.

181. CLOVES. For importing into Great Britain or Ireland, in the year 1804, the greatest quantity of cloves, not less than twenty pounds weight, being of the growth of some of the islands in the West Indies subject to the British empire, or any of the British settlements on the coast of Africa, or the several islands adjacent thereto, and equal in goodness to the cloves brought from the East Indies; the gold medal, or fifty guineas. Samples, not less than two pounds weight, with *certificates* that the whole quantity is equal in goodness, together with satisfactory *certificates* signed by the governor, or commander in chief, of the place of growth, with an *account* of the number of trees growing on the spot, their age, and the manner of culture, to be produced to the Society on or before the first Tuesday in January, 1805.

182. The same premium is extended one year farther. *Certificates* to be produced on or before the first Tuesday in January, 1806.

183. KALI FOR BARILLA. To the person who shall have cultivated, in the Bahama Islands, or any other part of his Majesty's dominions in the West Indies, or any of the British settlements on the coast of Africa, or the several islands adjacent thereto, in the year 1803, the greatest quantity of land, not less than two acres, with Spanish kali, fit for the purpose of making barilla; the gold medal, or thirty guineas.

184. For the next greatest quantity, not less than one acre; the silver medal, or fifteen guineas. *Certificates*, signed by the governor, or commander in chief, for the time being, of the quantity of land so cultivated, and of the state of the plants at the time of signing such *certificates*, to be delivered to the Society, with samples of the kali, on or before the second Tuesday in January, 1805.

185, 186. The same premiums are extended one year farther. *Certificates* to be produced on or before the second Tuesday in Jan. 1806.

187. DESTROYING THE INSECT COMMONLY CALLED THE BORER. To the person who shall discover to the Society an effectual method of destroying the insect commonly called the borer, which has, of late years, been so destructive to the sugar-canes in the West-India islands, the British settlements on the coast of Africa, and the several islands adjacent thereto; the gold medal, or fifty guineas. The discovery to be ascertained by satisfactory *certificates*, under the hand and seal of the governor or commander in chief, for the time being, and of some other respectable persons, inhabitants of the islands, or other place, in which the remedy has been successfully applied; such *certificates* to be delivered to the Society on or before the first Tuesday in January, 1805.

188. CULTIVATION OF HEMP IN UPPER AND LOWER CANADA. To the person who shall sow with hemp the greatest quantity of land in the province of Upper Canada, not less than six arpents (each four-fifths of a statute acre), in the year 1804, and shall at the proper season cause to be plucked the summer hemp (or male hemp bearing no seed) and continue the winter hemp (or female hemp bearing seed) on the ground until the seed is ripe; the gold medal, or one hundred dollars.

189. To the person who shall sow with hemp the next greatest quantity of land in the same province of Upper Canada, not less than five arpents, in the year 1804, in the manner abovementioned; the silver medal, or eighty dollars.

190. For the next greatest quantity of land, in the same province, and in a similar manner, not less than four arpents; sixty dollars.

191. For the next greatest quantity of land, in the same province, and in a similar manner, not less than three arpents; forty dollars.

192. For the next greatest quantity of land, in the same province, and in a similar manner, not less than one arpent; twenty dollars. *Certificates* of the number of arpents, the method of culture, of the plucking of the hemp, with a general *account* whether sown broad-cast or in drills, the expense, soil, cultivation, and produce, to be transmitted to the Society, certified under the hand and seal of the governor or lieutenant-governor, together with 28lb. of the hemp, and two quarts of the seed, on or before the last Tuesday in November, 1805.

193, 194, 195, 196, 197. The same premiums are extended one year farther. *Certificates*, &c. as before mentioned, to be transmitted to the Society, on or before the last Tuesday in November, 1806.

198 to 208. Premiums exactly similar in all respects to those held out for the province of Upper Canada, are also offered for the province of Lower Canada, and are extended to the same period.

209. IMPORTATION OF HEMP FROM CANADA. To the master of that vessel, which shall bring to this country the greatest quantity of marketable hemp, not less than one hundred tons, in the year 1804, the produce of Upper or Lower Canada; the gold medal.

210. To the master of that vessel which shall bring the next quantity, not less than fifty tons; the silver medal. *Certificates* satisfactory to the Society to be produced by the master of the vessel on or before the first Tuesday in February, 1805, to testify that such hemp was grown and prepared in Canada.

211, 212. The same premiums are extended one year farther. *Certificates* to be produced on or before the first Tuesday in Feb. 1806.

PREMIUMS OFFERED FOR THE ADVANTAGE OF THE BRITISH SETTLEMENTS IN THE EAST INDIES.

213. BHAUGULPORE COTTON. To the person who shall import into the port of London, in the year 1804, the greatest quantity, not less than one ton, of the Bhaugulpore cotton, from which cloths are made in imitation of nankeen, without dying; the gold medal. A quantity of the cotton, not less than five pounds weight in the pod, and five pounds carded, to be produced to the Society, with proper *certificates*, signed by the Secretary to the Board of Trade of Bengal or Bombay, on or before the last Tuesday in February, 1805.

214. The same premium is extended one year farther. *Certificates* to be produced on or before the last Tuesday in February, 1806.

215. ANNATTO. To the person who, in the year 1804, shall import into the port of London, from any part of the British settlements in the East Indies, the greatest quantity of annatto, not less than five hundred weight; the gold medal. A quantity of the annatto, not less than ten pounds weight, to be produced to the Society, with proper *certificates*, signed by the Secretary of the Board of Trade of the respective settlement, that the annatto is the produce of such settlement, on or before the last Tuesday in February, 1805.

216. The same premium is extended one year farther. *Certificates* to be produced on or before the last Tuesday in February, 1806.

217. TRUE COCHINEAL. To the person who, in the year 1804, shall import into the port of London, from any part of the British settlements in the East Indies, the greatest quantity of true cochineal, not less than five hundred weight; the gold medal. A quantity of the cochineal, not less than ten pounds weight, with proper *certificates*, signed by the Secretary of the Board of Trade of the respective settlement, that the cochineal is the produce of such settlement, to be produced to the Society on or before the first Tuesday in February, 1805.

218. The same premium is extended one year farther. *Certificates* to be produced on or before the first Tuesday in February, 1806.

CONDITIONS FOR THE POLITE ARTS.

No person who has gained the first premium in any class shall be admitted a candidate in a class of an inferior age; and no candidate shall receive more than one premium in one year; nor shall they, who for two successive years have gained the first premium in one class, be again admitted as candidates in that class.

No person shall be admitted a candidate in any class, who has three times obtained the first premium in that class.

No more than one performance in any class shall be received from the same candidate.

All performances (to which premiums or bounties are adjudged) shall remain with the Society till after the public distribution of rewards in May, when they will be re-delivered unless mentioned in the premiums to the contrary.

No performance shall be admitted, that has obtained a premium, reward, or gratification, from any other society, academy, or school, or been offered for that purpose.

All performances that obtain premiums in the Polite Arts must have been begun after the publication of such premiums, except line engravings.

To encourage real merit, and prevent attempts to impose on the Society, by producing drawings made or retouched by any other person than the candidate, the Society require a specimen of the abilities of each successful candidate, under the inspection of the Committee of Polite Arts, in every instance where such proof may appear necessary.

All candidates in the Polite Arts are required to signify, on their drawings, their age; and whether the performances are originals or copies; and if copies, whence they were taken.

SOCIETY'S OFFICE, ADELPHI, JUNE 1st, 1804.

ORDERED,

That the several Candidates and Claimants, to whom the Society shall adjudge Premiums or Bounties, do attend at the Society's Office in the Adelphi, on the last Tuesday in May, 1805, at Twelve o'Clock at Noon precisely, to receive the same; that day being appointed by the Society for the Distribution of their Rewards: And before that time no Premium or Bounty will be delivered, excepting to those who are about to leave the Kingdom.

In Cases where the Society may think fit to admit excuses for not attending in Person, Deputies may be substituted to receive the Rewards, provided such Deputies are either Members of the Society, or the superior Officers thereof.

GENERAL CONDITIONS.

As the great object of the Society in rewarding individuals is to draw forth and give currency to those inventions and improvements, which are likely to benefit the public at large, candidates are requested to observe, that if the *means*, by which the respective objects are effected, do require an expense or trouble too great for *general purposes*, the Society will not consider itself as bound to give the offered *reward*; but, though it thus reserves the power of giving in all cases such part only of any premium as the performance shall be adjudged to deserve, or of withholding the whole if there be no merit, yet the candidates may be assured the Society will always judge liberally of their several claims.

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, such claimant sending with it a paper sealed up, having on the outside a corresponding mark, and on the inside, the claimant's name and address; and all candidates are to take notice, that no claim for a premium will be attended to, unless the conditions of the advertisement are fully complied with.

No papers shall be opened, but such as shall gain premiums, unless where it appears to the Society absolutely necessary for the determination of the claim; all the rest shall be returned unopened with the matters to which they belong, if inquired after by the mark within two years.

All models of machines, which obtain premiums or bounties, shall be the property of the Society; and, where a premium or bounty is given for any machine, a perfect model thereof shall be given to the Society.

All the premiums of this Society are designed for Great-Britain and Ireland, unless expressly mentioned to the contrary.

The claims shall be determined as soon as possible after the delivery of the specimens.

It is expected that all articles for claims or bounties be sent to the Society carriage paid.

No person shall receive any premium, bounty, or encouragement, from the Society for any matter for which he has obtained, or purposes to obtain, a patent.

A candidate for a premium, or a person applying for a bounty, being detected in any disingenuous method to impose on the Society, shall forfeit such bounty, and be deemed incapable of obtaining any for the future.

No member of this Society shall be a candidate for, or entitled to receive any premium, bounty, or reward, whatsoever, except the honorary medal of the Society. The candidates are, in all cases, expected to furnish a particular account of the subject of their claims; and where certificates are required to be produced in claim of premiums, they should be expressed, as nearly as possible, in the words of the respective advertisements, and be signed by persons who have a positive knowledge of the facts stated.

Where premiums or bounties are obtained in consequence of specimens produced, the Society mean to retain such part of those specimens as they may judge necessary, making a reasonable allowance for the same.

No candidates shall be present at any meetings of the Society or committees, or admitted at the Society's rooms, after they have delivered in their claims, until such claims are adjudged, unless summoned by the committee.

N. B. The Society farther invite the communications of scientific and practical men upon any of the subjects for which premiums are offered, although their experiments may have been conducted upon a smaller scale than the terms of each require, as they may afford ground for more extensive application, and thus materially forward the views of the Society, and contribute to the advantage of the public. Such communications to be made by letter, addressed to the Society, and directed to Mr. CHARLES TAYLOR, the Secretary, *at the Society of Arts, Adelphi, London.*

The models required by the Society should be upon the scale of one inch to a foot. The Winchester bushel is the measure referred to for grain; and, as the acres of different districts vary in extent, it is necessary to observe, that the Society mean Statute Acres of five and a half yards to the rod or pole, when acres are mentioned in their list of premiums; and they request that all communications to them may be made agreeably thereto.

The Society desire that the Papers on different subjects sent to them may be full, clear, explicit, fit for publication, and rather in the form of Essays than of Letters; and where descriptive Drawings can be conveniently sent, with the Models and Machines laid before the Society, is is recommended to be done.

Presents to the Society of Books for their Library will be thankfully received.

*** To persons inclined to leave a sum of money to this Society by will, the following form is offered for that purpose.

Item. I give and bequeath to A. B, and C. D. the sum of upon condition, and to the intent that they, or one of them, do pay the same to the Collector for the time being, of a Society in London, who now call themselves the Society for the Encouragement of Arts, Manufactures, and Commerce; which said sum of I will and desire may be paid out of my personal estate, and applied towards the carrying on the laudable designs of the Society. By Order of the Society.

CHARLES TAYLOR, *Secretary.*

N. B. *The Society for the Encouragement of Arts, &c. considering that it would be beneficial to the Commerce of the United Kingdom, to bring the British Marbles into more general use, and that the most effectual method of accomplishing their object, would be,* for the present, *to make them more generally known in the capital, have come to the following resolutions:—*

Resolved,—That specimens of British Marbles be exposed in the Society's Rooms at the Adelphi for the inspection of the Public, under the following regulations:

1st, That all specimens be exact to a given size, *viz.* eight inches high, six inches broad, one inch thick, and polished on one face.

2d, That a book be kept containing the number of each specimen, and describing the situation of the quarry, the name of the parish where situated, the distance of the quarry from a beaten road, and the distance of that road from water-carriage, with the name of the donor and proprietor. Any remarks on the qualities of the marbles, or on the lime produced from them, will be gratefully received and preserved by the Society, as materials for future inquiries.

Resolved,—That as the exertions of the Society can only be beneficial to the public, inasmuch as their views are seconded by the public, the Society request, that all persons proprietors of marble quarries will favour them with a specimen of the marble, worked to the exact size above mentioned, with the description of the quarry as above, that the same may be entered in the book to be preserved for the use of the public.

Society of Arts, Manufactures, and Commerce, Adelphi.

ON Tuesday the 29th May, 1804, the Rewards of the Society were, as usual, distributed by his Grace the Duke of Norfolk, arranged under the following classes; and on Wednesday the 6th of June the Society held the last Meeting of that Session, and adjourned to the fourth Wednesday in October next.

IN AGRICULTURE.

To J. C. Curwen, Esq. M.P. of Belle-isle, Winandermere, for planting 814,956 timber-trees, class 23, the gold medal.

To J. A. Borron, Esq. Warrington, for planting 600,000 osiers, class 14, the gold medal.

To Thomas Plowman, Esq. Broome, in Norfolk, for an improved sheepfold, the gold medal.

To J. C. Curwen, Esq. M.P. Belle-isle, Winandermere, for drains extending 6000 yards, the gold medal.

To Mr. William Watson, North Middleton, near Belford, Northumberland, for the comparative culture of turnips, the silver medal.

To John Hutton, Esq. Marske, near Richmond, Yorkshire, for planting 19 acres with forest-trees, the silver medal.

To Mr. William Pearce, Landewednack, near Helston, Cornwall, for unremitted industry, the silver medal and 15 guineas.

To Mr. John Shirreff, Captain-Head, for preserving turnips in winter, class 51, thirty guineas.

IN CHEMISTRY.

To Sir H. Englefield, Bart. Tilney-street, for lake from madder, the gold medal.

To Dr. William Dyce, Aberdeen, for a mine of manganese, the gold medal.

To Mr. Matthew Gregson, Liverpool, for useful applications of burnt articles, the gold medal.

To J. Machlachlan, Esq. Calcutta, for accounts of the Eastern red dyes, and mineral products, the silver medal.

IN POLITE ARTS.

To Miss Elizabeth Penman, Glasgow, the gold medal.

To Miss Elizabeth Crutwell, Hammersmith, the silver medal.

To Miss Harriet Gough, Pontatawee Cottage, near Neath, Glamorganshire, the silver medal.

To Miss Grindall, Lower Brook-street, Grosvenor-square, the silver medal.

To Miss Sophia Charlotte Day, Lower Bryanstone-street, Portman-square, the silver medal.

To Miss Spurgeon, Lowestoft, Suffolk, the silver medal.

To Miss Andree, Hatton-Garden, the silver medal.

To John Churchman, Esq. the silver medal.

To Miss Matilda Lowry, Titchfield-street, the gold pallet.

To Mr. George Shepherd, Ratcliffe-row, City-road, the greater silver pallet.

To Mr. Henry Corbould, John-street, Fitzroy-square, the gold pallet.

To Mr. W. Heseltine, Bromley, near Bow, the greater silver pallet.

To Mr. G. Jones, Great Portland-street, the lesser silver pallet.

To Mr. Middiman, Lower Grafton-street, the gold medal.

To Mr. Henry Hole, Liverpool, the gold pallet.

To Mr. Richard Austin, jun. Paul's-alley, Barbican, the greater silver pallet.

To Mr. J. Carey, the gold medal.

To Mr. J. S. Halfpenny, Stafford-place, Pimlico, the greater silver pallet.

To Mr. H. D. Thielcke, Stafford-place, Pimlico, the lesser silver pallet.

IN MANUFACTURES.

To Mr. James Birch, Tavistock-Mews, Tavistock-street, Tottenham-court-road, for an improved swivel-loom, 25 guineas.

To Mr. James Pickard, Skinner-street, Bishopsgate-street, for an improved engine-loom, 20 guineas.

IN MECHANICS.

To the Rev. D. Pape, Penn, near Wolverhampton, for improving Rye Harbour, the gold medal.

To Capt. Brodie, Royal Navy, Leith, for marine improvements, the gold medal.

To Mr. R. Seppins, Chatham-yard, for obviating the necessity of lifting ships, the gold medal.

To Mr. George Walby, Goswell-street, for a hammer for making trowels, the silver medal and 40 guineas.

To Mr. George Dodd, Duke-street, Portland-place, for an improved gun-lock, the silver medal and 10 guineas.

To Mr. James Rawlinson, Derby, for an improved colour-mill, the silver medal and 10 guineas.

To the Chevalier Edelcrantz, of Sweden, for a safety valve for steam-engines, the silver medal.

To Mr. J. M. Elliot, Little Castle-street, for an improved repeating watch, 30 guineas.

To Mr. W. Hardy, Chapel-street, for a method of banking the balance of a time-keeper, 30 guineas.

To Mr. Thomas Holden, of Petworth, in Sussex, for a machine to do all the thread-work in shoemaking standing, 15 guineas.

IN COLONIES AND TRADE.

To J. W. Clarke, Esq. Montreal, for the culture of hemp, the gold medal.

To Mr. Jacob Schneider, York, Upper Canada, for the culture of hemp, class 188, the gold medal, or 100 dollars.

To Mr. Daniel Mosher, Kingston, Upper Canada, for the culture of hemp, class 189, the silver medal, or 80 dollars.

To Walter Baine, Esq. Greenock, for curing white herrings, the silver medal.

The Number of Noblemen, Ladies, and Gentlemen, elected Members since October last, is 115.

XX. *Extract from a Memoir on Platina, by* Fourcroy *and* Vauquelin*.

We shall not follow the authors of this memoir in all the details of their experiments, because they are too numerous; and as it would be impossible to give a clear account of them in a short extract, we shall attend only to the most interesting points, and those which exhibit new results.

To ascertain the influence which the foreign substances that accompany platina in its ore have in operations on a grand scale with this metal, the authors first separated and then carefully examined them. It results from this first labour, that the sand of platina contains iron, copper, titanium, chrome and silex, forming together different combinations, the state and manner of which the authors have explained from analogies known in the mineral kingdom.

They then treated platina thus freed from foreign bodies with nitro-muriatic acid, in order to obtain it in solution; but they observed, as Mr. Proust and several other chemists did, that there remained a small quantity of black powder, formed by brilliant laminæ, soft to the touch, which blackened paper like plumbago, and on which the nitro-muriatic acid had scarcely any action.

This black matter having particularly engaged their attention, they subjected it to a great number of experiments after they had obtained a sufficient quantity of it: as acids could be of no use to them in the examination of this substance, to make known its nature, they employed alkalies. Four parts of caustic potash, and one part of the black powder, were fused and calcined together in a platina crucible for an hour: the mass, which had then a very rich green colour, was diluted in water, to which it communicated the same tint.

When the green liquor was separated, and the residuum, which was also green, had been washed, they saturated the excess of alkali which the liquor contained, and exposed it to heat. By these means the green matter was separated under the form of flakes, and the liquor retained only a reddish yellow colour. The green flakes were united to the residuum not dissolved by the potash, and the yellow liquor was subjected to different tests, by the help of which they found that it contained chromic acid.

The residuum treated with concentrated muriatic acid was in

* From the *Annales de Chimie*, No. 143.

in a great measure dissolved, and gave a liquor of a beautiful green colour; but there still remained a portion of the black powder which had not been attacked by the potash, and on which the muriatic acid had exercised no action. On repeating this operation several times in succession with potash and muriatic acid, they decomposed it entirely, and obtained the whole chromic acid in the alkali, and the green matter in the acid.

It was then necessary to examine the green matter dissolved in the muriatic acid. For this purpose the authors began by evaporating the solution, in order to separate the excess of acid; but they were much surprised to find, at the moment when the liquor entered into ebullition, that its green colour was changed into a beautiful red. When the greater part of the superabundant acid was volatilized, they tried the rest by the following means.

1st, Alkalies precipitated from it a brownish red matter. 2d, A small piece of the sulphate of iron made it immediately lose its red colour, and gave it a green tint, which in the course of time acquired more intensity. 3d, Prussiate of potash formed in it a green precipitate, which became blueish in the air. 4th, Infusion of gall nuts produced a blackish brown precipitate. 5th, A solution of muriate of ammonia did not form a precipitate, as it does in a solution of platina. 6th, A solution of tin put into this solution, diluted with water, did not become red like solution of platina mixed with the same re-agent. 7th, This liquor mixed with a solution of pure platina, which was precipitated yellow by sal-ammoniac, gave it the property of being precipitated of a very dark red colour by the same salt.

This last experiment made Fourcroy and Vauquelin suspect that this might be the same substance which causes that diversity of colour which the precipitates of platina formed by sal-ammoniac assume; and this opinion they placed beyond all doubt by processes which we shall here mention. Hitherto every thing announced to them, that the black powder which remains after the solution of the platina contained together with chrome a new metal; but to be convinced of this fact it was necessary to obtain it separately, and in the metallic state.

For this purpose, as the above trials had indicated to them the presence also of a small quantity of iron, they evaporated to dryness the muriatic solution before mentioned, and then treated the residuum with alcohol: the latter dissolved the muriate of iron, and left a red powder in which the

the most scrupulous researches were not able to discover the least trace of that metal.

The residuum when calcined in a platina crucible exhaled at first vapours of muriatic acid, and then a substance which gave a blue colour to the flame of charcoal: at last there remained a black powder, which was not attacked by acids. They then subjected this black powder, covered with borax, to the action of a strong fire for an hour, and obtained a white metal, in part fused, brittle, and of which a part was still inclosed in the borax. To separate the whole of this metal from the borax they reduced it to powder, and washed it till the separation was complete.

This metal, when thus purified, does not dissolve in any simple acid. It combines with the nitro-muriatic acid, and gives it a very dark red colour. This solution takes place with more difficulty than that of pure platina, and requires more acid. It loses its colour by sulphate of iron: with prussiate of potash it gives a brown precipitate, which becomes green in the air: it communicates to a solution of pure platina the property of precipitating it of a very dark red colour by sal-ammoniac.

Such are the properties which Fourcroy and Vauquelin found in this metal, and which they are inclined to think do not belong to any of those hitherto known.

We shall now give, in a few words, an account of some of those experiments which they made on the different kinds of triple salts formed by solutions of platina and sal-ammoniac, to ascertain the cause of their various shades.

If a solution of crude platina in nitro-muriatic acid be twice precipitated by sal-ammoniac, it almost always happens that the second precipitate is of a very dark red colour, while the former is of a pale yellow or orange colour, and the mother-waters of these two precipitates, when evaporated, furnish more red.

If the yellow precipitate, when washed, be reduced to the metallic state by a sufficient heat, it does not dissolve speedily and in large quantity in the nitro-muriatic acid without leaving a sensible residuum: on the other hand, the red precipitate, when treated in the same manner, dissolves with more difficulty and in less quantity in the nitro-muriatic acid, and always leaves a black powder, more or less absorbent, which, when washed and exposed to a strong heat, is reduced to a metal having a perfect resemblance to that which they discovered in the residuum of crude platina dissolved in aqua regia. The whole of this metal, however, is not separated by the aqua regia of the platina,

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arising from the red salt; for the new solution which thence results is still precipitated red, though less intense: so that, if these operations were repeated several times on the same platina, it would at length be freed from this foreign metal. The authors found also another method of separating this metal from platina: it consists in dissolving the red salt in boiling water, and mixing with it, as soon as it is dissolved, caustic potash. The liquor then becomes turbid, and there are formed in it green flakes, which when washed and heated give the metal again. The pale yellow precipitate of platina, treated in the same manner, presented nothing of the same kind.

It is then proved by their experiments, that there exists in crude platina a new metal which communicates to the triple salts of platina the red colour which is almost always peculiar to them. As this metal is little susceptible of alteration by the agents employed to purify platina on a large scale, the authors suspected that traces of it more or less abundant ought still to be found in it; and this suspicion was confirmed by experience.

They found it in platina purified by C. Jannety and Necker Saussure in almost as great quantity as in crude platina; which induced them to say that in all probability they had not yet met with this metal in a state perfectly pure.

C. Vauquelin and Fourcroy terminate their memoir by recapitulating briefly the different results to which they were conducted, and by saying that they suspect that the new metal existing in platina enters conjointly with the latter into the composition of the palladium announced by Mr. Chenevix.

They promise to continue their labour, and to procure a greater quantity of the new metal for the purpose of subjecting it to new experiments, that they may make themselves better acquainted with its properties, and particularly to discover means more proper for purifying platina than those hitherto known.

XXI. *On Animal Cotton, and the Insect which produces it. By M.* Baudry des Lozieres.

Some successful experiments have been made in America and the West Indies to preserve and increase the insect known there by the name of *fly-carrier,* which produces an animal

animal cotton in many respects superior to vegetable cotton. An intelligent member of the American Philosophical Society, M. Baudry des Lozieres, has drawn up an interesting memoir on this cotton, and the insect which produces it.

"Every inhabitant of the West Indies," says this gentleman, "knows and dreads the greedy worm which devours their indigo and cassada plantations; it is called by some the cassada worm; by others, the fly-carrier; and is produced, like the silk-worm, from eggs scattered by the mother after her metamorphosis into a whitish butterfly. The egg is hatched about the end of July, when the animal is decked with a robe of the most brilliant and variegated colours. In the month of August, when about to undergo its metamorphosis, it strips off its superb robe and puts on one of a beautiful sea green, which reflects all its various shades according to the different undulations of the animal, and the different accidents of light. This new decoration is the signal for its tortures. Immediately a swarm of ichneumon flies assail it, and drive their stings into the skin of their victim over the whole extent of its back and sides, at the same time slipping their eggs into the bottom of the wounds that they have made.

"Having performed this dreadful operation, the flies disappear, and the patient remains for an hour in a motionless state, out of which it awakens to feed with great voracity. Then his size daily increases till the time of his hatching of the ichneumon flies. The eggs deposited are hatched at the same moment, and the cassada is instantly covered with a thousand little worms. They issue out of him at every pore, and that animated robe covers him so entirely, that nothing can be perceived but the top of his head. As soon as the worms are hatched, and without quitting the spot where the eggs are which they have broken through, they yield a liquid gum, which, by coming into contact with the air, is rendered slimy and solid. Each of these animalcula works himself a small cocoon, in the shape of an egg, in which he wraps himself, thus making, as it were, his own winding-sheet. They seem to be born but to die. These millions of cocoons, all close to each other, and the formation of which has not taken two hours, form a white robe, and in this the cassada worm appears elegantly clothed. While they are thus decking him, he remains in a state of almost lethargic torpidity.

"As soon as the covering is woven, and the little workmen, who have made it, have retired and hidden themselves in their cells, the worm endeavours to rid himself of his

 guests,

guests, and of the robe which contains them. He comes out of the inclosure deprived of all his former beauty, in a state of decrepitude, exhausted, and threatened with approaching death. He shortly passes to the state of a chrysalis; and, after giving life to thousands of eggs, suddenly loses his own, leaving to the cultivator an advantage which may be so improved, as to more than compensate the ravages which he occasions. In about eight days, the little worms contained in the cocoons are metamorphosed into flies, having four wings. Their antennæ are long and vibrating; some have a tail, others do not show it; they feed upon small insects of the family of *acarus*, and evidently belong to the ichneumon tribe.

"The cotton-shell or wrapper is of a dazzling white, and as soon as the flies have quitted the cocoon it may be used without any preparatory precaution; it is made up of the purest and finest cotton; there is no refuse, no inferior quality in it; every part is as fine and beautiful as can be imagined."

M. D. Lozieres, the author of this memoir, urges the Americans to preserve and endeavour to increase the fly-carrier, in the same manner and for similar purposes that the breed of the silkworm is encouraged. He declares that he has frequently seen so abundant a harvest of the animal cotton, that in the space of two hours he could collect the quantity of one hundred pints, French measure. Moreover, animal cotton is attended with none of the difficulties which occur in the preparation of vegetable cotton, and it requires less time and less trouble to procure it; and there seems to him no doubt that it will stand the competition with silk and with vegetable cotton: these, when applied to wounds, serve only to inflame and envenom; but the animal cotton may be used as lint, without the smallest inconvenience.

XXII. *Report made to the Class of the Physical and Mathematical Sciences, by* C. Ramond, *of a Memoir of* C. Daubuisson *on the Basaltes of Saxony.*

[Concluded from p. 66.]

The author, supported by this series of observations, proceeds to the considerations which they suggest, and which appear to him proper for establishing the aqueous origin of basaltes. Such is the object of the third chapter. The following chapter is destined to strengthen this first conclusion

clusion with every thing that can tend to prove that this kind of rock cannot have a volcanic origin. The author's proofs may be reduced to the following three principal classes: 1st, Position; 2d, Connection; 3d, Structure and Composition of the Basaltes.

If it be considered then in regard to position, we shall observe, with the author, that it is never found but on summits; that it covers all the mineral substances of which these mountains are composed, and that it is never covered by them; that always similar to itself, whether it rests on granite, gneiss, micaceous schist or porphyry, or whether it extends over gres, gravel, sand, and argil, it never participates in the nature of the soil which supports it. These data conduct to very simple results: the basaltes of Saxony has been the product of a special labour altogether distinct from that which produced the subjacent strata. This labour has been posterior to the formation of primitive rocks; it is even very recent, since transported earth is among the number of the substances by which basaltes is supported.

But what is the agent to which we are indebted for this new production? If fire be admitted, it will be necessary to indicate also the focus where the matters were fused; the mouths by which they were thrown up; the route they pursued to arrive at these summits, which command the country to a great distance around. In this hypothesis the whole will be reduced to either the one or the other of the following suppositions:—Each basaltic crown must be considered as the production of a local eruption, or all these masses must be the fragments of an immense stream which formerly covered the whole region.

According to the first system, every basaltic mountain must have been a volcano; but who does not know that a volcanic mountain is a confused accumulation of blocks, fragments, rapilli, pumice stones and scoriæ, intermixed with torrents of lava? Here nothing of this disorder is seen: rocks solidly deposited, and regularly placed one upon the other, have retained the situation given them by the water which formed them. Before an eruption, prepared in the interior of mountains, could charge their summits with the basaltes added to them, it would be necessary that it should form a passage in the axis of the mountain; that is to say, in the line of the greatest resistance; and where are the traces and aperture of this chimney, which, according to the simplest laws of mechanics, must be classed among the number of gratuitous suppositions? For six hundred years these mountains have been pierced, and their interior parts have

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been examined: every where the mountain is sound, its rocks are entire, and geologists are obliged to look for those pretended volcanic abysses, which interrupt as little the gallery of the miner as the vein for which he searches, in a few small superficial cavities which may have been formed by the hand of man, or by the least accident.

The second system will not be more fortunate. It will be readily admitted that the valleys by which the chain is traversed are posterior to its formation; that the strata now divided by these hollows were formerly continued; that the basaltes now accumulated on these summits formed an uninterrupted covering along the ridge, of which these strata are the remains. But in that case, whence did this enormous stream of fused matters proceed? At what distance are we to search for the volcanic region whence it issued? How can we conceive that the paste-like fluidity of the lava should yield to the length of the passage, and to so many surfaces of a different level, and that a deluge of fire should have overwhelmed such an extent of ground without calcining the calcareous matters, without baking the argillaceous, consuming the coals, filling up the places where it originated, and interspersing those where it passed with scoriæ, pumice stones, and ashes?

On this point the author derives great advantage from the thick stratum of coal on which the masses of the mount Meissner, in Hesse, are deposited. He observed this fact after the celebrated Werner. Like him, he asserts that it is impossible to distinguish the least traces of alteration in this accumulation of combustibles, which in general is separated from the basaltes only by a thin stratum of argil, and which very often is absolutely contiguous to it. But this is not all: in other places the basaltes is found alternately with the coals. This phænomenon has been observed in Bohemia, the Feroe isles, the isle of Mull, at Borrowstownness, in the mountains of Bathgate. Will it be said that the basaltes thus inserted between strata of combustible matters has been currents of fused stones? By what fire were these stones liquefied, if it spared in the centre of it crystals more fusible than itself; if it sported in the midst of bitumen without dissipating it in flames and in smoke: in a word, if it respected every thing except these stones themselves?

On the other hand, if we restore to the water that part of its domain which has been taken from it, all these difficulties will vanish. The basaltes of Saxony consists of strata regularly placed above each other, and formed by water,

water. The basaltes of Bohemia, Scotland, &c. are strata regularly inserted between strata which have no other origin. Why should we separate operations which are inseparable, and seek for forced explanations to facts which may be explained in so natural a manner? If it be admitted that the basaltes of Saxony is the work of water, nothing is more simple than what took place on that occasion. The mass of this chain was formed when the aqueous solution which inundated the country covered the old sediment with a stratum of basaltes. This stratum was at first continued like the banks and masses, which served it as a support; but being exposed to the erosion of currents and the destructive action of the weather, it yielded to the first of all the causes of degradation: it is at its expense that the first valleys have been dug out, and what remains on the summits is nothing but the last fragments.

Such is the first point of view under which the present question may be considered; and it must be allowed that, adopting the common laws of nature, the partisans of the latter opinion will not throw the whole *onus probandi* on those who propose exceptions. But this first advantage would become illusory, if it should be contradicted by a more minute examination of those masses which hitherto we have considered only under their more general aspect, and if we should discover some circumstances respecting the existence of basaltes easier to be explained by igneous than by aqueous fluidity.

The second object of consideration which occurs to us in the order we have adopted, is that of the connection of the basaltes. Though this substance seems to have been produced by the special and distinct labour of nature, it is not the only result. If we examine its position, it will be seen placed alternately with coals, and it is well known that it has been seen also alternately with shell stones. These successions are accidental in the formation. Coals and shell stones belong in part to its epoch without belonging to itself, and their presence indicates only the intermission of the cause which produced, in turn, these intercalated strata. But there exist two kinds of stones which are almost always associated with basaltes, which have the greatest analogy to it, which seem to be products of the same cause, and whose existence is so intimately connected with it, that no decision can be formed in regard to its origin till an opinion has been formed in regard to the rest: these rocks are *wacke* and *grunstein*.

What the Germans call wacke is a sort of stone which holds

holds a mean place between argil and basaltes. Like the latter, it often contains crystals of hornblend, but never olivin or augite; and always black hexagonal mica, which is rarely found in basaltes, and which serve to distinguish these two rocks when they approach so near to each other as to be confounded. Wacke often forms strata below those of basaltes.

Grunstein, on the other hand, generally covers basaltes. It is composed of feldspar and hornblend in distinct grains. It is the *whinstone* of the English, and the *granitella* of the French mineralogists. A comparative analysis of basaltes from Staffa, and whinstone from Salisbury, gave to Dr. Kennedy the same results with a precision worthy of remark; and it is proved, by the experiments of Sir James Hall, that these two rocks liquefy in the same manner, furnish by sudden cooling the same kind of glass, and by slow cooling the same stony substance.

If basaltes covered by grunstein be accurately observed, grains of feldspar appear between grains of amphibolite, and the rock at length assumes the granitoid texture. It was in the Meissner of Hesse that C. Daubuisson observed the most beautiful examples of this transition. He collected, he says, a series of specimens which in regard to the size of the grain present a decreasing progression from the most beautiful grunstein to the best characterized compact basaltes. And that it might not be objected that these specimens did not belong to the same mass, he chose some in which the granulated part was in the middle of the compact part, and in which they were seen, as it were, to blend into each other. We shall here remark, that the observation in question is exactly the same as that made by Desmarets and Dolomieu on certain kinds of basaltes which they have excluded from the number of volcanic productions.

On the other hand, if we consider the wacke on which basaltes rests, it will be seen to degenerate below into argil and then into gravel, while above it gradually assumes the colour, the texture, and solidity of basaltes. C. Daubuisson has seen prisms of basaltes very hard and very compact in its upper extremity, become tender and argillaceous at its lower. Dr. Reuss found in Bohemia basaltes the prismatic division of which was propagated in the wacke and the argil, which served it as a support. And before these observers, so long as fifteen years ago, the celebrated Werner, speaking of the Scheibenberg, said:—" I have seen, by a progressive series of shades, the most perfect transition of argil into wacke, and of the latter into basaltes.

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These three substances are the product of the same formation; that is to say, of the precipitation or sediment of the same solution, which becoming more and more tranquil has deposited argil, then wacke, and, in the last place, basaltes."

The partisans of the volcanic nature of the basaltes of Saxony have considered wacke sometimes as the production of muddy eruptions, and sometimes as the result of the decomposition of basaltes itself. If the observations here related were accurately made, these two suppositions are equally inadmissible. Wacke, which passes by insensible gradations to the state of basaltes, cannot be the result of muddy eruptions, if basaltes itself be not so. Nor is this wacke decomposed basaltes, for it contains neither the peridot nor the pyroxene of the latter; but, on the other hand, contains mica, of which the other is entirely destitute. In this supposition, founded on the gradual passage of basaltes to wacke, it would be necessary to draw the same inductions from the transition of wacke to argil, and from argil to the gravel which supports it. But who will believe that basaltes destitute of mica can be reduced by decomposition to wacke, which is filled with it; thence into argil, more and more sandy; and then into quartzy gravel, which did not exist in one of these substances more than the other?

But if we ascend from basaltes to the grunstein by which it is covered, what will become of all the explanations borrowed from the direct or indirect action of fire? This grunstein so entire, this granitella composed of grains of feldspar and amphibolite, endowed with all their splendour and freshness, which the least exposure to fire tarnishes, which a longer continued heat reduces to glass, and which more careful cooling reduces to a stony state where these elements are confounded never to be again separated,—can it be any thing else than the produce of water formed in the same manner as all other analogous rocks; and particularly as primitive grunstein, the origin of which is doubted by no one? Shall we suppose that it proceeds from basaltes itself, first thrown up by a volcano, then dissolved by the water, and again deposited?

It must therefore be allowed that simplicity is on the side of those who admit here only the effect of water. According to these, grunstein, basaltes, and wacke, with the argil and gravel on which they rest, are only sediments belonging to the same epoch, and constituting the different parts of the same system of coordinate rocks. The sea then contained all the elements, some of them suspended and others dissolved,

dissolved. It first deposited the coarsest under the form of argil and wacke, and, chemical precipitations succeeding to mechanical processes, in proportion as the waters became purified they then furnished basaltes and grunstein according as the crystallization, more or less turbid or tranquil, confounded or separated the hornblend and feldspar of which they were constituted.

But when we confess that this explanation is in many respects more natural, we must admit also that under other points of view there are difficulties: that this new labour of the seas, altogether distinct and detached from the preceding operations, supposes either the return of the waters which covered the globe, or strange changes in the properties of those by which it was still covered; that it is very singular to see these waters suddenly resume the dissolving power, which they had long lost, to cover the primitive and secondary mountains, and even the strata of alluvion, with new deposits, which represent in an inverse order those which they had before formed; to abandon first the coarsest matters, to finish by crystalline sediments, and the least soluble to crystallize the last; that one can hardly conceive how this solution, which covered very high mountains, and which consequently inundated a great part of the globe, should not leave more monuments of its existence; and how so great causes, acting so generally and at periods so modern, should produce only some thin deposits separated by intervals so vast.

It is, however, from the analogy which exists between the basaltes scattered throughout countries very remote from each other, that C. Daubuisson derives one of his most specious arguments in favour of its aqueous origin; and it is here that we shall enter into an exposition of this order of proofs, on which he founds the composition and structure of this kind of stone.

If we compare, says he, the basaltes from Sweden, Hesse, and Saxony; of Bohemia and Hungary; of Italy, d'Auvergne, and the island of Reunion; the same prismatic division, the same colour, fracture, and weight, will be found in them all. The foreign substances they contain are always amphibolite, peridot, pyroxene, &c.; when analysed they yield the same constituent principles. The different analyses of the same mineral seldom agree so much as those which Bergman, Klaproth, and Kennedy, have given us of the basaltes of Sweden, Bohemia, and Staffa. This conformity appears striking to the author of the memoir, and he finds in it one of the distinctive attributes of

rocks

rocks produced in the humid way. The calcareous and schistous rocks, &c. are every where similar; while the lava of Solfaterra, Lipari, and Vesuvius, are sensibly different, notwithstanding their proximity to each other. Nay, more, the lava thrown up by the same volcano is far from being identic: and how can the case be otherwise, since the foci of these volcanoes, placed in the middle of different rocks, must impress on the substances thrown up characters as various as the matters which are subjected to their action?

These considerations would be of little weight in the hypothesis of Dolomieu. The lava of the author of this memoir would belong to the strata which compose the crust of the globe: the basaltes would have issued from the greatest depths, from that common reservoir where this great observer of volcanoes sought for the origin of the greater part of his lithoid lavas. But could basaltes ever be fused? This C. Daubuisson denies, and it is from the crystals contained in it that he thinks he can deduce his most decisive proofs.

The crystals and grains found in basaltes are generally amphibolite, olivin, pyroxene, and feldspar, &c. These either must have pre-existed in the basaltes, and they must have been enveloped by the matter in fusion, or must have been formed in the bosom of that matter by the aggregation of the moleculæ of the same nature found disseminated in it. In the first case, how could those which are more fusible resist the heat which reduced them to the fluid state; and how could those which are more refractory preserve their colour, their transparency, and their splendour? In the second case, would not the paste-like fluidity of this lava have yielded to the movements of these moleculæ, and would not the heat have imprinted its character on their aggregation? But these crystals and grains which are generally found in basaltes are not the only bodies inclosed in them. The author found also gres. Others speak of several other substances, and particularly calcareous fragments. According to Werner, the basaltes of Carlsbad, in Bohemia, contains so large a quantity of it that it is employed for making lime; and Saussure relates in his Travels, that he saw basaltes which contained angular fragments of compact gray calcareous stone, which was in no manner altered at the point of contact. Nay, fossils themselves are not entirely foreign to this rock, and to that of the same epoch. M. de Buch found turbinites in a rock of trap. The author quotes Dr. Blagden and Mr. Chenevix as having seen the impression of shells in the hardest and most

compact

compact basaltes detached from prisms of the Giant's Causeway. In that of Vicentin, camites have been found. M. de Besolding has described an ammonite found in a basaltes of Forez: it still had a pearly splendour. The same naturalist speaks of other ammonites and gryphites contained in basaltes in the neighbourhood of Constance. In the last place, there exists in the neighbourhood of Bohemia a large mass of wacke which contains whole trees half petrified, and still retaining their bark, and even their leaves.

This wacke, which envelops whole trees, could not certainly be the production of a volcanic eruption. Basaltes in which shells are found with their pearly splendour does not appear to have been fused. But can these observations, made on some kinds of basaltes, be every where generalized? If it should result from the state of several of them that they have not an igneous origin, can we thence conclude that all, without exception, are of an aqueous origin? And does not the existence of certain kinds of basaltes, in places where its position gives reason for classing it among the lava, prove that the crystals in them may, in certain cases, have been subjected to the action of subterranean fire without being altered?

Here the long discussion which took place on the degree of the heat of volcanoes is renewed. Deluc, Dolomieu, and those who adopt their opinion, will affirm that they saw, as we may say, with their own eyes, torrents of lava the heat of which respected substances much more fusible than hornblend and feldspar.

The author of this memoir did not see any of this lava, but he answers this objection by experiments which establish the relative degrees of fusibility of basaltes and of the crystals found inclosed in it.

The former will set out from their observations to establish the hypothesis of a certain mode of fusion which does not alter the stones subjected to it.

Their adversaries will insist on experiments and analogies which tend to prove that fused mineral substances exhibit the same phænomena in nature as in our laboratories, and will mention instances of these kinds of lava having burnt, calcined, and destroyed, every thing they met with in their passage.

The one, then, will doubt what the others establish as a principle, and will reciprocally inclose each other in a kind of circle, from which it will be difficult for them to escape.

The question was in this state long before the time when the author of this memoir took it up; and we shall not enlarge

large further on this part of the discussion, where the strength of both parties seems to be balanced, and which scarcely contains any thing which has not been repeated a hundred times. But more numerous observations and more careful analyses have furnished new arms to the partisans of the aqueous origin of basaltes. It therefore remains to show how far they make the balance preponderate in their favour.

All the kinds of basaltes hitherto analysed contain a certain quantity of water, and from fifteen to twenty per cent. of iron. The case is the same with the wacke and the grunstein: they are in no manner different from basaltes, as appears by the analyses of Dr. Kennedy, which the author quotes.

If it be believed that the water contained in basaltes belongs to crystallization, it is evident that it has been in a state of aqueous solution itself, and the question is decided. This is the opinion of C. Daubuisson; and he refers also to the analysis of lava properly so called, which has all the principles of basaltes, except that water is not found in it. This argument, however convincing it may appear, is not unanswerable. The presence of this small quantity of water may be a consequence of the texture of basaltes rather than an indication of its origin. Since it is proved that fused stones resume, under certain circumstances, the lithoid form, it is probable also that it recovers the property of admitting water, which the most vitreous lava rejects; and this property is even proved in basaltes by the existence of geodes, which the infiltration of the water may have lined with crystals.

The quantity of iron which basaltes contains is of more importance to the fate of this dispute. All volcanic products properly so called, conduct, by observation and analysis, to known kinds of rock from which they originated. But whence does basaltes proceed, and what stone furnishes from fifteen to twenty per cent. of iron, if we exclude from the number of rocks basaltes and similar substances?

Shall we search for this iron in the depths of the common reservoir, which Dolomieu has supposed? C. Daubuisson will demand whether there exist other indications of this basaltes, and whether it is possible to admit an hypothesis which is of no other use than to explain this supposition.

Shall we retort the argument by asking him whence proceeds that lava so well characterized, that lava of Mount Ætna, which gives by analysis the same principles as basaltes, including the fifteen or twenty per cent. of iron? His answer will be very simple,—It proceeds from basaltes itself, which constitutes a large portion of the soil of Italy and Sicily: and this answer is the decisive word of the memoir, and the fundamental opinion of its author.

We shall add, that this is the opinion also of the best English and German mineralogists, and particularly of the celebrated Klaproth, who announced it almost in the same terms in his analysis of basaltes, translated and inserted in the *Journal des Mines* by C. Daubuisson *.

Hence real prismatic basaltes, which is found in volcanic soil, will belong to the mass of mountains, and not to their lava. Lava having the aspect of basaltes, and being composed of its constituent principles, will be basaltic lava, and not basaltes. The greatest difficulties, therefore, of this great question would rest, in some measure, on ambiguities, and would be removed by a simple distinction.

Let us now stop, and terminate here the analysis of the memoir, the examination of which has been confided to us.

C. Daubuisson first examined the basaltes of Saxony. He then gradually rises to more extensive considerations on basaltes in general, and deduces from them conclusions which form the subject of the fifth and last article of this memoir.

In regard to the first object, we are of opinion that he has discharged well the task imposed on him, and that his observations give a new degree of probability to the opinion received in Germany on the origin of the basaltes of that part of Europe.

In regard to the general considerations, by which he raises the basaltes known to him to that which he has not had an opportunity of observing, we are of opinion that he must naturally have been conducted to this extension of his first conclusions, either in the course of reasoning or by the authority of observers whose testimony he invokes.

A subject, however, where hazarded analogies seem already to have occasioned more than one mistake, requires, more than any other, great reserve in the employment of them; and on ground which two parties dispute inch by inch, each step ought to be justified by an observation and marked by a fact.

C. Daubuisson never saw those of volcanoes still burning, nor those of extinguished volcanoes, the existence of which he has not disputed. Being placed hitherto in the midst of the works of water, we wish he would proceed to

* Brumaire, year 11.

5 those

those places where the empire of fire has prevailed. We are desirous, above all, that he should examine the basaltes of Auvergne, which M. Leopold Buch, another pupil of Werner, has visited, and among which he observed some the volcanic origin of which he could not venture to dispute. C. Daubuisson knows how to observe; we have a proof of it in the works he has already published, were it not furnished by the memoir in question: and the attention which his observations seem to us to deserve, cannot be testified to him in a manner more useful to science than by encouraging him to continue them.

(Signed) Hauy and Ramond.

The class approves the report, and adopts the conclusions.

(Signed) Cuvier, perpetual secretary.

XXIII. *A short Account of Mr.* Arthur Woolf's *Improvement in the Construction of Steam-Engines.*

Mr. Woolf founds his improvements on a very important discovery which he has made respecting the expansibility of steam when increased in temperature beyond the boiling point, or 212° of Fahrenheit's thermometer. It has been known for some time, and for this discovery the world is indebted to Mr. Watt, who has been the principal improver of the steam-engine, that steam acting with the expansive force of four pounds the square inch against a safety-valve exposed to the atmosphere, is capable of expanding itself to four times the volume it then occupies, and still to be equal to the pressure of the atmosphere. Mr. Woolf has discovered that, in like manner, steam of the force of five pounds the square inch can expand itself to five times its volume; that masses or quantities of steam of the like expansive force of six, seven, eight, nine, or ten pounds the square inch, can expand to six, seven, eight, nine, or ten times their volume, and still be respectively equal to the atmosphere, or capable of producing a sufficient action against the piston of a steam-engine to cause the same to rise in the old engine (with a counterpoise) of Newcomen, or to be carried into the vacuous part of the cylinder in the improved engines first brought into effect by Messrs. Boulton and Watt; that this ratio is progressive, and nearly if not entirely uniform, so that steam of the expansive force of 20, 30, 40, or 50 pounds the square inch of a common safety-valve will expand itself to 20, 30, 40, or 50 times its

volume;

volume; and that, generally, as to all the intermediate or higher degrees of elastic force, the number of times which steam of any temperature and force can expand itself is nearly the same as the number of pounds it is able to sustain on a square inch exposed to the common atmospheric pressure: provided always that the space, place, or vessel in which it is allowed to expand itself, be of the same temperature as that of the steam before it be allowed room to expand.

Respecting the different degrees of temperature required to bring steam to, and maintain it at, different expansive forces above the weight of the atmosphere, Mr. Woolf has found, by actual experiment, setting out from the boiling point of water, or 212°, at which degree steam of water is only equal to the pressure of the atmosphere, that in order to give it an increased elastic force equal to five pounds the square inch the temperature must be raised to about $227\frac{1}{2}$°, when it will have acquired a power to expand itself to five times its volume, still be equal to the atmosphere, and capable of being applied as such in the working of steam-engines, according to his invention: and with regard to various other pressures, temperatures, and expansive forces of steam, the same are shown in the following table:

Table of the relative pressures per square inch, temperatures and expansibility of steam at degrees of heat above the boiling point of water, beginning with the temperature of steam of an elastic force equal to five pounds per square inch, and extending to steam able to sustain forty pounds on the square inch.

	Pounds per square Inch.		Degrees of Heat.		Expansibility.	
Steam of	5		$227\frac{1}{2}$		5	
an elastic	6		$230\frac{1}{4}$	and at	6	times its
force pre-	7	requires	$232\frac{3}{4}$	these re-	7	volume,
dominat-	8	to be	$235\frac{1}{4}$	spective	8	and con-
ing over	9	maintain-	$237\frac{1}{2}$	degrees of	9	tinue
the pres-	10	ed by a	$239\frac{1}{2}$	heat,	10	equal in
sure of	15	tempera-	$250\frac{1}{2}$	steam can	15	elasticity
the atmo-	20	ture equal	$259\frac{1}{2}$	expand	20	to the
sphere	25	to about	267	itself to	25	pressure
upon a	30		273	about	30	of the at-
safety-	35		278		35	mosphere
valve,	40		282		40	

And so in like manner, by small additions of temperature, an expansive power may be given to steam to enable it to expand to 50, 60, 70, 80, 90, 100, 200, 300, or more times its volume, without any limitation but what is imposed by the frangible nature of every material of which boilers and the other parts of steam-engines have been or can be made; and prudence dictates that the expansive force should never be carried to the utmost the materials can bear, but rather be kept considerably within that limit.

Having thus briefly explained the nature of Mr. Woolf's discovery, we shall proceed to give a description of his improvements grounded thereon, and for which he has obtained his majesty's royal letters patent. Mr. Woolf in his specification states, that in describing his invention he has found it necessary to mention the entire steam-engine and its parts, to which, as an invention well known, he neither can nor does assert any exclusive claim: he observes, however, that from the nature of his aforesaid discovery, and its application, there can be no difficulty in distinguishing his said improvements from the improved engine (of Mr. Watt) as to its other common and well known parts, and then gives the following account of an engine embracing his new improvements.

" If the engine be constructed originally with the intention of adopting my said improvement, it ought to have two steam vessels of different dimensions, according to the temperature or the expansive force determined to be communicated to the steam made use of in working the engine; for the smaller steam vessel or cylinder must be a measure for the larger. For example, if steam of forty pounds the square inch is fixed on, then the smaller steam vessel should be at least one fortieth part the contents of the larger one; each steam vessel should be furnished with a piston, and the smaller cylinder should have a communication both at its top and bottom (top and bottom being here employed merely as relative terms, for the cylinders may be worked in a horizontal or any other required position, as well as vertical): the small cylinder, I say, should have a communication both at its top and bottom with the boiler which supplies the steam, which communications, by means of cocks or valves of any construction adapted to the use, are to be alternately opened and shut during the working of the engine. The top of the small cylinder should have a communication with the bottom of the larger cylinder, and the bottom of the smaller one with the top of the larger, with proper means to open and shut these alternately by cocks, valves, or any other well known contrivance. And both the top and bottom of the larger cylinder or steam vessel should, while the engine is at work, communicate alternately with a condensing vessel, into which a jet of water is admitted to hasten the condensation, or the condensing vessel may be cooled by any other means calculated to produce that effect. Things being thus arranged, when the engine is at work, steam of high temperature is admitted from the boiler to act by its elastic force on one side of the smaller piston, while the steam which had last moved it has a communication with the larger steam vessel or cylinder, where it follows the larger piston now moving towards that end of its cylinder which is open to the condensing vessel. Let both pistons end their stroke at one time, and let us now suppose them both at the top of their respective cylinders, ready to descend; then the steam of forty pounds the square inch entering above the smaller piston will carry it downwards, while the steam below it, instead of being allowed to escape into the atmosphere or applied to any other purpose, will pass into the larger cylinder above its piston, which will take its downward stroke at the same time that the piston of the smaller cylinder is doing the same thing; and while this goes on, the steam which last filled the larger cylinder, in the upward stroke of the engine, will be passing into the condenser to be condensed during the downward stroke. When the pistons in the smaller and larger cylinder have thus been made to descend to the bottom of their respective cylinders, then the steam from the boiler is to be shut off from the top and admitted to the bottom of the smaller cylinder, and the communication between the bottom of the smaller and the top of the larger cylinder is also to be cut off, and the communication to be opened between the top of the smaller and the bottom of the larger cylinder; the steam, which in the downward stroke of the engine filled the larger cylinder, being now open to the condenser, and the communication between the bottom of the larger cylinder and the condenser shut off; and so on alternately, admitting the steam to the different sides of the smaller piston, while the steam last admitted into the smaller cylinder passes alternately to the different sides of the larger piston in the larger cylinder, the top and bottom of which are made to communicate alternately with the condenser.

"In an engine working with the improvements which have been just described, while the steam is admitted to one side of the piston in the smaller cylinder, the steam on the other side has room made for its admission into the larger cylinder, on one side of its piston, by the conden-

sation

sation taking place on the other side of the large piston which is open to the condenser; and that waste of steam which takes place in engines worked only by the expansive force of steam, from steam passing the piston, is prevented; for all steam that passes the piston in the smaller cylinder is received into the larger.

"In such an engine, where it may be more convenient for any particular purpose, the arrangement may be altered, and the top of the smaller made to communicate with the top of the larger, and the bottom of the smaller with the bottom of the larger cylinder; in which case the only difference will be, that when the piston in the smaller cylinder descends, that in the larger will ascend, and while the latter descends the former will ascend, which for some particular purposes may be more convenient than the arrangement before described."

Mr. Woolf then proceeds to describe various other modifications of his invention, and points out means for applying his improvements to the working of steam-engines already constructed and now in use, of which we shall give some account in our future numbers.

We cannot, however, conclude without observing that the benefits likely to result to the manufacturing interests of this country by Mr. Woolf's improvement of the steam-engine, cannot possibly be calculated. On this we shall offer a few thoughts on some future opportunity.

XXIV. *Experiments to ascertain whether there exists any Affinity betwixt Carbon and Clay, Lime and Silex, separately or as Compounds united with the Oxide of Iron forming Iron Ores and Iron Stones. By* David Mushet, *Esq. of the Calder Iron-Works.*

[Continued from p. 40.]

The following experiments were made with a view to unite carbon with silex by fusion.

I. Some pieces of very transparent quartz were introduced alone into a Sturbridge clay crucible, and exposed to a heat of 160° of Wedgwood. When cold, and examined, I found the form and number of the crystals entire. The surfaces were slightly vitrified: the colour white pearly. The interior of each crystal was spongy, and adhesive to the tongue.

II. Fifty

II. Fifty grains of this roasted quartz were pulverized and mixed with 3 grains of lamp black. The colour of the mixture was blueish black. I exposed it in a Cornwall clay pot to 170° of Wedgwood; but found the contents unfused, and still pulverulent. The mixture had become nearly of a black colour, but the fragments of silex remained unchanged.

III. Fifty grains of roasted quartz, mixed with half a grain of lamp black, were exposed in a similar manner as No. II. The result was the quartz in as pure and unfused a state as when introduced. The half grain of lamp black was nearly dissipated, and had communicated a shining lead colour to the interior of the crucible.

IV. A crystal of quartz possessing great depth of water was found to weigh 36½ grains. It was afterwards, for six hours, exposed in a bright red heat; when it was found to have lost nearly half a grain. The lustre and shape of the crystal remained unchanged.

V. The same crystal, after losing a small fragment, weighed 35½ grains. It was then exposed to 168° of Wedgwood. It was found shivered into a number of small pieces of a pearly white colour tinged with blue. A few fragments still possessed their original angle and transparency. The whole were carefully collected, and weighed only a quarter of a grain less than when introduced. In this experiment a total change was effected upon the subject, but scarcely any less of weight could be reckoned.

VI. I took two crystals of quartz, weighing 42 grains, and introduced them into a Cornwall clay crucible filled with charcoal. The heat to which they were exposed was nearly 170°. When examined, the following was found to be the result. The crucible was found still nearly filled with charcoal. The two crystals, with the exception of one small fragment, remained entire, though frittered a good deal. Excepting where the charcoal had entered the fissures, there was not the most distant appearance of contact, or any combination betwixt the siliceous matter of the quartz and it. The crystals had entirely lost their transparency, were possessed of a whitish enamelled surface, and seemed spongy in the centre. Their weight was 41 grains; and if the small portion of carbonaceous matter be taken into the account, which had entered the fissures, not more than 3-4ths of a grain was lost, of weight, in the exposure. This experiment proves that the combination of carbon with the matter of silex and clay, which constitutes quartz, takes place at a higher temperature than 170° of Wedgwood, and renders

ders it highly presumable that the affinity is not excited in any degree of heat short of fusion.

VII. 50 grains of roasted quartz, pulvérized,
5 ditto pure lime.

These were exposed, in a Cornwall clay crucible, to 167°. The result of this was a semi-vitrified mass, granulated, pure in colour, and very hard. The angles cut glass with considerable facility.

VIII. 50 grains of roasted quartz,
10 ditto pure lime, were softened into a white mass of porcelain, possessing a slight tint of azure.

IX. 50 grains of roasted quartz,
15 ditto pure lime, were melted into a whitish mass covered with some very perfect glass. The fracture was dense throughout, though not homogeneous.

X. 50 grains of roasted quartz,
15 ditto pure lime,
1 ditto lamp black, formed a solid mass of glass of a lead-blue colour. The carbonaceous matter had disappeared.

XI. 50 grains of roasted quartz,
15 ditto pure lime,
2 ditto lamp black.

This mixture fused, and formed a very black glass considerably spongy. The charcoal had, as in former experiments, disappeared. In this experiment, the interior of the crucible of Cornwall clay had received the usual glaze observed in experiments where the quantity of carbon made use of approaches nearly to that which the mixture is capable of taking up.

XII. 50 grains of roasted quartz,
15 ditto pure lime,
3 ditto lamp black.

This mixture was fused into a honey-combed mass of dark-coloured glass possessed of neither beauty nor transparency. A portion of the lamp black remained in its original state, partly enveloped in the mass and partly upon the surface. It was found to amount to nearly half a grain. The quantity, therefore, taken up by the quartz in this experiment, supposing the pure lime remained neutral, is exactly equal to 1-20th; and, by the combination of this proportion of carbon, the pure white porcelain, produced in Experiments VIII and IX, is changed into a honey-combed mass of black glass.

XIII. Fifty grains of pure silex were introduced into a Cornwall clay crucible, and exposed to a heat of 170° of

 Wedgwood.

Wedgwood. I found the silex fused into a rich pearlish green glass containing an immense number of air-bubbles. A minute speck of colour was noticed in one part, which resembled coal. The experiment was therefore repeated a second and third time; and the fused silex obtained in a state of great purity as to colour, though still containing a number of minute cells.

XIV. Fifty grains of pure silex and a quarter of a grain of lamp black were mixed. The carbon gave a delicate shade of blue to the silex. The mixture was fused into a singular glass composed of concentric laminæ or convexes of thin glass. The colour was indefinite and mixed, of a straw, watery, smoky tinge, and much clouded. It was, however, very transparent, and so buoyant as to float in air.

XV. 50 grains of pure silex,
$\frac{1}{2}$ grain of lamp black, were fused into a porous glass possessing a watery transparency, but of a light lead-blueish colour.

XVI. 50 grains of pure silex,
1 grain of lamp black, formed a glass considerably darker in point of colour than the former: the cells were much of the same size, but the thickness of the laminæ much increased, and the transparency proportionally diminished. In these three experiments the carbon had completely disappeared, nor had the interior of any of the crucibles exhibited the usual style of glazing.

XVII. 50 grains of pure silex,
2 ditto lamp black.

These were intimately mixed together, and exposed to a similar heat with the former. The result was a jet black glass much honey-combed, and apparently approaching a state beyond simple vitrification. The whole carbon had disappeared, and the interior of the crucible remained unglazed.

XVIII. 50 grains of pure silex,
3 ditto lamp black, were fused into an irregular mass of a very dark colour possessing large honey-combs. The transparency of the glass no longer existed, but a minute porosity admitted light with a singular effect. The carbon had disappeared, and the crucible had received a slight degree of colour from the carbon.

XIX. 50 grains of pure silex,
5 ditto lamp black.

This mixture assumed an earthy appearance of a very black colour, in a few places shining, but in general dull. The honey-combed appearance was less in this than in the former,

mer, and the porosity so visible in the last was considerably diminished. A portion of the carbonaceous matter remained untaken up which weighed 3-4ths of a grain, so that in this experiment $4\frac{1}{4}$ grains of carbon had disappeared, and united with the silex. This is equal to $8\frac{1}{2}$ per cent., or 1-12th part the weight of the silex.

It will not therefore appear rash to conclude, from these experiments, that carbon in high temperatures unites with siliceous matter in the same manner as indicated by the experiments with clay, and that its colour and appearance are totally changed by the union.

The conclusions to be drawn from these experiments, and facts in general, so far as they regard the manufacture of iron, will present themselves with more force of reasoning connected with the analysis of artificial and natural iron ores, containing solely or in excess a particular earth of the before-mentioned varieties.

The present may be concluded with one general remark, that the carbon does not appear to enter siliceous matter by cementation, as was evident in exposing the two siliceous crystals No. VI. In the experiments with clay, not only a mass of Cornwall clay was pervaded by the carbon, but many of the crucibles used in all these experiments were frequently penetrated a considerable portion of their thickness.

[To be continued.]

XXV. *Dr.* Thornton's *Second Letter to Mr.* Arthur Aikin.

July 10, 1804.
No. 1, Hind-street, Manchester-square.

SIR,

I was almost morally sure that you could never have allowed such gross ignorance and abuse to have passed in your Annual Review, had you "been aware of it," as have been exhibited in the "critique" on my work. Certainly you must have been *planet-struck*, when you read, probably, for the first time, in the letter I had the honour to address you, that, in your review, it was asserted that the *satellite* of Venus had not been mentioned in any work on astronomy, and that this before unheard of moon was of *my* invention; which seemed to afford your reviewer an opportunity of fpewing out a torrent of personal abuse against me. Such conduct could not fail to astonish one, who was in the habit of esteeming you before as a scholar and a gentleman, a character adopted from your learned father, and which I should

should be greatly surprised if you ever departed from. When excusing yourself as editor, I must beg leave to observe you have fallen into a slight mistake, when you say, "Astronomy has nothing to do with botany." Antiently agriculture was founded on a knowledge of the stars.

> Quid faciat lætas segetes, *quo sidere* terram
> Vertere, Mæcenas, ulmisque adjungere vites
> Conveniat —— *Virgil. Georg. lib.* 1.

Astrology and botany were early connected; and the four *seasons* are so much concerned in botany, that a scientific knowledge of their production is expected from the accomplished botanist. The effect of *light* on plants supposes some slight acquaintance with the bright luminary producing it—

> . . . . quandoque bonus dormitat Homerus.—*Hor. de Arte Poeti a.*

I am now publicly challenged by your reviewer to answer other passages of his "critique" on my work. "If I can show the same want of information in these as in astronomy, he promises to take shame on himself and *kiss* the *rod*." He trusts "the decision to those who understand the subject. To their impartial judgment he *calmly* leaves it." With the same *sang froid*, he says, "he has *long since* learnt, that no *real* honour is lost by the acknowledgement of an *error*;" "that he has made a *blot*, which Dr. Thornton has fairly *hit*; and he has a right to avail himself of it as far as it will go. But he must make many more such *hits*, or he will not save *his* gammon." Although I conceive a contest in which reputation and fortune are both deeply concerned is more *serious* than a game at back-gammon, and the *hits* of more importance than such light amusements, and that many would excuse my contending with such an adversary; yet, as greatly provoked to the contest, in the next letter I shall have the honour to address you, I will promise "satisfactorily" to prove to you, and the philosophic world, that this reviewer of yours is as "slenderly" acquainted with authors on botany, as he has been proved to be with regard to those on astronomy; and that all my botanical doctrines are founded on authors of the highest reputation, and not more of my invention, than was the *satellite* of Venus; and, therefore, that I cannot merit, as has been "unjustly" attempted, to be held up for those opinions to public ridicule. His sneers have arisen from his total unacquaintance with the valuable writings of modern vegetable physiologists, as Bonnet, Duhamel, Lamarck, Senebier, Ventinat, &c. equally as he was ignorant of what had been

been said by authors on the satellite of Venus, in Rees's improved edition of Chambers's Dictionary, the French and English Encyclopædias, Long's Astronomy, Wright's Clavis Cœlestis, the Philosophical Transactions, and many other works: and hence all the ridicule he would wish to throw upon me, will, I trust, fall on his own head. My misfortune is to have gone further than the surface, and to have read where your reviewer had no opportunity of obtaining information. Hence my literary reputation has received a shock from an *unexpected* quarter, and my botanical undertaking nearly ruined by misrepresentations. You, sir, who can feel for Rees's New Cyclopædia, in which you are only partially connected, and complain "that I have, in my *otherwise* laudable zeal to vindicate myself, been betrayed into an *unjust* and *ungenerous* allusion to that work;" who was so feelingly alive to its interests, as to take *in earnest* what every other must at once have understood as a *joke*; for, after the fine display of deep reading in astronomy exhibited by your reviewer and yourself (for this part of your review you had not then disavowed), could I for a moment seriously intend to assert, that you, or your reviewer, was meant to be associated with the learned writer on astronomy in the New Cyclopædia, and really refute what is incapable of answer? It would have been the highest insult to Dr. Rees, the sagacious director of that national work, where, in each department of science, the ablest men are judiciously chosen, and where, with the utmost propriety, you are singled out for mineralogy and chemistry, in which departments of science, it is but justice to say, you have but few rival contemporaries;—it is, I should think, next to impossible, but that you must also feel some *small* interest for a work hardly less expensive, conducted at the risk of an individual, and which, if crushed, must involve me in a heavy loss, and disappoint many of my hitherto satisfied subscribers:—Surely, under all these circumstances, you will forgive, I assure you, an unintended *hoax*; and if I have expressed myself *too* strongly with regard to your reviewer, it has arisen from that natural indignation, resulting from the firm persuasion, that I have been "ungenerously" and "unjustly" attacked, and most ignorantly misrepresented. But believe me at all other times,

Sir, with respect and esteem,
Your faithful obedient servant,
ROBERT JOHN THORNTON.

XXVI. *From*

XXVI. *From Dr.* Thornton, *Lecturer on Botany at Guy's Hospital, to Mr.* Tilloch, *Editor of the Philosophical Magazine.*

July 10, 1804.
No. 1, Hind-street, Manchester-square.

SIR,

Although the writer Y. Z. in Mr. Arthur Aikin's Annual Review, in his letter addressed to you, says not a word of a *second hit* obtained from *your pen* (the *first* he acknowledges has been fairly gained by *mine*), I would here beg leave to remind Mr. Aikin of it, at the same time thanking you for the clear light in which you have placed before the philosophic world my very anxious endeavours. These sentiments of yours are so much in unison with those of a great poet, that I trust I shall be excused inserting them in this place.

To Philip Reinagle, *Esq. A. R. A. on his Paintings for Dr.* Thornton's *Temple of Flora, or Garden of Nature.*

Oh! thou, whose radiant tints with beauty glow,
Like those that charm us in th' ethereal bow;
Though bright with heavenly fire the picture shine,
Say, whose bold genius plann'd the vast design,
Bade the majestic plant its leaves unfold,
The blossoms shoot in vegetable gold;
Bade gathering clouds the darken'd sky deform,
Where round the Cape loud howls th' eternal storm?
Or in more genial skies bade *Eden* rise,
And waked the blooms of opening *Paradise?*
Howe'er by THEE in matchless charms array'd,
'Twas THORNTON, first, *his* daring powers display'd;
Thine those bright tints, but *his* th' inspiring soul
That breathes, that burns, throughout the beauteous whole.

Dr. Darwin, who possessed the most refined taste, with critical discernment, and at once entered into *new ideas*, was so pleased with my *picturesque* botanical coloured plates, that in his Phytologia (as you mention) he celebrates them as having "*no equal,*" and as such "recommends them to the public." In some letters which I have now by me (which I shall inclose for your satisfaction), this eminent poet says, "All my acquaintance, to whom I have shown the prints you have been so good as to send me, greatly admire them indeed! The coloured print of the tulips quite astonishes them!" In another letter, he writes: "Besides a compliment to the fine execution of your work, I will endeavour also to compose some verses on the flowers as they occur." And in another letter Dr. Darwin kindly says, "I shall be happy to hear your work *succeeds* according to your expectations, and its merits, in these *bad* times. I have

have got our botanical society at Litchfield to subscribe to it." Such was the favourable opinion of a great genius, whose sudden loss the literary world, and myself in particular, will ever deplore, respecting my TEMPLE OF FLORA, or GARDEN OF NATURE. The sentiments of Professors Martyn and Rutherford have been long before the public. Y. Z. allows, indeed, that these coloured plates "do the highest honour to the *artists,* and will be *lasting** monuments of the *fine taste* and *masterly execution* which characterize the British nation in the present age;" and the question now at issue, therefore, is, how far my exertions are interwoven with those of the eminent artists employed for the production of these *picturesque botanical* plates. To the arguments already adduced by you, I will add the following facts:—First, take, for example, the oblique-leaved Begonia. A plant was obtained from the Physic Gardens at Chelsea. It had only *female* flowers. This was sketched in, and Mr. Reinagle went with me in a chaise ten miles off to obtain a branch with *male* flowers, in order to complete the picture. The blue Passion-flower contains *eleven stages* of that flower, from its first appearance in the bud to the perfect fruit. No one branch showed these gradations. The flowers were obtained at Barr's nursery, at Dalston, and the perfect fruit from North's nursery, near the Asylum. The superb Lily, &c. required the same observances; and as the *Venus de Medicis* is the assemblage of different parts, selected first, and afterwards combined, so no one plant ever appeared in that perfection of beauty as displayed by the artists engaged. My object was to unite *botanical correctness* with *picturesque effect,* as far as the association could be accomplished. Hence I engaged for my work neither a professed botanical painter nor engraver. The paintings being directed by me was sufficient to obviate any loss of such a knowledge to the artists employed, and accident gave me more share than usually falls to an author in these pictures. Is there no conjunction of exertions in the beautiful group of flowers expressive of the system of Tournefort? The merits of the respective artists stand equally the same, as far as regards *their* profession, now as before, and they willingly would allow me *this share* in the *fame* of these pictures I never, I believe, before claimed. Had the specimens been entirely of their own choice, and fair copies of nature, as she appeared before them, and the descriptions

* How could these be *lasting* monuments, (rather fragments,) if my work had been crushed, as was intended?

also

also theirs, the whole merit would have been *exclusively* their own. As it is, the reviewer, in his eagerness to ruin me in the public estimation, without possessing, as he declares, one jot of "malice*," has again here also exposed either his ignorance or folly; and, fearful that the philosophic world would not credit such an *unjust* attack in a work professing Arthur Aikin's name as editor, I will put down the very words of this most extraordinary reviewer. After highly praising in general the botanical plates, he goes on:

"But when Dr. THORNTON claims *a share of the fame,* we are reminded of a *farce,* which in our *play-going* days afforded *us much amusement.* It is called, if *we* mistake not, *A Peep behind the Curtain,* and is written on the plan of the duke of Buckingham's celebrated dramatic satire. Its plot turns on the rehearsal of a musical piece, founded on the story of *Orpheus* and *Eurydice,* in which some *cows* are to be introduced *dancing* to the *lyre* of the *antient bard.* When *every thing* else is ready, the *cows* are wanting, and the *prompter* is dispatched in haste to inquire the reason of the delay. *We* quote from *memory*; and, after a lapse of *thirty* years, will not vouch for more than the general SPIRIT of the dialogue. "The author," *cries* the trusty messenger, *out of breath,* "is impatient to see *his cows;* he relies much on *them* for the success of *his* piece." "*His cows!*" replies the indignant *maker,* "they are *my cows:* I *know* that *his* play will be nothing without *them*; and I will have *him* to *know* that, vain as he is, he shall not run away with the glory of the *carpenter*†." *!!!*

I have the honour to remain, sir,
With much esteem and gratitude,
Your obliged faithful servant,
ROBERT JOHN THORNTON.

* Did the story of the immense common-place book show no malice? or the following,—"Sed ohe: jam satis est. The *patience* of the public must be *soon* exhausted. As to *ourselves,* we have not *a drop* left. Never were lavish promises more scantily realized. His work is, indeed, little more than a piece of shreds and patches clumsily stitched together with coarse packthread; and, instead of a *national honour,* may more justly be deemed a *national disgrace.*" The impartial public will soon perceive where the *national disgrace* lies.

† What will the philosophic world think of a reviewer, who publicly tells us that wooden *cows* dancing to a *lyre* gave him *great amusement* in his younger days, and who gravely represents the dialogue which was held by a messenger *out of breath,* and a carpenter of wooden cows, as relevant to my work? Are my added marks of astonishment misplaced?

XXVII. *On*

XXVII. *On the Freezing of Water in leaden Pipes, indicating Means for its Prevention; with some Thoughts relative to the increased Temperature of the Earth at small Depths.* *By* G. J. Wright, *Esq.**

The perplexity arising from the defect of an usual source of water for domestic use in the winter season, is a casualty which most individuals have at one time or other experienced, probably not less to their cost than their inconvenience. Such is the consequence inevitably ensuing from the stagnation of water in leaden tubes in frosty weather, particularly in exposed situations; the tubes being not unfrequently burst by that expansion during the congelation of the included water, to which if any opposition is made, the hardest metals and most solid bodies give way.

To endeavour to obviate the same by the naturally suggested mode of surrounding the pipe with the most perfect non-conductors of heat, is a method only partially applicable, and eligible no further than the course of the pipe under ground; because the impossibility of ascertaining, in a long course of covered pipe, the exact portion of the tube where any rupture may have taken place, would occasion the necessity of laying open the non-conducting coat for a considerable length to arrive at the injured part. Neither can we expect by any combination of metals to form a conduit capable of resisting the effects of external cold, they being all of them good conductors of heat. On the other hand, if we have recourse to compositions of an earthy nature, as porcelain, baked clay, &c., we labour under inconveniences from the inflexibility of such tubes; their liability to crack in sudden transitions from heat to cold; their incapability of yielding to internal distension; and especially the thickness such tubes would require to be, in order effectually to prevent the transmission of the temperature of the contained water to the surrounding air.

Leaden tubes have always gained the preference as conduits for conveying water in small quantity for domestic and other uses; for, although they are liable to the casualty of bursting during frost, their valuable properties of flexibility, ductility, and unalterableness by pure water, render them well adapted for the purpose.

Leaden pipes are usually of a certain thickness, about an eighth of an inch: it is this thickness, and the ductility of

* Communicated by the Author.

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the metal itself, which prevents them from bursting at all times. Thus they can only allow of expansion from contained frozen water a limited number of times; and old pipes, and such as may have been frequently repaired by soldering, must be expected to give way in every rigorous season.

The pipe being new when first laid down, the low temperature of the succeeding winter occasions a congelation of the water throughout the whole length of the tube; an expansion every way ensues by this process of icefaction; the ductility of the metal allows of an enlargement of its diameter throughout its whole length; its thickness is proportionally diminished; a milder temperature ensues, and a thaw subsequently takes place in the tube without occasioning damage. A second, third, and perhaps more winters thus pass on; the water each time frozen in the pipe, each time enlarging its diameter and diminishing its thickness: at last, the diminution of this latter renders it no longer capable of withstanding the force of internal distension, and the succeeding frost occasions a rupture in that part of the tube where the resistance may prove the least.

If the tube had been constructed of a more refractory metal, as iron, &c., the first expansion would have burst the same; while it is obvious that the durability of a leaden pipe must be very precarious after the first occasion for repairing a rupture therein: for, in casting a pipe, if the cooling were slowly and uniformly conducted (a precaution not at all attended to in their manufacture), its texture and ductility would be the same throughout, and we should have good reason to conclude that the diminution in thickness throughout the pipe, by all the previous expansions of the freezing water, would be alike; and the necessity of repairing a rupture in one part would be a certain indication of the extreme thinness of the whole, and its incapability of undergoing any further distension. But as the tube is never uniformly cooled, but cast in small lengths of two to three feet, each of which is allowed to cool as speedily as the temperature of the surrounding air will admit, and afterwards joined together to form one pipe of any required length, there may be certain portions the ductility of which may better allow of progressive distension than others; and I add, that the mode of cooling a pipe after casting the same, were it attended to, would have considerable influence on its ductility; instances of which we have in every substance capable of fusion (whether metallic or not), whereby the regular annealing of the same, or cooling them in the most gradual manner, leaves the particles of such substance in that equable state with respect to each other, as proves, in the subsequent use of the article, the surest safeguard from casualties arising either from change of temperature or mechanical extension. Thus the durability of leaden pipes, relative to the freezing of their contained fluid, is proportional to their thickness, and the uniformity in the yielding of each portion of the cylinder, which uniformity depends on the accurate and equable cooling originally observed in their manufacture.

The compression of air exerted by the mechanical impulsion of the water, is another source of injury to pipes: thus, before water flows into a cistern, a hissing and undulating noise is heard for some time to issue from the cock supplying such reservoir, occasioned by the flux and reflux of air confined in the pipes, such air being urged to escape by the engine, or height of the head of water, powerfully throwing forward the water, whose progression is retarded till the air before it is made to escape at various outlets. If no vent were any where allowed to this air, that is to say, if every copper cock was air-tight as well as water-tight, and each kept shut, the progress of the water would be not only prevented, but weak pipes in many instances would be burst by the mechanical power of the engine thrusting forward the water, and therefore proportionally compressing the air before it. Thus, in frosty weather, all pipes supplied by any powerful machine have a double hazard of rupture from cylinders of ice retained in them, so closing the whole number as to prevent the escape of the air, more and more compressed by violent alternate propulsions exerted in the water.

So long then as we remain unacquainted with any substance conjoining, at ordinary temperature, elasticity with the ductility and hardness of metals, we can scarce look to other methods of preventing the freezing of water in conduits, than by the radical resource of keeping them full only during the short interval of supplying the cistern or reservoir of each dwelling or manufactory.

The air-valve here suggested for the purpose, as facile of construction as its mode of action, bears with it its own demonstration, consonant to the most simple of hydrostatical laws, and in most situations applicable as a self-acting principle, is delineated in fig. 3, wherein A B represents the body of the valve formed of pewter; being of six inches height, and having in the centre of its summit a small hole 1-4th of an inch diameter. The upper cylindrical portion

A, of four inches height and two in diameter, screws on to the funnel-shaped part B, to the extremity of which is soldered the straight copper cock C, which is inserted into any leaden pipe, as DE, (fig. 1.) supplied at its extremity D from the original forcing-pumps of the public water-works, and emptying itself into the cistern F. ab is a circular piece of cork of half an inch less diameter than the cylinder A; its upper surface is furnished with a leathern covering, and from the centre of this proceeds a small wooden stem or slender wire c, of such length as that, when the cork shutter rests in its proper situation upon the three projecting pieces d d d, the top of the wire may just emerge through the orifice at A. Thus, if, upon opening the stopper or turning the cock C, water rise into the cylindrical portion of the valve (owing to the mechanical propulsion of the fluid from D onwards), the rising of the cork shutter with the fluid will be perpendicularly directed by the wire so as effectually to prevent the fluid from escaping at the orifice A*: on the other hand, when the water ceases to be impelled from D onwards, and consequently does not rise through the stopper C into A, the cork shutter remains in its former situation, and a free passage is allowed for air to pass through the open stopper C round the edge of the shutter, as being half an inch less in diameter than the cylinder. Thus, the entrance of the air from A through C into any attached pipe, will allow the water therein to flow out at any lower orifice in such annexed tube; which thus emptying itself remains in that state till the mechanical impulsion of the fluid is again commenced, that is, till the water is again turned on by the turncock on the usual day of supply.

The connection here applies to every case wherein the cistern is placed at a lower level than the supplying tube DE, and proves at all times a self-acting principle, as bare inspection, by any one acquainted with the properties of the syphon, will convince. But the case is exactly reversed in those situations where the cistern is at a higher level than the supplying tube, as at H. Here it is evident that, when the mechanical impulsion at D is discontinued, the pipe from G to D will remain full of fluid, although an air-valve were placed at D, for D is lower than G. Here then

* It is not improbable that the lower surface of the cork shutter may be so moist in cold weather as to allow it to be frozen to the resting pieces d d of the cylinder, preventing its rise with the water should it gain admittance. To be sure of its desired action, we may unscrew the cylinder and inspect the condition of the apparatus, and, if the cork be then frozen, easily detach it.

we

we have no need of the valve, but in its stead a cock only, as at *e*; for, when the water ceases to flow from D through G into the cistern H (the cock G still remaining open), it is plain that if the cock *e* be opened, the upper syphon DEG will empty itself at *e*, the lower orifice of its longest leg, the air entering at the upper and open cock G allowing of the same.

The principle of the whole is too plain to require further comment; and any person of ordinary ability, acquainted with the actual course of a pipe, would be at no loss to apply it to any system of pipes however complicated; only remembering that the portion of pipe included between the street and the cistern must become a syphon, (either by the application of an air-valve at D when the cistern is at a lower level, or a cock when at a higher,) air entering at a higher portion of the pipe, (whether through a valve in the former instance, or the cock G in the latter,) and hence allowing the contained water to flow out at any aperture lower than any point or curve formed between*.

With regard to in-door situations, including the pipes leading from the cistern downwards to the various apartments of the house, I can scarce conceive it requisite to be at any pains respecting them, as the frost must be intense indeed to freeze the water contained in them, not only on account of their less exposed situation, but also because the occasional drawing of water from the cocks at the extremities of the pipe, carries down, by the rushing motion of the water, any small particles of ice that may have begun to form: but in cold aspects the same principle is easily applicable, placing a cock immediately at the side of the cistern, as at f, and an air-valve directly beyond it. By this disposition you are enabled, by first closing the cock f, and then opening all the cocks at the extremity, to empty the pipe either every night on going to rest, or once or twice during the day, as the rigour of the season and degree of exposure may indicate; but the chief utility of the plan is the ensuring the constant supply of water into the cistern;

* When the cistern is at a higher level, if an intermediate curve should unavoidably fall lower than the level of D the supplying tube, the pipe must be either divided into two syphons by placing an air-valve at D, and a cock at the lowest part of the curve as at E (fig. 2.), or else the whole length may be formed into one syphon by placing a stop-cock at D, and a descending pipe immediately beyond it, the orifice of which must be lower than the level of the intermediate curve E: then, first closing the stop-cock at D and opening the lower one g, the syphon GEDg will empty itself at g, the lower aperture of its longest leg.

 exclusive

exclusive of the advantage it gives us of a command of a pipe when requiring repair, without being obliged to empty the cistern before the plumber can solder a rupture in the tube; as also the further resource of pouring down hot water into the same, through the valve, to melt any ice that may have been formed accidentally therein; cylinders of ice so contained would be melted by the water, because the lead encircling such cylinders of ice would conduct the heat from the boiling fluid, and the ice, now surrounded by a heated body, would gradually receive an augmentation of temperature sufficient for its liquefaction.

Pumps are less frequently found frozen than leaden pipes, chiefly because the water in the upper chamber of the pump is occasionally renewed and violently agitated by the working of the piston at every draught of water, and that, perhaps, several times in an hour; and partly because the water raised from the well, being of a higher temperature than the external air, requires some time to cool to the freezing point; and also in the case of wooden pumps, the thickness of the wood, as a bad conductor of heat, prevents any speedy transmission of temperature from the water to the surrounding air.

The supply of water through the streets from the public water-works is very rarely, if ever, obstructed by frost, however intense. The reason of this hinges on the fact, as ascertained by accurate observers, that in this country the temperature of the earth at two feet depth does not materially diminish throughout the year, and is scarcely ever, even in rigorous winters, lower than 40° of Fahr. This is about the depth at which the wooden pipes, running under the street, are usually laid. We have therefore at all times a certain supply from them in the severest seasons, by placing plugs over orifices immediately in the pipes themselves: it is only the smaller leaden tubes proceeding from their sides that are usually frozen, and that not till they emerge into such situations as to be unprovided with that shelter from the cold which a stratum of earth, of two feet in every direction, before afforded them.

Mr. Boyle, after a fortnight's hard frost, found the same to have penetrated only 14 inches depth; and at Moscow the frost is never known to penetrate, in the most severe seasons, more than two feet. Hales also found the earth at two feet depth to be unaffected by the continued cold of a rigorous winter. Exclusive of the non-conducting quality of earthy matters, there appears to be a source of heat at about this depth, which diminishes as we proceed further

till

till about 50 or 80 feet: beyond that the temperature of the earth is invariably found to increase, and is supposed to do so continually as we approach the centre of the earth.

The warmth of the sub-stratum of mould in gardens, or wherever the surface or vicinity abounds with the roots of vegetables, may, I think, be reasonably expected to exceed, at times, the temperature of situations not so circumstanced: for, as the roots of vegetables have the power of absorbing moisture from their vicinity, and this having ever a tendency to penetrate toward that point where may prevail the greatest dryness; so, in proportion as these roots exhaust the moisture of the earth immediately surrounding their fibres, will the aqueous vapour from greater depths be attracted *.

Hence, whenever extreme drought in the soil and supernatant atmosphere is such as to be unfavourable to vegetation, the finely divided aqueous vapour from beneath will ascend toward the upper vegetable mould; where having penetrated to that level which (owing to the non-conducting quality of the earth) can only, as we have seen, be affected by the temperature of the air, namely, the uppermost stratum of soil within a foot or two of the surface, the vapour so arising must undergo a condensation agreeable to the established laws of heat, whereby the before combined caloric of that vapour, now rendered free, becomes diffused among the surrounding media, augmenting of course the temperature of the adjacent earth, and that as frequently in summer as at other times †. Consequently, wherever there exists the most frequent cause of dryness in a soil, *there* will the rise and condensation of subterranean aqueous vapour be most frequently found to ensue; and agreeable thereto, the effect must more repeatedly take place in situations where vegetables abound than elsewhere.

On the contrary, in humid states of the atmosphere, this water for the support of the vegetable kingdom will be by priority attracted from the air (dry earth acting as an hygrometer), and the effect will be, the soil cannot then have that warmth imparted to it as formerly, from the two-fold cause of the moisture of the atmosphere being at a lower

* In the driest season, if a drinking glass be placed on the ground in an inverted position, its interior surface will soon be seen covered with drops of water, from the condensation of these extremely divided vapours exhaled from the earth, and condensed on the cold sides of the glass. The fluid thus evaporated from the earth, Watson and Hales have calculated to amount to a considerable quantity per hour from a square foot of ground, even after a drought of some weeks' continuance.

† Hales's Staticks, vol. i. p. 67.

 temperature

temperature and in a less divided state than that which is attracted from great depths under ground; hence containing less combined heat, and being also, in the case of showers, applied to the earth and roots already in its fluid state. In the cold seasons of winter the same cause will prevail in a yet greater degree; for, the colder the upper stratum of mould, the more copious must be the ensuing condensation.

Thus, in proportion as the state of the ambient atmosphere is more or less favourable to the vegetable process as carried on by all the parts of the plant above ground; so, the greater the obstacles here presented to the procedure of the same, the more do they require of stimuli around their radical fibres to obviate the opposing circumstances in the atmosphere. These will be in some measure compensated by the additional stimulus of heat now imparted around the roots by the vaporous condensation alluded to: yet, if the same unfavourable season be of too long continuance, this underground stimulus will, like all other excessive stimuli, be followed by an equal degree of depression on the part of the individual plant so circumstanced; and in this view a hot and dry summer, by excessive exhaustion of the vegetable powers from root to leaf, must prove more deleterious to vegetation than a cold winter.

From the above premises I beg to draw a conclusion, consistent with the established laws of caloric, not less warrantable from actual fact than from analogy in another kingdom, and conformable to the ever-prominent uniformity observable throughout the various operations of nature, that plants are endowed with the property of indirectly generating in the vicinity of their roots, by their exhaustion of moisture, and consequent ascent and condensation of aqueous vapour from beneath, that temperature, which, acting as a stimulus, and hence enabling them to counteract externally opposing circumstances, proves most favourable to, and the natural consequence of, their vegetation,—in the same manner as the effect of existence is the engendering of that degree of heat within the animal system which not only favours the continued performance of the various functions of the body, but which increases as the external medium is more cold and unfavourable to the living process, and without which animal life itself would soon terminate in insensibility, torpitude, and death.

Kennington,
May 18, 1804.

XXVIII. *De-*

XXVIII. *Description of a Furnace destined for the Liquefaction of Copal and Amber. By Professor* TINGRY *.

THOSE who have examined in detail the laboratories destined for a course of chemistry, may easily form a clear idea of the construction of this furnace, by recollecting that employed for separating sulphuret of antimony from its matrix. But to render it fit for the object in question requires some alterations; by the help of which one may use it without inconvenience for the liquefaction of solid resins, and even for mixing them with drying oils.

This furnace, a section of which is represented fig. 1. Plate II, may be entirely constructed of burnt clay, three large apertures being made in the lower chamber, A, which supplies the place of an ash-hole in the common furnaces. The upper part of these apertures is arched; and the pillars or solid parts between them should be as narrow as possible, in order to enable the artist with facility to extract the liquefied matter, and even to mix it with the drying oil, if this kind of varnish be required.

The upper part, B, or fire-place of the furnace, is separated from the lower part, A, by a bottom or plate, which answers the same purpose as a grate in the common furnaces. This plate has in the middle a circular aperture, the diameter of which corresponds to that of the tube, C, which it is destined to receive, and which extends a considerable way below it. This plate may either form one piece with the furnace or may be moveable. In the latter case it is supported by three projections, or by a circular ledge which projects inwards. In my furnace this partition is composed of an iron plate covered with a coating of potters' clay an inch in thickness. This precaution is indispensably necessary, to prevent the heat from penetrating to the lower division, A.

The sides of the fire-place, B, are pierced with holes an inch in diameter, and distant from each other about three inches. These apertures admit air sufficient to maintain the caloric (heat) at the degree proper for this kind of operation. The following are the proportions of the three parts of this furnace, which served me for my experiments, and in which I liquefied six ounces of copal in the space of ten minutes, without altering its colour in a sensible manner.

* From his work entitled "*The Painter and Varnisher's Guide*," English edition.

	Inches.
Total height of the furnace - - - - - - - -	$17\frac{1}{2}$
Height of the lower chamber, A, including the bottom, which was an inch in thickness - - -	11
Height of the upper chamber, B, or of the fire-place, - - - - - - - - - - - - - - - - -	$5\frac{1}{2}$
Diameter, taken at the upper interior edge of the fire-place, B - - - - - - - - - - - - -	$9\frac{1}{2}$
Diameter of the same, taken at the bottom or partition - - - - - - - - - - - - - -	7

This part decreases in diameter $2\frac{1}{2}$ inches, tapering towards the lower part of the furnace, A.

The tube, C, is conical at the upper extremity and cylindrical towards the bottom: it is $9\frac{1}{2}$ inches in length, $4\frac{1}{2}$ in diameter at the top, and $2\frac{1}{2}$ towards the middle. Both ends of it are open.

The tube, C, is placed in the aperture formed in the middle of the partition, in such a manner as to rise 3 or 4 inches into the fire-place. The place where it joins to the partition is luted with clay, to prevent the ashes or small coals from falling down.

When this arrangement is made, the net, D, (see fig. 2.) made of brass wire worked very open, is placed in the tube. It has the shape of a funnel, the upper edge of which is made fast to a ring of wire of the same diameter as the upper part of the tube, C. The decrease in the diameter of the tube C conduces to the stability of this net, and the conical form of the latter prevents it from coming into contact with the lateral parts of the tube, which is a matter of great importance to preserve the copal from too great alteration by the heat.

The copal is placed on this metallic filter in pieces not larger than a small nut, and the whole is closed up with the iron plate or cover, E, an inch in thickness, taking care to lute the joining with clay, to prevent all communication with the exterior air.

A shallow dish or capsule, F, filled with water, (fig. 3.) is placed under the bottom of the tube, C, in such a manner that the tube is immersed in the water two or three lines.

The fire-place, B, being filled with burning coals so as to rise above the iron cover of the tube, the first impression of the heat on the copal is announced by a kind of crackling, the consequence of its dilatation, which makes it split into small pieces. This noise is a sign of beginning liquefaction, which indeed takes place soon after. A small iron pallet-knife

knife terminating in an elbow is introduced under the tube, and moved in such a manner as to cause the liquefied part of the copal to fall down into the water, and to bring it under the solid form towards the edge of the capsule. When the operation is finished, the copal is spread out on dry linen cloths, or on unsized paper, to dry; it is then piled up and exposed to a gentle heat, to deprive it of all its humidity.

While the copal is falling down there is separated a very small portion of oil, which remains fluid after the operation. It floats on the water as well as the copal, and gives to the latter a greasy appearance. But when the tube is of sufficient length there will be no necessity for immersing the end of it in the water, or even for receiving the matter in the water; but, in this case, a kind of smoke will escape, which may be offensive to the artist. The essential point is to graduate the fire in such a manner as not to alter the colour of the copal. When a very thick smoke issues through the lower aperture of the tube; when the latter is very red; and when the drops which fall into the water rise into bladders and form small explosions, there is reason to conclude that the fire is too violent.

I have succeeded in composing varnish with fat oil, in the same operation, by substituting for the water drying oil in a state of ebullition, and maintaining it in that state by means of a mass of very hot iron, which served it as a supporter. The mixture of the liquefied matter is facilitated by means of a spatula, with a knee at the extremity; and the boiling essence is afterwards added. The inconvenience of placing under the apparatus a volatile and highly inflammable oil may be readily conceived.

This new mean enables the artist to compose a very durable varnish, very little coloured, and superior to copal varnish composed with drying oil, as the composition of the latter requires processes which alter the essential qualities of the substances that form the basis of it.

For operations on a larger scale the dimensions of the furnace may be changed; but in this case it will be proper to elevate the fire-place, properly so called, on a kind of iron tripod, as represented at G, fig. 4, in order that the workman may be more at his ease. I must however always insist on the advantage of employing, in the process, doses of only four and six ounces.

The valuable advantages which accompany this new method will be perceived when a trial has been made of the varnish composed with essence of turpentine, which results from

from it. Copal thus prepared has properties different from, and more extensive than, those communicated to it by the common method; and it has not that dark brown colour which it acquires by too high a temperature, and too long exposure to heat. Immersed here in an atmosphere of caloric (heat), it receives the impression only at the surface, which soon yielding to the power of that agent escapes under the liquid state from the continuance of its action; new surfaces are successively subjected to the same effect; and the final result is copal as little altered as possible, and which can have undergone but a very slight modification in its constituent principles: the force only of the connexion which existed between its parts, and which opposed so great an obstacle to the solutions proposed to be effected, is diminished. In a word, it is possible to compose fat copal varnish almost colourless, by making use of oil as little coloured as possible; such as that of pinks prepared in leaden vessels, according to Watin's method.

In like manner also this copal, simply modified, may increase the solidity of alcoholic varnish in a more direct manner than when it is employed without any preliminary preparation. A second liquefaction would perhaps give it the property of being soluble in alcohol in greater quantity; but there would be reason to apprehend that the alteration in its principles, carried too far, would give it no superiority over those resins which are most soluble in that liquid.

To prepare Copal Varnish with Essence of Turpentine, without any intermediate Substance.

Take Copal liquefied, according to my method, 3 ounces.
Essence of turpentine 20 ounces.

Place the mattrass containing the oil in a balneum mariæ, and when the water is warm add the pulverized copal in small doses. Keep stirring the mixture, and add no more copal till the former be incorporated with the oil. If the oil, in consequence of its particular disposition, can take up three ounces of it, add a little more; but stop when the liquid becomes nebulous; then leave the varnish at rest. If it be too thick, dilute it with a little warm essence, after having heated it in the balneum mariæ. When cold, filter it through cotton, and preserve it in a clean bottle.

This varnish has a good consistence, and is as free from colour as the best alcoholic varnish. When extended in one stratum over smooth wood, which has undergone no

 preparation,

preparation, it forms a very brilliant glazing, which, in the course of two days in summer, acquires all the solidity that may be required.

The same essence employed with copal of two fusions, that is to say, copal liquefied a second time, takes up a third more than in the former case. But it produces very little effect on copal not prepared.

The facility which attends the preparation of this varnish by the new method here indicated, will admit of its being applied to all coloured grounds which require solidity, pure whites alone excepted. Painted boxes, therefore, and all small articles, coloured or not coloured, where it is required to make the veins appear in all the richness of their tones, call for the application of this varnish, which produces the most beautiful effect, and which is more durable than turpentine varnishes composed with other resinous substances.

XXIX. *Parallel of* Rome de L'Isle's *and the Abbé* Hauy's *Theories of Crystallography.*

To Mr. Tilloch.

DEAR SIR,

So early as in the first number of the Philosophical Magazine you turned your attention to the Abbé Haüy's theory of crystallography: you seemed to predict that his labours might lead on some future day to deep philosophical research. An erroneous opinion, however, has been pretty generally propagated in this country as to the similarity of the systems of Romé de l'Isle and of the Abbé Haüy, which gave rise to the enclosed paper. With leave of the author, the Abbé Buée, who had written it in French for a friend of his, I send you a translation of it. It may awaken the energies of the learned public; and it may be gratifying to you to find that the science of crystallography, as treated by the Abbé Haüy, will probably lead to the most philosophical results. May I, therefore, request the insertion of it in one of your ensuing numbers?

I remain, sir, yours, &c.

Welbeck-street, No. 10. R. Clifford.

A Letter

A Letter from the Abbé BUEE *to Mr.* * * *, *on M.* ROME DE L'ISLE'S *and the Abbé* HAUY'S *Theories of Crystallography.*

SIR,

IN consequence of your request, I send you the parallel of the two theories of crystallography which seem to divide mineralogists in this country; those of Mr. Romé de l'Isle and of the Abbé Haüy. You are perfectly acquainted with the former theory, but nearly a stranger to the latter. Having lived for six-and-thirty years in habits of intimacy with the Abbé, I dwell with pleasure on his works, and will do my utmost to satisfy your curiosity.

To Mr. de l'Isle is due the merit of having called the attention of naturalists to that neglected branch of mineralogy, crystallography; of having discovered that that branch, though neglected, was perhaps the most interesting part of mineralogy, and the only part which could raise it to the dignity of a correct science; in short, of having discovered order, by numerous observations, as ingenious as new, where a Cronstedt, a Bergman, a Buffon, or a Kirwan, could perceive nothing but confusion; and thus seemed to rescue nature from the charge of caprice, almost imputed to it, because great mineralogists had neglected to study its unerring laws.

It was exclusively reserved to the Abbé Haüy to point out, to explain, and apply those laws. He demonstrated where De l'Isle affirmed. He discovered those *hidden facts*, which he has since shown to be the mathematical consequences of facts observed by De l'Isle. If the latter furnished a part of the materials, the Abbé has augmented and employed them.

The discoveries of these two writers force me to subdivide crystallography into two distinct parts; descriptive, and philosophical; and under these two heads I will rapidly describe the labours of each author.

Descriptive. The most important part of Mr. de l'Isle's work consists in his crystallographical tables. In each of these tables (seven in number) he describes one of the principal forms assumed by crystals; and then delineates the different modifications of which that form is susceptible, by means of different truncations (*troncatures*), as he calls them.

For elucidation, take a cube the primitive form of the second table. A cube, it is known, has 6 faces, 8 solid angles, and 12 edges. If the cube be truncated in a parallel

rallel to one of its faces, a rectangled parallelopipedon will be produced, and the equality of the faces will be destroyed. If the eight solid angles of the cube be struck off, eight new faces will replace the eight solid angles; and in place of six sides we shall have fourteen. If the twelve edges be taken off, twelve new faces will succeed the straight lines, and the solid will have eighteen sides. Such are De l'Isle's *simple truncations*. They may be then combined with each other, and made more or less deep: hence an immense variety of new figures. But these new forms again may be truncated in the directions either of their faces, solid angles, or edges; and these new truncations, more or less deep, called by De l'Isle *sur-troncatures*, may also be combined with each other. Here the forms must multiply to infinity, and their boundless numbers will soon bury the primitive cube in oblivion.

It must not be supposed that nature has furnished us with this infinite series of forms; indeed Mr. de l'Isle in his tables has only mentioned those he had observed, with some few additional supposititious figures, of which several have been since discovered to exist.

This ingenious naturalist has given us, as I have already said, seven crystallographical tables. In the first, he describes the tetraëdron and its modifications; in the second, the cube; in the third, the rectangular octaëdron; in the fourth, the rhomboidal parallelopipedon; in the fifth, the rhomboidal octaëdron; in the sixth, the dodecaëdron with triangular faces; and to each are subjoined their respective modifications. The object of the seventh table is to point out certain modifications of the octaëdron and parallelopipedon, whether rectangular or rhomboidal. Plates accompany each table, where the figures are drawn, and in the observations and notes on them are to be found the measures of the principal angles.

These crystallographical tables exhibit only general representations of solids, which Mr. de l'Isle in the course of his work applies to the different crystals which had already been discovered, and fallen within his observation. His work consists of three parts. In the first he treats of saline crystals; in the second, of stony (*pierreux*) crystals; and in the third, of metallic crystals. Those of the first class are artificial; those of the two latter classes are natural, and subdivided into genera, species, and varieties.

When treating of a species or of a variety, he refers his reader to the table where the figure of that species or variety is to be found, and he then enumerates every thing relating

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to minerals assuming that crystalline form. But I cannot terminate this sketch better than by the following extract from the Abbé Haüy's Treatise on Mineralogy.

"In short, Romé de l'Isle reduced the study of crystallography to principles more exact, and more consistent with observation. He classed together, as much as he was able, crystals of the same nature. From among the different forms belonging to each species he selected one which appeared to him to be the most proper, on account of its simplicity, for the primitive form; and then supposing it to be truncated in different manners, he deduced the other forms, and established a certain gradation or series of passages from the primitive form to that of polyedrons, which would scarcely appear to have any connection with it. To the descriptions and figures which he gave of the crystalline forms, he added the mechanical measurement of the principal angles, and he showed (a most essential point) that these angles were constantly the same in each variety. In a word, his crystallography is the fruit of immense labour, by its extent; almost entirely new in its object; and of great value for its utility." (Vol. i. p. 17.)

The Abbé Haüy in his Treatise on Mineralogy embraces a far greater extent than Mr. de l'Isle. His mineralogy is not only descriptive, but it is physical, chemical, and geometrical. In the persuasion that a mineral cannot be well described, nor even in many cases recognized, unless its physical, chemical, and geometrical characters are clearly laid down, the Abbé never omits any one of those characters, when ascertained, and exposes with the most scrupulous exactness every thing relating to them that observation has authenticated. He has bestowed particular attention to the electrical and magnetic phænomena, and has enriched the science with a multitude of new and curious observations. He attentively examined the property of double refraction which several transparent minerals enjoy; and here again he has extended the boundaries of science. A few minerals were known to possess this property, and the Abbé has discovered it in several where it had never been surmised.

When we consider that writers on mineralogy have hitherto grounded their systems *exclusively*, some on the exterior characters, others on the chemical properties of minerals; and that the Abbé really has, pursuant to his plan, (see in the beginning of the volume of plates, *La distribution méthodique des mineraux, par classes, ordres, genres et espèces*, The methodical distribution of minerals into classes, orders,

orders, genera and species,) united all that has hitherto been discovered on mineralogy, without falling into that confusion which has ever been imputed to other mineralogical writers, we are almost astonished at his success.

"To class mineral bodies;" "to furnish the means of discovering to which class, genus, and species a mineral under examination belongs," are the two great problems which the Abbé Haüy proposes for solution.

He solves the first in following Bergman's method (founded on chemical properties), much improved by the immense progress which chemical analysis has made since the days of that great chemist. In the solution of the second he follows Werner's method (grounded on exterior characters), but corroborated by a multitude of new experiments, easily made, and brought to a surprising degree of correctness by the Abbé's own labours, on the forms of crystals. But I perceive that the immensity of matter contained in this treatise is leading me from that point which I had particularly in view, I mean crystallography.

In the description of crystals the Abbé employs three different means. 1st, He draws their figure; he does not give crystallographical tables, as Romé de l'Isle, which are only general representations, but draws separately each species and variety. Every form given in the plates has been examined by himself; he has calculated every angle, and, nevertheless, his plates contain one-third more figures than De l'Isle's tables. 2d, He makes use of symbolic signs, than which nothing can be more simple, and which were invented not to recall the form of the crystal to the mind, but the laws by which it had been produced. Yet I have met with persons who were so accustomed to these signs, that at the first sight of them they could immediately figure to themselves the form of the corresponding crystals. These signs can also be spoken, and much circumlocution in consequence avoided. 3d, A significative nomenclature, subdivided into general and particular. The general is for the *minerals*, and comprises only substantives; the particular for the *crystals*, and is entirely composed of adjectives. He studiously avoided introducing new names, and nevertheless has been obliged to introduce many, where new substances, names capable of giving false impressions, or others void of signification, and unsupported by long usage, required it. He then substituted names taken from the Greek; a language, he says, that eminently enjoys the faculty of combining several words together, so as to form one representing concisely the object to be named. The adjectives used in the nomen-

nomenclature of the crystals also allude to some remarkable circumstance of the crystalline form.

I shall now proceed to philosophical crystallography, which might be called the philosophy of mineralogy. It does not consist in searching for the primary causes of phænomena; nothing can be less philosophical than such a research; primary causes will ever be beyond the reach of the human mind. The immortal Newton was the first to point out to us, by the method followed in his admirable book of the *Principia*, that the only true philosophical way of treating a physical science, or of explaining a natural fact, was to demonstrate that it was the mathematical consequence of a general law, grounded on an aggregate of facts already observed and capable of correct calculation. If any one of these conditions be wanting, we immediately launch out into hypothesis; explanations become vague; and, however much we may be persuaded of the truth of our assertions, we can acquire no certainty.

Let us apply these principles to our two writers. De l'Isle, in declaring that the various forms observed in crystals of the same substance are only modifications of one constant primitive form, certainly announced a most important truth. It was a flash of genius; but in a philosophical inquiry, to prove it, and not simply to say it, was the necessary step. On the first inspection of his crystallographical tables, a student is tempted to think that important truth demonstrated; but, on a closer examination, the impression is done away. The same order pervades every table. By slight passages the student is led from the simpler to the more compound forms, and after every passage is tempted to say, This can only be a modification of the primitive. Then when the real crystals and the figures of the tables are compared together, and all those of the same species (with a very few exceptions) are found in the same table, how easy it is to persuade ourselves that nature *must* operate by similar passages when producing the various forms of crystals! and the primitive of the table before us *must* be the primitive of the crystal under examination. In a word, it is the most simple form; and first impressions greatly strengthen the illusion. If persuasion was the sole object of philosophy, De l'Isle would have been a powerful philosopher; but philosophy must convince, demonstrate, and wrest consent, however violently opposed. An enemy must not, therefore, be able to make use of the same arms, or adduce the same proofs, to establish a contrary opinion. Nevertheless, such would be the case with Mr. de l'Isle's tables, and the

the application of them. For it is an incontestable fact, that by a series of arbitrary truncations we may pass insensibly from any given form to any other. Grounded on this principle, and seconded by Mr. de l'Isle's ingenuity, any form may become primitive, and any other deduced from it. Now, as the combinations are infinite, a multitude of tables may be constructed; forms of the same species may be dispersed in different tables; the most simple of each table will be the primitive; therefore forms of the same species will have different primitives. But when by the same principle both sides of the question can be proved, nothing is proved.

To say the most simple form must be the primitive, is an illusion; for we know not what is the most simple for nature. With our feeble organs and confined senses we can form no judgment of *simple* when the operations of nature are in question. Nature embraces the entire universe; her laws are simple; but the combinations made according to those laws are unbounded, therefore complicated.

Let us not forget, however, that the idea of truncations, and the idea of taking the most simple form for the primitive, are so natural, that they must have been the first to present themselves to the man who was opening the career. "Often," says the Abbé Haüy, (vol. i. p. 14.) "a more compound form only differs from a more simple one by certain little faces, which may be produced by sections either at the solid angles, or on the edges of the simpler form." And in a note he says: "This was the observation which gave the celebrated Romé de l'Isle the idea of his system of truncations, that he might successively deduce from each other the different varieties of crystalline forms assumed by the same substance."

Mr. de l'Isle terminates the introduction to his work by certain axioms, as he styles them, the 2d and 16th of which are as follow:

II. "Every angular polyëdron, or every crystallized substance, is a SALT in the most extended acceptation of that term."

XVI. "Every saline substance whose constituent parts are perfectly saturated and combined, affects the *cubic* form, or its inverse the *octaëdron*; whereas the salts which are not neuter, or whose constituent parts are not exactly combined, affect either the *prismatic* or the *rhomboidal* forms."

I need scarcely observe that, to treat such axioms only as doubtful, would be treating them kindly. The other axioms are

are matters of fact from which he draws no consequences; and indeed it would have been difficult for him to have drawn any.

The Abbé Haüy does not undertake to prove, generally, that among the different crystalline forms of the same substance, one of them is the primitive. But he produces from each crystal that primitive form which is always similar in similar substances. He demonstrates it analytically and synthetically: by an analys is which might be called *mineralogical analysis*, and pointed out by nature herself; by a synthesis hitherto the property of mathematicians, but here supported by the general laws which his analysis has revealed to him. The constant accord found between this synthesis, and daily observation, is a proof of the exactness of his method.

Two facts were the foundation of his theory.

1st, In all times, jewellers and lapidaries have remarked that stones are easier cut in some certain directions than in others.

2d, Whoever has been in the habit of seeing natural crystals must have observed that, when their forms are well determined, they are always terminated by plane surfaces. "Thus," says the Abbé, "those soft outlines, and that roundness so frequent in the animal and the vegetable kingdoms, where they are inherent to the organization and contribute even to the elegance of the forms, indicate, on the contrary, in minerals, a want of perfection. The characteristic of true beauty in minerals is the straight line, and it was with truth that Romé de l'Isle declared *that line* to be the peculiar property of the mineral kingdom." The first fact suggested the mineralogical analysis, and the second furnished him with the laws on which he grounded his synthesis.

Inquiries on the first fact.

1st, All crystals that can be split by means of instruments offer to the view, if split in certain directions, plane and smooth surfaces. If divided in other directions, the fracture is rugged. I use the word *split*, and not *sawed* or *cut*, as the sections of the crystal are not to be obtained by slow and continued efforts, but by sudden shocks. Patience, dexterity, and habit enabled the Abbé to split a great number of crystals; in all he discovered plane smooth surfaces, when split in certain directions, but when in other directions the fracture was always rugged and irregular. I request, sir, your attention to this important fact; it is fundamental, and the more important, as several persons of much general information have neglected to attend to it,

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and in consequence have supposed the whole of this theory to be grounded on hypothesis. It would be equally erroneous to confound these sections of crystals with De l'Isle's truncations. The latter, indeed, warns his readers that, by the word *truncations*, he wishes only to figure the appearance of the crystal examined. They are not, therefore, real, but only a means of warping the imagination to the exterior form of the crystal, and are by their nature only descriptive. The Abbé Haüy's sections are real, and are pointed out to the observer by the interior structure of the crystals; they are experimental.

2d, The plane smooth surfaces obtained by the above method are respectively parallel to 3, 4, or 6 planes. The mutual inclination of these planes to each other is constant in crystals of the same substance, whatever may be the exterior form of the crystal. Native antimony, phosphate of lead, and quartz, seem to show an appearance of more than 6 planes, and the Abbé Haüy leans to the opinion of only 5 planes in some cases; but as these are exceptions to the general rule, and would only tend to complicate this statement, I shall take no further notice of them.

Let us suppose the smooth surfaces to be only parallel to 3 planes, or, in other words, that the substance will only split in three directions. In that case, the sections can only produce a parallelopipedon, whose nature is determined by the mutual inclinations of the planes to each other. If the planes are perpendicular, it will be rectangular, &c.

We next suppose the smooth surfaces to be parallel to 4 planes. Here a distinction arises, whether 3 of these planes have a common intersection, or not; and it must be remembered that, if the 4 planes have a common intersection, no solid can be produced; as they can neither bound nor include a space. If, therefore, 3 of the 4 planes have a common intersection, the splittings will produce either 1 hexaëdral prism, or 3 parallelopipedons, which will be similar or dissimilar, according to the similarity or dissimilarity of inclination of the planes, or 1 triangular prism. On the contrary, if the 4 planes only intersect each other, two and two, there will be produced either 1 octaëdron, or 4 parallelopipedons, or 1 tetraëdron.

Lastly, let us suppose the smooth surfaces to be parallel to 6 planes; then there arise an immense number of cases. But we will for the present confine ourselves to the only case that has hitherto been observed in nature,—where the intersection of the planes is two and two. Then we obtain either 1 dodecaëdron, with pentagonal, quadrilateral or triangular faces, according to the sections made; or 15 octaëdrons, or 20 parallelopipedons, or 15 tetraëdrons. It may be proper to observe here that, though the sections parallel to the 6 planes may be clearly indicated, nevertheless, it rarely happens they can all be executed; but it will suffice for the purposes of geometry, that they be clearly indicated to render the consequences drawn from them mathematically correct.

Having laid down these premises, let us proceed to the dissection of a crystal of carbonate of lime (the spath calcaire of De l'Isle), whose primitive form is a rhomboid, or a parallelopipedon bounded by rhombs. Hitherto sections have only been obtained in the three directions parallel to its faces. If these sections be directed so as to always pass through the centre of two opposite faces, they will produce 8 rhomboids equal to each other, and similar to the original one. The same operation may be repeated on each of these 8 rhomboids, and continued so long as the substance remains carbonate of lime, that is to say, to be a combination of 55 parts of lime, 34 of carbonic acid, and 11 parts of water of crystallization (see Bergman). But this division of the crystal into similar solids has a term, beyond which we should come to the smallest particles of the body, which could not be divided without chemical decomposition, that is to say, without an alteration in the proportions of lime, carbonic acid, and water. These last particles, which are still rhomboids, are what the Abbé Haüy calls *integrant particles* of the carbonate of lime. In the supposition, therefore, that a rhomboid of this substance can only be divided in three directions, by sections parallel to the faces, it is evident the integrant particles must be rhomboids.

If a crystal can be divided by sections in more directions than three, what will be the form of the integrant particle? For example, in the phosphate of lime (the chrysolite of De l'Isle), where the sections are parallel to 4 planes, 3 of which have a common intersection. According to what has been said above, these sections can produce either 1 hexaëdral prism, or 3 parallelopipedons, or 1 triangular prism. It is evident that, by carrying the division according to those sections to its greatest length, either the last hexaëdral prism, or the last 3 parallelopipedons, or the last triangular prism, will be produced. Are these last solids the integrant particles; are each of them so; or is there only

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one of them entitled to that denomination; and if only one, which of them? My answer is, Only one of them, and that one the triangular prism; which may be proved thus:

It cannot be denied that the integrant particle is that little solid which contains the least possible quantity of the body, without affecting the chemical composition of the substance. This granted, let us suppose the hexaëdral prism to be the integrant particle. In that supposition the last triangular prism must contain the last hexaëdral prism, and is equal to the latter more three triangular prisms; or, in other words, to nine similar triangular prisms, while the hexaëdral prism only contains six. But the last triangular prism, and the last hexaëdral prism, each contain an exact proportion, and therefore a similar proportion, of chemical component parts; therefore their differences also contain an exact proportion. But it is impossible to conceive how their differences can contain the exact proportion, unless each of the three little triangular prisms also contain it; they must therefore contain it, and each of them must be an integrant particle; therefore the hexaëdral prism cannot be one: neither can the parallelopipedons be integrant particles, as the same arguments will stand good against them, which have been applied to the hexaëdral prism; therefore the triangular prism must be the integrant particle; therefore the sections producing the hexaëdral prism cannot lead to the integrant particle; therefore all sections, though perfectly practicable in crystals, will not lead to the integrant particle.

"The forms of the integrant particles," says the Abbé (vol. i. p. 30.), "may be reduced to three; the tetraëdron, or the most simple of pyramids; the triangular prism, or the most simple of prisms; and the parallelopipedon, or the most simple of solids having parallel faces two and two; and as four faces are necessary to circumscribe a space, it is evident that the above three forms, in which the number of faces are successively 4, 5, and 6, are again in this point of view the most simple posible."

The phosphate of lime or chrysolite is a substance that has given rise to much curious anecdote. It shows in what a state the Abbé Haüy found the mineralogical nomenclature, and points out the accuracy of his analytical method. Achard, a chemist at Berlin, had analysed the chrysolite, and published that it contained of silex 15 parts, alumine 64, lime 17, and of iron 1. This startled the celebrated Vauquelin, who had seen Klaproth's analysis of the chrysolite (the apatite of Werner), containing of lime 55 parts, and of phosphoric acid 45 (probably the water of crystallization is added to the acid). A Frenchman of the name of Launoy sent from Spain a quantity of this substance to Paris: some of it was purchased by the *Ecole des M nes*, and Vauquelin was desired to analyse it. The latter soon suspected Achard had been misled by the name, and had not obtained the proper substance; a mistake the more easily made, as, says Vauquelin, "the name of chrysolite was given to a great variety of stones, such as the *peridot*, the *chrysoberil*, the *olivine* (since found to be the same as the *peridot*), and in general to stones having a yellow colour." He observed that the chrysolite sent from Spain contained lime and phosphoric acid. "I had no sooner made this discovery," says he, "than I inquired of Abbé Haüy whether he had compared the integrant particles of the chrysolite with those of the apatite or crystallized phosphate of lime. He answered me that he had not made the comparison, but that he would get his papers on primitive forms," (this was four years before the publication of his work) "see what notes he had made on each of those substances, and immediately compare them together; when with pleasure he found that there was not the least variation between them. Thus had the Abbé Haüy discovered, by the help of geometry alone, that which I confirmed by chemical analysis; and this satisfactory accord between two sciences apparently so distant from each other, while securing each other's steps, serves also to show the certainty of the principles on which they are grounded."—*Journal des Mines*, xxxvii. p. 21.

A more singular anecdote is what took place with respect to the emerald and the beril. Vauquelin had analysed the emerald of Peru, and read the result of it at a sitting of the *Ecole des Mines*, which is preserved in the journal, (No. xxxviii. p. 96.) viz. of silex 64, of alumine 29, oxide of chrome 3, of lime 1, and of volatile substance 2; I have neglected decimals. Soon after he discovered a new earth, which he called the *glucine*, and gives the following account of it to the National Institute:—"The Abbé Haüy having observed a perfect conformity between the structure, the hardness, and the weight of the beril and the emerald, pressed me a few months back to make an analysis of these two substances, to know whether they contained the same principles, and in similar proportions. In the result, the fact that will most interest the Institute is the discovery of a new earth, &c. &c."—(*Annales de Chymie*, vol. xxvi. p. 157.)

I am certain, sir, it will give you no less pleasure to learn that Vauquelin, in consequence of this discovery, made an *addition to the paper* read at the *Ecole des Mines*, beginning thus: "Since the reading of the above paper, having discovered a new earth in the beril, and as this stone, according

cording to the observations made by Haüy, contained substances similar to the emerald; I have in that point of view made a new analysis of this latter stone:" and the former analysis was immediately corrected, and the 29 parts of alumine became 16 parts of alumine and 13 *of a new earth.* I hope, sir, it is not too much to say that, on this occasion, a new earth was discovered, if not by, at least in consequence of, a geometrical analysis.

But to return to our subject. The abbé makes a distinction between the *integrant particle* and the *primitive form.* The former, as I have said, is that last particle, which, preserving an exact proportion of the component parts, contains the *least number* of those parts; it is the last term of mineralogical analysis. The primitive form, on the contrary, is its first result, and, retaining the exact proportion of the component parts, contains the *greatest number* of those parts. It is easy to see, in the case above mentioned of the phosphate of lime, that the hexaëdral prism will be the primitive form, precisely for the reasons adduced to show that it is not the integrant particle. Though the Abbé does not decidedly define the integrant particle, as containing the *minimum* of space under the *maximum* of surface, and the primitive form as containing the *maximum* of space under the *minimum* of surface, the inclination of the intersecting planes being the same; nevertheless he makes a remark that authorizes the above definitions (which, sir, you will observe, are mine, lest any fault be found with them). He says the dodecaëdron with rhomboidal faces, which is the primitive form of the garnet (grenat), contains the *maximum* of space under the *minimum* of surface; and if it be cut into two equal and similar parts, it will present the same form as the bottom of the cell of the honey-comb, which has the similar property.

An objection might be taken on the *cuivre pyriteux* and the *cuivre gris,* or the yellow and gray copper ore of Kirwan, the Abbé mentioning the regular tetraëdron as their primitive form, and not the octaëdron as in other cases. The reason may be, that all the crystalline forms of these substances which he describes are slight modifications of the regular tetraëdron.

"The primitive forms hitherto observed," says the Abbé Haüy, "are reduced to 6; the parallelopipedon, the octaëdron, the tetraëdron, the regular hexaëdral prism, the dodecaëdron bounded by rhombs all equal and similar, and the dodecaëdron with triangular faces, and formed by two right pyramids united base to base."

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He also makes a distinction between integrant particles and *substractive particles*; these latter are always parallelopipedons. I shall speedily mention whence they derive their name. They are substituted for the integrant particles to facilitate calculations; and it is worthy of observation, that parallelopipedons can always be obtained in all dissections of crystals.

Thus far, sir, I have stated the first principles of mineralogical analysis; I shall now proceed to the synthesis.

[To be continued.]

XXX. *On cutting Screws by Means of the common Turning Lathe.* By ROBERT HEALY, *A. B.*

To Mr. Tilloch.

Dublin, Dec. 2, 1803,
James-street, 43.

SIR,

AN application which I propose for adapting the plain lathe to the purpose of cutting screws is submitted to your consideration, which if you deem worthy of insertion, your doing so will oblige

Your obedient servant,

ROBERT HEALY.

Turning, like many of the other arts, unites the agreeable with the useful, and, whilst it is a necessary helpmate to several branches of mechanics, it often induces gentlemen, by the ease with which it is accomplished, to fill up their vacant hours in forming a variety of things the execution of which both pleases the fancy and exercises the ingenuity. But to expatiate here on its advantages is not my intention: suffice it to say, that of the different branches of the art that of turning the screw has been most cultivated, not only from the utility which arises from it, but perhaps from the celebrity that is gained by it, since he is looked upon as having obtained the summit of perfection in his art, who can cut every variety of the screw with facility. Thus, then, it was necessary for those who could not afford time sufficient for this acquirement, either to resign all idea of turning them, or else bear with the inconveniences of doing it imperfectly, till the traversing manderil was thought of; and from its general use among one class of turners, it is obvious that it affords an easy, pleasing, and certain method of turning screws. But to those who require most its as-

sistance

sistance little advantage has arisen, owing as well to the expense of purchasing it, as to its incapability of turning that variety which is necessary, since only screws similar to those traced on the traversing manderil can be cut with it; and these are limited to a very small number. To those, then, who find it difficult to cut screws without such an instrument, an apparatus is proposed, by the application of which to the plain lathe that difficulty may be obviated. The plate represents a perspective view of the tool; and the letters referring to the different parts of it may, perhaps, make its description clearer. On the common manderil A (Plate IV.), is screwed a chuck, B, to which may be screwed the chucks of the lathe, as R. On the outside of this chuck, B, is turned a screw, which is fitted to an inside or female screw worked in the circular block C, from which block extends an arm, D, as long as may be thought fit for the purpose of permitting another arm, E, to slide up and down it: a piece of iron should be screwed to the circular block, C, of such a length as to be capable of moving in a groove that may be cut in the collar, or adapted to it. The rest, GFO, must not stand, as usual, parallel to the work, in cutting an outside or male screw; but at right angles, as when an inside or female screw is to be cut, in order that the further arm of the rest, F, may be joined to the end of the second or intermediate arm, E. It is necessary that this second or intermediate arm, E, shall be capable of fastening firmly the first arm, D, to any part of the rest, GF, as also to have a joint at each end to admit in a horizontal plane its free play. Thus, as the lathe turns to us or from us, the arms must traverse forwards or backwards; which gives a similar motion to the tool H, that is held steadily or fixed with a screw on the further arm, F, of the rest; and thus a screw is cut with a tool of a single point. It is unnecessary to mention that no joggling should arise from the motion of the arms, as that would cause a failure in cutting a perfect screw. If the centre of the rest should be drawn nearer to us, and by that means bring the tool closer to the intermediate arm E, then a screw of a much larger size will be cut; for as the rest, turning within its socket (the thumb-screw for fixing it being in this operation always withdrawn), moves on a centre, the further the tool is moved from this centre the greater will be the radius of the circle described, and consequently the coarser will be the screw; and, *vice versâ*, the nearer the tool is brought to the centre the smaller will be the radius of the circle, and thus the screw will be finer. Should the intermediate arm, E, be connected to the

the nearer arm of the rest G, and the tool held on the further one, F, then a left-handed screw will be cut of a thread the distance between the turns of which will vary according to the distance of the point at which the tool is held between the centre and extreme end; for, as the lathe turns to us, the arms receive a forward motion, except the further arm, F, of the rest, which receives a backward motion; but when the lathe turns from us, then the further arm receives a forward motion; and as the tool meets the wood, so it cuts a left-handed screw. It may be apprehended that a piece of wood so far removed from the collar, K, might spring in its motion; but this may be obviated by not making use of the traversing chuck, B, till the screw is to be turned; for, as the cutting of it is light work, there will be little resistance, and of course but little spring; or the traversing screw, B, may be turned on the manderil A. Another disadvantage would seem to arise from the impossibility of cutting screws when the poppet head is made use of, to prevent the springing of a long piece of wood. But this may be obviated by lengthening the intermediate arm, E, to the part where we intend cutting the screw, and thus we have the same screw as that of the traversing one: if a finer or coarser screw should be required, then, by having an arm of the rest to slide in and out, and the intermediate arm to be connected to the centre of the rest, we have just the same power of turning screws as in the former case. A socket, S, is represented, the lower part of which slides on the rest, and may be fastened firm to it by a screw: the upper part, that turns on a pivot, admits the intermediate arm to slide through it, which arm is held stationary in it by a screw. Should the difficulty that might arise from turning screws with a plain lathe be obviated by this method, I shall feel a double gratification in the reflection that that time which was spent in amusement has tended to the advantage of others.

To Mr. Tilloch.*

Dublin, April 27, 1804.
James-street, 43.

SIR,

I PERFECTLY agree with you, that was the rest to make a right angle with the piece of wood on which the screw was

* In answer to a letter stating the objection mentioned in the beginning of the present letter, which we have published, as tending to explain more fully Mr. Healy's invention.—EDIT.

to

to be turned, at the commencement of the process, and to become parallel to it when the screw was finished, an approximation would take place from a larger screw to a lesser, or *vice versâ*; but it is impossible that the rest could become parallel to the work, from the connection of the arms. Now let the traversing arm, D, lie in the centre of the screw B, on which it plays, and let the rest make a right angle with the wood on which we intend to cut the screw. The rest may traverse thirty degrees on either side of the right angle; which will not cause any sensible approximation in the thread, and will admit a motion sufficiently extensive for turning the common length of screws. But as the method answers for a short screw of a few turns, that is sufficient for every purpose. For, in order to make a long screw, there may be three different ways for doing it:—1st, At the commencement the rest stands at right angles with the wood on which the screw is to be cut; by it describing an arch of a few degrees, a short screw is cut; then by bringing back the rest to its original angle, the right one, and sliding forward the single-pointed tool to the last thread of the screw that was just cut, we proceed to any length by repeating the same process. 2dly, When one or two threads of a screw is cut, by making use of a common screw tool, the most unskilful hand will be able to continue the screw to any length. 3dly, Should a side tool with many teeth be made use of, a screw of any length may be cut, the rest describing its usual arch. But actual experience of the utility will, I trust, also do away all objection; for I assure you, when I first thought of the method, I reduced it to practice, and, having made the instrument, worked with it, to my utmost satisfaction, in the presence of many friends. Permit me to return you my many thanks for the trouble you have taken in considering this paper, and also for the friendly manner in which you expressed your objection. Believe me, sir,

Your much obliged servant,

ROBERT HEALY.

LETTER

XXXI. *On the Catoptrical and Dioptrical Instruments of the Antients.*

LETTER III.*

1. As I have reason to think that my two last letters have not been unacceptable to many of your readers, I should now proceed to inquire (according to my means) into the state of catoptrics and dioptrics among the antients. But here our learned and ingenious friend *Mr. Johnston*, who in translating, as he has ably done, *Beckmann's* History of Inventions, has had occasion to pay particular attention to the progress of the arts and sciences, has very opportunely put into my hand a work which will leave me little more trouble than that of translation. It is the *Amusemens Philosophiques* of father *Abat*, printed, it would appear, for the first time, at Amsterdam, and sold at Marseilles in 1763. If certain parts of this learned performance could have been known to Dr. S., whose book appeared in 1738, he would probably have been induced to alter some parts of that valuable performance.

2. It is possible that some may think such an investigation has little other use than to gratify an idle curiosity; and it must be confessed that such an opinion has received but too much countenance from some men of character in the literary world. Dr. *Thomas Burnet* †, in particular,

* The first letter is inserted in the Philosophical Magazine, vol. xviii. p. 53, &c.; the second, same volume, p. 245, &c.; and its conclusion, vol. xix. p. 66, &c.—Part of the note to § 21 of letter 2d, should be read thus: Mr. Gibson, watchmaker, at Hampstead, a very ingenious mechanician, whose late brother, at Kelso, was one of the first opticians in Great Britain, and who has himself paid particular attention to perspective, complains, that he scarcely knows a scientific (especially an astronomical) book, the figures of which are free from gross errors in perspective, where perspective is necessary, or is attempted. But he acknowledges the merits of many writers on this branch of science, particularly Dr. B. Taylor, Hamilton, Noble, Tho. Malton, and H. Clarke; and I hazard little in adding Gravesande, Murdoch, in the first sect. of his *Newtoni Genesis Curvarum per Umbras*, and Wolfius in his *Elementa Matheseos Universæ*.---In § 19. line 9th from the bottom, for *merely* read *chiefly*. § 26, before Kepler, insert *The great*.—In the note to § 38, I state the sum which Bacon laid out on experiments, &c. in twenty years, at about 18,333l. of our present money; but the learned Dr. Henry (Hist. of G. Brit. vol. viii. p. 217, 2d ed.) makes it about 30,000l.—At the end of the next note are meant, of course, practical astronomy and navigation in their present improved state.—The writer will be thankful for remarks and corrections, if made with good manners.

† *Archæologia Philosophica*, lib. I. cap. 8, as quoted in *Heathcote's Historia Astronomiæ*, p. 7.

does

does not scruple to speak of such inquiries in these words: "*Ego lites illas*, &c. I hold these national controversies, about the origin of literature and the first discovery of the sciences, to be of little moment, since there was nothing to hinder them from being invented by several at the same time; and it more interests us to know who extended and promoted the sciences, how far they carried them, and what monuments or precepts they have left to posterity, whereby those sciences may be further advanced."—Undoubtedly scientific "monuments and precepts," that is to say, the sciences themselves, are more interesting to us than it is to know who were their inventors. Yet it is not easy to see, why the "extenders and promoters of the sciences" have a better claim to be remembered than the "inventors." The truth is, that this learned and worthy author (for such he was in many valuable respects) was a still greater master in classical and archaiological erudition than in strict argument; and, when he wrote this passage, seems not to have recollected that a little fame, too often posthumous, is the *only* reward * of many inventors; a cheap reward, surely, for all their labour and ingenuity. Nor, judging from his Answers to the Exceptions against his Theory of the Earth, would he have been pleased, if he could have foreseen that his own elegant but unsound performance would be neglected as it now is; except by those philosophers who do not unreasonably deride antient writers (sometimes including those of the Bible), and who still respect *Burnet* for his excellent elucidations of many parts of the Scriptures, and other venerable antient writings. It may be said, that the love of fame is a modification of pride, and ought to be discouraged. Perhaps I might accede to this proposition, if accompanied with certain limitations, which I have not room to state. At present I shall only observe, that it is entertaining enough to hear men talk thus, who in their practice act—just like other men; take human nature as they find it; and even occasionally show that they themselves are not dead to the influence of the "universal passion." I must, moreover, appeal to every discerning, well-disposed man, whether he does not feel more satisfaction in tracing the progress of arts, and sciences, and civilization, in such a work as *Henry's* History of Great Britain †, than in wading through volumes filled with genealogies,

* ——*Quis enim Virtutem amplect'tur ipsam,*
Præmia si tollas? JUVEN.

† *Dr. Henry*, speaking of *Roger Bacon*, has these words: "We learn from the best authority, that no lectures on optics had been read at Paris, or at any other place among the Latins, except twice at Oxford, before A. D.

nealogies, and intrigues, and torturing, and throat-cutting, and desolation; to which we must now add, the late improvements in poisoning and guillotining. It is, indeed, no wonder that such scenes should have provoked honest Dr. *Johnson* to brand history in general with the name of "The Annals of Blood." But I cannot stop to moralize.

3. Before I proceed to *Abat*, however, I must lay before the reader a passage which I have found since writing my last (in Heathcote's *Historia Astronomiæ*, p. 41), and which comes very properly into this place. "*Wood in Historia*, &c. *Wood*, in his Universal History of Oxford, book i. p. 122, hath extracted a passage from a manuscript book of *Roger Bacon, De Perspectivis*, in which he appears to own that the invention of the optical tube is much more antient than his days. For he writes (*Julium Cæsarem, tubi ope, a Gallicano littore, portus Angliæ, urbesque maritimos spectasse, cum bellum in Britannos meditaretur*) that *Julius Cæsar*, by the help of a tube, viewed, from the coast of Gaul, the ports and maritime towns of England, when he meditated a war against the Britons." Here there is not, any more than in *Bacon's* words to the same effect, which I translated, at § 25, of my last, any mention of "raising up speculums to a great height," as Dr. S. would have it, in order to make *Bacon's* glasses entirely fixed and stationary. Yet, if *Cæsar* used telescopes, it is natural to think that he would carry them to the highest ground, or to the *speculæ*, or watch-towers, which were erected along the narrow part of the British channel, and of which one lately existed at Dover. All that I would be understood to mean is, that, as far as I can find, Bacon did not suppose that *Cæsar's* instrument was *necessarily* fixed to a spot.

4. Be this as it may, *Bacon's* belief of this story of *Julius Cæsar's* optical tube, seems to be no bad proof of the ex-

A. D. 1267: and that there were only three persons then in England who had made any considerable proficiency in that science. Friar Bacon was one of those three; and that he had made great proficiency in it, we have the clearest evidence still remaining in his admirable treatise *De Scientia Perspectiva*."—"In a word, there is the clearest evidence, in the works of this wonderful man, that he was acquainted with the construction of all the different kinds of instruments for viewing objects to advantage, which have been so much admired as modern inventions." Hist. of G. Brit. 2d ed. vol. viii. p. 198, 200, where the learned author quotes *A. Wood Hist. Oxon.* lib. i. p. 122; and *Ola Borrick, De Ortu et Prog. Chem. apud Manget, Biblioth. Chem.* t. i. pp. 31 and 600. Was not *John Peccam*, archbishop of Canterbury, who wrote a book on optics in 1279, about nine years after the celebrated Pole *Vitellio* wrote his, one of the three English opticians here mentioned by *Dr. Henry*?—*Vid. Wolfii Elem. Math. Univ.* t. v. p. 95.

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cellence of his own. For, if a man of his scrupulous, philosophical turn of mind, could believe, as he certainly appears to have done, that any optical contrivance could be useful at such a distance as even the smallest breadth of the British channel, he must have had sufficient reason for such belief; and this reason, one would think, could only be the performance of his own instruments. Mere speculation could never have produced *such* a belief in *such* a mind. Thus it was exactly, when the happy performance of *Buffon's* burning apparatus constrained the most fastidious sceptics to believe in the similar exploit of *Archimedes.*

5. But I have now cited this passage chiefly to prove, as I think it does satisfactorily, that *Bacon* did not claim the invention of the telescope, or equivalent instrument, but referred it to an age much anterior to his own. This leaves us at liberty to carry our inquiries on this subject into times much more remote. And this I shall do by submitting, though not implicitly, to the able guidance of *Abat.* I shall, however, take the liberty to retrench his French verbosity when it becomes tiresome; to support and illustrate his valuable text with occasional notes; and to express freely my dissent when I think him in the wrong.

6. " *On a mirror placed by Ptolemy Euergetes upon the tower called the Pharos of Alexandria.*

" We read in several authors that Ptolemy Euergetes caused to be placed on the tower of the Pharos, at Alexandria, a mirror which represented accurately every thing which was transacted throughout all Egypt, both on water and land. Some authors relate, that with this mirror an enemy's fleet was seen at the distance of 600,000 paces; others say 500 parasangs, or more than 100 leagues.

7. " Most persons whom I have heard mention this fact, treated it as a random story, and as a thing impossible. There are even celebrated opticians who think that, if the fact was real, it could only be the effect of magic, or a delusion of the devil. Such, among others, is the opinion of father *Kircher,* who, when speaking of several effects of superstition, includes this in the number. The following are his words: (*Ars magna Lucis et Umbræ,* lib. x. c. 1. at the end) " *Verum cum hæc omnia,* &c. But as all these things are owing to the delusions of the devil, we shun them with all our might; and, after the example of holy mother church, we condemn and execrate them *. Of this kind,

* It is probable that many of the Scottish peasantry still follow, without

kind, if historians have truly related the facts, was that speculum, which king Ptolemy Euergetes is said to have constructed on the Pharos tower, in which were represented hostile fleets, and whatever else was to be seen by sea or land throughout Egypt; to all which things, since they exceed the limits of nature, no credit is to be given."

8. "Taught by experience that many facts reckoned chimerical by a number of learned men, having been better examined by other learned men, have been found not only possible but in actual existence, I have suspected that the same might be the case with this mirror of Ptolemy. I therefore at once concluded that the decision of this fact ought not to depend on the sole authority of some learned men; but that, in the laws of optics, dioptrics, and catoptrics, we ought to look for just marks to condemn it as fabulous, or good reasons to demonstrate its possibility.

9. "We frequently observe, that in historical details relating to the sciences, which are commonly but little known to such authors, their ignorance makes them intersperse circumstances which render their accounts obscure and undistinguishable, and even sometimes unintelligible or impossible, although, in truth, they may be perfectly real. Optics, catoptrics, and dioptrics, are among the sciences of which most historians are ignorant, or of which they possess but a very superficial knowledge. To banish, then, to the regions of fable or impossibility this famous mirror of Ptolemy, it is not enough that we find in its historians impossible circumstances which stamp it as chimerical; we must moreover have proofs, which, independently of the accessory circumstances with which ignorance has

out knowing it, the example of holy mother church, when they ascribe the wonders performed by *Michael Scot*, to his being a *warlock*, or a person *in compact wi' the de'il*. They will tell you, that if you put a wand through the key-hole of his door at Melrose, it will come out peeled; that the de'il carried him through the air to Rome, and back again, in one day, &c. &c. It seems that *Scot* really was sent to Rome to represent to the pope the absurdity of some claim of superiority over the clergy of Scotland, which had been set up by the archbishop of York. About 17 or 18 years ago, a writer in one of the periodical publications alleged (seriously to all appearance) that an air-balloon had been the vehicle in this wonderful journey. The believers in Scot's supernatural powers always add, that he got all his *lair*, and was taught all his *uncanny tricks*, at Oxford. The truth is, that *Michael Scot*, of Balwirie, the cotemporary of *Roger Bacon*, (for he was born about the end of the 12th or the beginning of the 13th century, and died in 1290,) "was one of the greatest philosophers, mathematicians, and linguists, of his age." See *Mackenzie's* Lives of Scottish Writers, vol. i. p. 214, as quoted in *Henry's* Hist. of G. Brit. 2d ed. vol. viii. p. 222.—*Translator.*

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clothed it, place the principal fact beyond the bounds of probability, or demonstrate its impossibility.

10. "It is evident that the possibility of the principal fact, and of the foundation of this story, consists in the possibility of a mirror, which could alone enable us to see objects at as great a distance and with as much clearness and distinctness, as a good telescope. The proofs of this possibility depend on several delicate experiments in catoptrics and dioptrics, of which many persons conversant with those sciences are still ignorant.

11. "We shall have little trouble in discovering the source of the absurdities, which have been mixed with the history of this fact, if we prove that the execution of such a mirror is possible, and that it was also possible in the days of Ptolemy. This will not be difficult; and I propose to do it in the present memoir, which I shall divide into two parts. In the first, I shall prove, by the strictest evidence, the possibility of this mirror; in the second, I shall deliver some proofs that it really existed.

12. "PART FIRST. *Proof of the possibility of the fact.*

"Let a concave mirror be constructed, of a great size, and forming a portion of a large sphere: I say, that in such a mirror we may see objects as distant, and with as much clearness and distinctness, as with a good telescope.

13. "In order to this, the observer must stand between the object and the mirror, but so as not to intercept any of the rays. The mirror then should be so placed, that the incident rays coming from the object, and the rays reflected by the mirror to the eye, may make a small angle with the axis. This angle ought not to be greater than is necessary, in order that all the rays which come from the object to the mirror may pass by the observer. Things being thus arranged, I establish the following facts:

14. "*First,* If the eye be near the focus, or the place where the image of the object is formed, and between the focus and the mirror, the object will be seen much magnified and in the natural situation. But here we must remark, that if the observer be a myope, or short-sighted, he will see nothing but a confused appearance. If his sight be good, and he be neither a myope nor a presbyte, he will distinguish the objects well, and will see them much magnified, but with some confusion and obscurity, unless the mirror be a portion of a very large sphere. Lastly, if the observer be a presbyte, or long-sighted, he should stand at the distance at which he sees the objects direct and much magnified.

magnified. And thus the objects will appear as clear and well defined, as if viewed through a good telescope.

15. "*Secondly,* If the eye of the observer be placed exactly in the focus, or very near it, he will only behold a very confused appearance, without distinguishing the objects at all.

16. "*Thirdly,* If the observer stand further from the mirror than the focus, so that his eye be distant from the focus about as far as he holds a book when he reads with ease, then, I say, that whatever be the state of his sight, long or short, he will see the objects much magnified, with very great clearness and distinctness, and as well as if he viewed them with the best telescope. In this case, however, the objects will be inverted.—I have established these facts by many experiments, some of which I shall now describe.

17. "*Exper.* 1*st.* I took a concave glass mirror, which was silvered on the convex side, its diameter being somewhat more than 10 inches (above 10 and 7-10ths English inches), and its focal distance about 22 feet. Standing before this mirror, in the manner I have described, I saw clearly and distinctly all the distant objects opposite to the mirror. I must observe that this glass was coarsely polished, and of a bad material; which very considerably diminished the effect. This mirror was also too small. It is proper to add here, that mirrors of metal, well polished and accurately wrought, are better for this purpose, on many accounts, than those of glass.

18. "*Exper.* 2*d.* I took a glass lens, both whose sides were of equal convexity, each side being a portion of a sphere, whose diameter was about 44 feet. It was not silvered, and was six inches and a half in diameter. Its focus, made by reflection of the rays, which after passing through the first surface were turned back by the second, was distant about five feet and a half.

19. "Having placed this glass in the situation described in the preceding experiment, in order to view the objects by reflection from the second surface, as if it had been silvered, I saw them with much clearness and distinctness.

20. "It is easy to conceive that the number of rays reflected by the lens in this situation must have been very small, in comparison to what it would have reflected had it been silvered; and consequently in this last case, it would have produced a much greater effect. Hence it appears farther, that a concave metal, well polished, of a regular figure, and of the same focal distance, would produce a very

good

good effect, although its surface should not be greater than that of the lens in this experiment.

21. "Every optician will easily conceive, that if, with a single convex glass, he can see distant objects, by refraction, with as much clearness and distinctness as with a telescope composed of several glasses, he will experience the same effect, by reflection, from a single concave mirror. I shall therefore state some experiments and observations which prove incontestably, that this effect may be produced with a single object-glass; which, consequently, will be a new proof that a single concave mirror will do the same thing.

22. " M. *de Fontenelle*, in his History of the Academy of Sciences for the year 1700, tells us, that M. *Tschirnhausen* had described to the learned, the effects of a new object-glass which he had made. Its focal distance was 32 feet: it was a double convex, a Rhenish foot (12 and 4-10ths English inches) in diameter. He used it without an eye-glass, and altogether uncovered; and he affirms that objects were seen more clearly with his single lens than they had ever been seen with telescopes, and that they appeared brighter than to the naked eye. Such a glass, then, will answer its end without any tube, and the object will always be seen distinctly, notwithstanding the solar rays, which pass between it and the eye. The field, or the space which may be viewed at once with such a lens, is of incredible extent. M. *Tschirnhausen* assures us that, without either eye-glass or tube, he saw very distinctly, at noon-day, a whole town, at the distance of a German mile and a half (about six English miles).

23. " After M. *Tschirnhausen*, the same thing was done by M. *Wolff*, or *Wolfius*, with a large plano-convex, the diameter of whose convexity was 30 Rhenish feet (31 English). This lens was two feet long and a foot and a half broad (24 inches 8-10ths and 18 inches 6-10ths English respectively). In his *Elem. Diop. prob.* 38. *schol.* 4. *Wolfius* says, that in using this glass, which he left entirely open, without either tube or eye-glass, he saw very distinctly, with both eyes, some houses on the top of a hill, at the distance of two German (or about eight English) miles. He saw them erect, when he stood between the focus and the lens, and inverted when he stood beyond the focus. He observes, that his lens was by no means well polished*.

13. " Fa-

* I cannot but observe that particular attention, in my opinion, is due to this statement of *Wolfius*, whose candour and honesty appear to have been

13. "Father *Scheiner*, who, in his excellent work on the solars pots, entitled *Rosa Ursina*, describes very clearly many new dioptrical inventions, which others have since attempted to appropriate to themselves, was the first who observed that a single object-glass might produce the same effect as a telescope composed of several glasses. He made, in a *camera obscura*, experiments similar to those of *Wolfius* and *Tschirnhausen*, which I have just mentioned; and he made them public 70 years before M. *Tschirnhausen* published his. Here follow the very words in which he states the results of his experiments, lib. ii. cap. 6. at the end.

14. " *Quodsi quis intus positus*, &c. But if any one placed within (a *camera obscura*, or darkened chamber,) apply his eye between the paper and the lens, (that is, between the focus, or place of the image, and the lens,) he will see the external objects much larger, erect, and a good deal confused. If he apply his eye to the place of the image, or the paper, he will see a chaos; and if behind the place of the paper, or the picture, he will see every thing larger and more distinct, but in an inverted posture. Hence appears the vanity of the man's talk (I know not who he was) who applauded himself for the invention of the optical tube; since the same effect of augmenting visible things, may also be evidently obtained by one large convex lens, from a large sphere."

15. " This discovery of father *Scheiner* was not altogether unknown, or useless, during the interval between his time and that of *Tschirnhausen*: for I find, in the description of the cabinet of *Manfredi Septala*, written in Italian by *Scarabelli*, and printed at Tortona in 1656, that this learned canon of Milan, celebrated, among other things, for his famous mirror, which excited flame at the distance of 15 paces *, had also two lenses, one of which was a palm and a half in diameter, and its focal distance 7 brasses; and the

been equal to his ability, and who, at the place cited in the text, mentions a paper, which he published on the subject in the *Acta Eruditorum* for October 1710. He concludes the *Scholium* quoted above, with these words: " *Nec credo*, &c. Nor do I believe that this differs from the discovery of the illustrious *Tschirnhausen*, which, as concealed by him, is so highly applauded by the celebrated *Fontenelle*. (Hist. Royal Acad. of Sc. An. 1701, p. 165, Amst. edit.) For, through a glass not polished with sufficient exactness, I have observed the same things which *Tschirnhausen* did with his single lens, and which he described to the illustrious Acad. of Sciences; so that *Fontenelle* had no reason to suspect that there was any secret in the business."—*Translator*.

* A geometrical pace being 5 feet French, these 15 paces make nearly 80 English feet.

the other about a palm in diameter, and about 5 brasses in focal distance*. *Scarabelli* assures us, not only that both these lenses readily inflamed combustible bodies placed in their *foci,* but also that each of them could be used with good effect as a telescope, in the open country.

16. "Further; in searching for what old authors have written on the properties of convex lenses, I have found that *John Baptista Porta*, more than a century before father *Scheiner*, and even before the use of telescopes became common, knew that their end might be answered by a single lens; for in his *Magia Naturalis*, *lib.* 17. *cap.* 10, he propounds this problem: 'With a lens of glass, to see distant objects as if they were near.' Of this problem he adds an exact solution, although he gives neither the dimensions of the lens nor its focal distance; and does not enumerate the precautions which are necessary for success. His solution is this: '*Posito oculo*, &c. Having placed your eye in its centre, look at the remote object; for you will view distant things so near, that you will seem, as it were, to touch them with your hand, and to see the clothes, complexions, and countenances of men; so that you may distinguish your friends, though at a very great distance.' He knew the importance of this discovery; for in proposing it he observes, that it well deserves to be reflected on: *Quod sequitur*, says he, *longe præstantius vobis cogitandi principium affert.*

17. "*Porta* knew farther, that the same thing might be done with a concave mirror: for, in the 11th chapter of the same book, when speaking of the mirror of *Ptolemy* and its effects, he says, that he is wishful to show how it may be executed, so that we may know our friends at the distance of some thousands of paces (or some miles †), and read from afar very small characters. He assures us, moreover, that the thing is extremely easy. It is true that his explication of it is not intelligible; but it appears that he has done this on purpose, and with an intention, not to be understood; for he says it is a thing which ought not to come to the knowledge of the vulgar ‡. What he advances, therefore, being very true and very easy, as he assures us, and as we have already evinced, we cannot without injustice deny that he possessed this knowledge."

* An Italian palm is between 8 and 9 English inches, and a brasse, or brace, about 23 English inches. See Dr. Hutton's Dictionary, articles *Measure* and *Palm*.

† *Mille passuum* = *mille pas* = a mile = 1000 geometrical paces each 5 feet = about 5340 English feet.—*Translator.*

‡ See § 19. of my second letter.—*Translator.*

18. "Thus

18. "Thus the learned knew, before *M. Tschirnhausen* taught them, that, with a single object-glass, distant objects might be viewed, as with a telescope composed of several glasses. I believe, however, that *Tschirnhausen*, when he published the properties of his large object-glass, had no knowledge of what father *Scheiner* had written on the subject, or of what had been executed at Milan by *Septala*, who discovered the effect of his lenses, without having seen *Scheiner*. There may even be others who may have observed this property of large convex glasses, without having had any knowledge of what had been written or observed by the authors I have cited.

19. "I never could procure such large object-glasses as I wished, in order to repeat the experiments of these authors, and to make many more, which I have thought of. I have, however, made some experiments with the largest lenses, which I had it in my power to make or procure. I shall here give the results:

20. "(I.) With an object-glass, whose focal distance was about three feet, and diameter about six inches, by placing my eye farther from the glass than the focus, I saw distant objects clearly and distinctly, considerably enlarged and inverted. This glass was a double-convex.

21. "(II.) I observed the same thing, with still greater clearness and distinctness, with a plano-convex object-glass, a segment of a sphere about six feet in diameter, its own diameter being about seven inches.

22. "(III.) The clearness and distinctness, with which I saw the same distant objects, were much increased when I used a double-convex of about six inches and a half in breadth, and twenty-two feet focal distance. With this object-glass, I had a very accurate and distinct view of objects, which I could by no means have distinguished so well with a good telescope.

"*Remarks on the experiments which may be made with large object-glasses, and with others.*

23. "(I.) In all my experiments with these three glasses, I always saw the objects with the most clearness and distinctness when they were inverted, by placing the eye beyond the focus.

24. "(II.) The two first glasses did not produce a good effect, when, the eye being between the focus and the glass, the objects were seen erect; and the same is true of all other object-glasses of which the focal distance is not very considerable.

25. "(III.)

25. " (III.) In using the third object-glass, although I saw the objects clearly, by standing between the focus and the lens, it was not without some confusion. Yet persons whose eyes unite the rays from distant objects beyond the retina, by standing between the focus and the glass, will see objects erect with much clearness and distinctness; indeed as well as with the best telescope, and even better.

26. " (IV.) Objects seen through great lenses appear much more bright than they do to the naked eye, and as if they had a stronger light thrown on them. This effect is so sensible, that other objects seen with the naked eye, beside those looked at through these glasses, appear obscure, although equally illuminated. The direct contrary takes place, when objects are viewed through telescopes; for they always appear less illuminated than when seen by the naked eye. Hence it seems very probable, that these convex glasses and concave mirrors might be used with success, to view by night, objects which cannot be seen only because of the defect of light; for, happening in a very dark night to try the glass first mentioned, I saw distinctly objects which, without it, I could not see at all.

27. " (V.) Through a single great object-glass, several persons may view different objects at the same instant. I have frequently observed that, in order to distinct vision, it is not necessary that the eye be in the axis; for, though it be some degrees distant from the axis, the effect is not sensibly diminished.

28. " But, what is yet more extraordinary in these large object-glasses is, that two spectators, without disturbing each other, may, by means of the same single glass, view the same object at the same time. In order to this, one of the two spectators must be so placed that the lens may be between him and the object, his eye not being in the axis, but in a line which, passing through the point of concourse of the axes, and through the object, makes a small angle with the axis. Then, if a second spectator stand between the object-glass and the object, so that a line passing through his eye and the point of concourse of the axes may make with the axis an angle equal to that which a line passing through the eye of the first spectator and the same point of concourse, and both spectators be on the same side of the axis; I say then, that both of them will see the same object at the same time, the first by refraction, and the second by reflection.

29. " Let AB (fig. 4. Plate III.) be a large object-glass, of which FG is the axis, and C the point of concourse of

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the axes; I say that two spectators placed, the one in E and the other in I, so that the angles G C E and F C I may be equal, will see at the same time, the object placed at D; the first through the object-glass A B, and the other by reflection from the second surface A C B of the same glass.

30. "If the object-glass be very large, and its focal distance great, the two spectators may be placed in the axis, and they will both see the same object, though it be also situated in the axis, the one by refraction and the other by reflection; and this disposition of things will not in the least hinder the effect. This property of large object-glasses may be applied to useful purposes.

31. "*Fontenelle,* in the Hist. Acad. of Sc. for 1700, after describing the properties of the glass of *Tschirnhausen,* of which we have spoken, says, that, 'so many singularities in this lens of *Tschirnhausen* announce great and happy discoveries in dioptrics. Although this science is yet in its infancy, we shall be surprised at still making important discoveries in it, so much are we of this age accustomed to the rapid progress of the sciences.'

32. "More than sixty years have elapsed since M. *de Fontenelle* made this prediction; but I do not see that it is yet accomplished. But this does not prove that the prediction is not well founded; for it frequently happens that discoveries remain a long time unfruitful. For example, the discovery of the reflecting telescope is almost as old as that of the refracting one. This last was invented in 1609, and I find that the other began to be used as early as the year 1616; so that between the two discoveries there is only an interval of seven years. Father *Zucchi,* an Italian Jesuit, (in his *Optica Philosophia,* printed at Lyons in 1652, *par.* 1. *cap.* 14. § 5. *p.* 126.) says, that in 1616, reflecting on the theory of telescopes, then recently invented, it came into his head to employ concave metallic mirrors, instead of object lenses of glass, in order to produce by reflection the same effects which result from refraction. Having found, therefore, in a cabinet of curiosities a concave metallic mirror, exactly worked by an able artist, he applied to it a concave eye-glass, and with this telescope observed terrestrial and celestial objects, and experience confirmed what theory had taught him. I do not think that a more antient date of the reflecting telescope can be found.

33. "It appears, however, that this invention remained unknown, or neglected, till *Newton,* a long time after, in 1672, constructed in London a reflecting telescope, which presently became celebrated throughout Europe. For although,

though, after *Zucchi*, and before *Newton*, father *Mersenne* had proposed to *Descartes* the idea of using concave mirrors in making telescopes, and although *James Gregory* and *Cassegrain* had given descriptions of reflecting telescopes, I do not find any mention of such a telescope having been executed before that of *Newton**.

34. "Notwithstanding the happy success of the Newtonian telescope, and the great advantages expected from it, it was a long time neglected, and there appeared to be little earnestness to bring it into use. It was only some years ago that this instrument came into vogue, and was commonly used with effect†. And how many other fine discoveries

* "It must be acknowled that *Mr. James Gregory*, of Aberdeen, was the first inventor of a reflecting telescope. *Mr. Gregory* describes this telescope at the end of his *Optica Promota*. published in 1663; and was led to the invention of it, not by the consideration of the different refrangibility of rays, which was not then known, but by an inconvenience he foresaw would follow from an hyperbolic object-glass." Dr. S's Compl. Syst. of Optics, Rem. 135. "*Mons. Cassegrain's* is not pretended to have been contrived before the year 1672, and *Sir I. Newton's* was contrived in 1666, and executed in 1670, or at farthest finished in 1671. Besides, *M. Cassegrain's* differs in nothing from *Gregory's*, but that he would have the small metal to be convex, which *Gregory* makes concave, and therefore his instrument seems only to be *Gregory's* disguised." *Desaguliers's* Append. to the 2d ed. of *Dr. Browne's* Translation of *Dr. David Gregory's* (the nephew of *James*) *Elem. Catopt.* et *Diopt.* p. 234. There is no reason to suppose that *J. Gregory* knew any thing of the discovery of *Zucchi*; for, in the Pref. to his *Opt. Prom.* he complains that he was not timely apprised of those of *Descartes*, on account of the bad supply of new mathematical books, in the otherwise well-furnished public library at Aberdeen. Nay, *Descartes* himself did not (not to say *could not*, though *Mersenne* did) know of the discovery of *Zucchi*, who, as appears above, did not publish it till 1652; whereas *Descartes's* correspondence with *Mersenne* took place in 1639, though it was not printed till 1666, three years after *J. Gregory* published his *Opt. Prom.* (See *Descartes's* letters, vol. ii.) Add to this, that *Mersenne* proposed to *Descartes* his idea of a reflecting telescope in a way so very unsatisfactory, as to induce the latter to endeavour to convince him of its fallacy. If it should be said that *J. Gregory* might have got the hint from *Zucchi* in Italy, the answer would be easy: he published his *Optica Promota* in London in 1663, the 24th year of his age; but did not go abroad till 1665. In 1667 he published, at Padua, his *Vera Circuli et Hyperbolæ Quadratura*; and in 1668, at Venice, his *Geometriæ Pars Universalis*.—See Dr. Hutton's Dictionary, articles *Gregory* and *Telescope*.—*Translator*.

† From our author's manner of expressing himself here, it would seem that reflecting telescopes did not come into use in France nearly so soon as in this country. For Dr. S, in his Compl. Syst. of Opt. Rem. 136, says, "These telescopes were first brought to perfection in practice about the year 1719 by the great ingenuity and industry of *Mr. John Hadley*; *Sir Isaac Newton's* first, and *Mr. Gregory's* soon after." My original, as already observed, was printed in 1763.—*Translator*.

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are there, the utility of which negligence alone prevents us from seeing?

35. "I therefore join *M. de Fontenelle* in thinking, that great advantages might be derived from large convex glasses and concave mirrors; if they, who are blessed with a fertile genius and sufficient property, would particularly apply themselves to construct, in several ways, concave mirrors and convex lenses of a very large size, making at the same time, all the researches and experiments of which such men are capable.

36. "COROLLARY. *It is then very evident, from what we have said, that the mirror, which historians relate to have been placed on the Pharos of Alexandria, was possible.*

[The Second Part of this Memoir of *Abat* will be given in our next Number.]

XXXII. *A Report of the State of His Majesty's Flock of fine-woolled Spanish Sheep, for the Year ending Michaelmas* 1803. *By Sir* JOSEPH BANKS, *P. R. S.*

THE wether lambs of the last year having been sold in their wool, and the rams' wool retained, in order that two years' growth might be prepared for sale together, his majesty's Spanish flock consisted, when shorn in June 1802, of ninety-six ewes only; the fleeces of these, after having been washed on the sheep's backs as usual, weighed as follows:

In wool, as shorn from the sheep -	352 lbs
Loss in scowering - - - - -	96
Amount of scowered wool - - -	256

This wool, when sorted, produced as follows:

Prime wool, or R. -	221 lbs. at 5s. 9d.	£63	10	9
Choice locks, or F. -	32 —— 3 6 -	5	12	0
Fribs, or T. - . -	3 —— 1 9 -	0	5	3
		£69	8	0

After deducting the expense of sorting and scowering, at the high rate which an individual who is not a manufacturer must pay for these processes, this wool is worth about 5l. a tod, or 43l. 5s. a pack, as clipped from the sheep's back.

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The prime wool was purchased by John Maitland, esq. member of parliament for Chippenham, whose mercantile house, established for more than a century, has always dealt largely in the importation of Spanish wool, and who, from the first introduction of Merino sheep into this country by the king in the year 1787, has uniformly given the most liberal and zealous aid to the promotion of his majesty's patriotic views, though doubtful in the beginning of the ultimate success of the project.

It was made into cloth by Mr. Edridge, a manufacturer of Chippenham, whose skill and respectability in his line are exceeded by no man. He inspected its quality with the most minute exactness, and with an eye more inclined to expect symptoms of degeneration than of improvement, during the whole of the numerous processes to which wool is subjected in the making of broad-cloth, and he found that in every one of them it answered to his complete satisfaction.

The cloth made from this wool proved so excellent in its kind, that the king was graciously pleased, at the desire of Mr. Maitland and Mr. Edridge, to permit these gentlemen to explain, in his majesty's presence, its qualities and peculiarities.

Samples of this cloth may now be seen in Mr. Maitland's warehouse in Basinghall-street; and it will be found, in conversing with Mr. Maitland and his partners, that in their opinion the R's of his majesty's wool, considered as a pile, are inferior to but few of the best of those imported from Spain, though it is probable that no pile in Spain throws out so small a proportion of F's and T's. From this opinion it may fairly be deduced, that his majesty's wool has improved since the sheep were imported from Spain; indeed there is every reason to believe that it is still improving, and will in a very few years equal, if not excel, the very best piles that have hitherto been imported into this kingdom.

Mr. Tollet, a gentleman of Gloucestershire, who has purchased Merino sheep both from the king and from lord Somerville, has been very successful in improving the carcase without damaging the wool; he possesses a ram, bred from a ram and an ewe both purchased from the royal flock in 1801, which, when clipped in June last, yielded 11 lbs. 12 oz. of unwashed wool. The carcase of this sheep was then estimated by good judges at 16 lbs. a quarter, and it was admitted to be a handsome sheep.

For this animal Mr. Tollet has refused an offer of 200 guineas, or of 100 for the next season's use of him; he also refused 30 guineas each for the sire and the dam, though old

old and infirm, being unwilling to part with animals which had belonged to the royal flock; he however sold their ram lamb of the last year for 30 guineas, and thus made some progress in ascertaining the value of this important breed.

These facts, which prove an amelioration in the king's Merino sheep, are fully confirmed by the improved shape and weight of his majesty's sheerling rams of the present year, and give a justifiable hope, that by a due selection of rams and ewes, and a correct judgment in matching them, Merino sheep will in time be produced, with carcases perfectly fashionable, and wool as perfectly fine.

No purchaser having been last year found for the lambs' wool at a price adequate to its value, it was made into light ladies-cloth, which proves excellent, and promises to be a valuable article. A speculation, however, has offered for manufacturing the lambs' wool into superfine woollen hose, which seems likely to yield a still better price for the raw article than the cloth.

The demand for his majesty's Merino sheep increases at present beyond all calculation. The best-informed clothiers in Gloucestershire, enlightened no doubt by the useful labours of the Bath Society, and the valuable experiment of Dr. Parry, as well as by the doctor's, and by lord Somerville's publications, are among the most anxious applicants to purchase. The Bath Agricultural Society, whose attention has been most particularly directed to the improvement of English wool, humbly requested the king to give them a Spanish ram; which request his majesty most graciously complied with last autumn, and they returned thanks in the warmest terms of respectful gratitude and satisfaction.

As speculation on the value of Spanish sheep is evidently on the increase, and a reasonable probability now appears that his majesty's patriotic exertions, in introducing the breed, will at last be duly appreciated and properly understood, it would be palpably unjust should the views of those who wish to derive a fair advantage from the sale of the progeny of Spanish sheep purchased by them from the royal flock, be in future impeded by a continuation of the sale of the king's sheep at prices below their real value.

This circumstance having been stated to the king, his majesty was graciously pleased to permit the rams and ewes that are to be parted with from the royal Merino flock this year to be sold by auction, in the same manner as is done at Woburn by his grace the Duke of Bedford, and at Holkham by Mr. Coke, on the presumption of this being the most likely manner of placing the best individuals of their

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improved breeeds in the hands of persons most likely to preserve, and further to improve them.

August 17, 1803. JOSEPH BANKS.

POSTSCRIPT.

As the publication of this report has been delayed by unavoidable circumstances to so late a period, it is proper to add, that the wools of 1803 have yielded, both raw and scowered, much as usual. The prime, or R., of the ewe flock were sold for 6s. 9d. a pound, and that of the rams for 6s. 6d. These enormous prices, however, depended on a scarcity of imported Spanish wool, and are highly distressing to the manufacturer: they ought not, therefore, to be allowed to enter into the speculation of the grower.

The sheep that can be spared from the royal flock will be sold by auction this year at a barn opposite the Pagoda in Kew-lane, on the 15th of August next. Notice of the particulars will be given as soon as possible.

July 10, 1804.

XXXIII. *Illustration of Mr.* DALTON'S *Theory of the Constitution of mixed Gases. By Mr.* WILLIAM HENRY *of Manchester**.

To Mr. Dalton.

DEAR SIR,

IN the first enunciation of a new theory, it is not unusual that some links are omitted in the chain of reasoning which led to its formation; and thus the doctrine fails of that ready and general acceptance which immediately follows its more distinct developement. Such an omission appears to me to have taken place in your theory of the constitution of mixed gases; for, according to your own candid confession, several persons, versed both in chemical and mechanical science, have declared their inability fully to understand the scope of the hypothesis, and consequently to judge of its merits or defects. In the discussions, also, which took place in this society, on your several papers, the

* "The editor has been furnished with a copy of this letter (which was read before the Manchester Society) as a sequel to the various interesting communications from Mr. Dalton on the same subject which have appeared in the Philosophical Magazine. It may be proper to state, in apology for the repetition of a few circumstances already advanced in Mr. Dalton's letter, published in our last number, that the author had not seen the letter alluded to at the time when these illustrations were written."

the doctrine was opposed by almost every member interested in such subjects, and by no one more strenuously than myself. Subsequent attention, however, to the evidences of the theory, and, still more, the results of experiments, which were made under impressions very unfavourable to the hypothesis, have satisfied me that the opposition to it arose chiefly from an imperfect comprehension of the argument; and that your theory is far better adapted than any former one for explaining the relation of mixed gases to each other, and especially the connection between gases and water.

The distinguishing principle of your doctrine, I apprehend to be, *that mixed gases neither attract nor repel each other, and that every gas is as a vacuum to every other gas.* It is not my intention to recapitulate your proofs of this position, but merely to add to them the evidence of a few facts which have occurred to me, and which strongly tend to establish the same conclusion.

From a series of experiments, which I communicated to the Royal Society, and which appeared in their Transactions for 1803, it may, I think, be safely inferred, that the relation of gases to water is altogether a mechanical one; for the quantity absorbed follows exactly the ratio of the pressure. If then it can be shown that a gas, absorbed by water, is not retained in its place by an atmosphere of any other gas, we shall be furnished with a strong presumption, that different gases do not gravitate on each other.

It is well known that water may be charged with its own bulk, or rather more, of carbonic acid gas under a pressure of 30 inches of mercury. The gas, thus absorbed, is retained so long as the water is preserved from contact with any other gas; but, when exposed to the atmosphere, the carbonic acid gas rapidly escapes. Now this effect can be only ascribed to one of two causes: 1st, The affinity of carbonic acid for atmospheric air may surpass that of its affinity for water; or, 2dly, The air of the atmosphere does not press on the gas in the water, which is therefore placed under similar circumstances, as if exposed under the exhausted receiver of an air pump.

Were the first explanation the true one, it might be expected, that equal quantities of various gases would detach different quantities of carbonic acid from like volumes of impregnated water; because the affinities of these gases, as in all other cases of chemical affinity, differing in force, would occasion their combining with different quantities of carbonic acid, and in a certain order. But in making the experiment,

experiment, with all the attention I could bestow, this did not prove to be the fact: for similar measures of impregnated water gave up equal bulks of carbonic acid to like quantities of all the different gases.

The converse of this fact also occurred to me in the course of a series of experiments, to which I have already referred; viz. that the admixture of common air with carbonic acid gas diminishes considerably the proportion of the latter gas taken up by water. Thus, when 20 measures of pure carbonic acid gas are agitated with 10 of water, at least 10 measures of gas are absorbed. But from a mixture of 20 measures of carbonic acid with 10 of common air, 10 parts of water take only six of carbonic acid. That chemical affinity between the mixed gases is not the cause of the diminished amount of absorption, is perfectly clear; since it is indifferent, as to the effect, what gas is added, and the proportion alone influences the result. The effect is therefore to be ascribed to the diminished density of the superincumbent carbonic acid by mixture with another gas; and the pressure of gases being directly as their density, and the quantity absorbed by water being as the pressure, the absorbed carbonic acid must necessarily quit the water. This escape continues till the carbonic acid *above* the water has a density equal to that *in* the water, and no longer.

Previously to my acquiescence in your theory of mixed gases, I undertook an extensive series of experiments, with a view to ascertain the order of affinities of gases for water. But, after a great variety of trials, made with all the accuracy in my power, I could discover nothing like a series of elective attractions. Each gas, it was found, displaced every other, and, reciprocally, was dislodged by them.

It may be urged against the doctrine of the non-gravitation of gases on each other, that from water, impregnated with carbonic acid gas, and exposed to the atmosphere, the gas ought, on this principle, to escape as rapidly as under an exhausted receiver. It must be remembered, however, that the escaping gas constitutes, by admixture with the air of the atmosphere, a gas of diminished density, but still of such density as to retard the escape of further portions. All that the air-pump effects is to remove these as fast as they are liberated.

There are various facts satisfactorily explained on this doctrine which are irreconcileable to any former hypothesis. Of these I shall mention only a few; since the theory will receive from yourself all the elucidation that its establishment can require.

1st, If each gas be a vacuum to every other, a heavier gas should ascend into a lighter one without the aid of agitation; and, on the contrary, a lighter one should descend into a heavier one. That this is actually the fact, and under circumstances very unfavourable to their mixture, your own experiments have fully proved.

2dly, The hypothesis explains why sulphuret of potash withdraws oxygen from the air without agitation, and whether placed at the top or at the bottom of a jar; for it acts as if the absorbed gas were the only one present in the vessel.

3dly, It explains why the last portions of common air are expelled from water by carbonic acid and other absorbable gases. For these gases act as a vacuum to the air contained in the water, which must, therefore, necessarily quit its place. It solves also the problem how to expel, completely, any gas from water; for, to effect this, the water must successively be agitated with portions of some other gas of the greatest attainable purity. Thus, to expel atmospherical air entirely from water, it may be agitated with pure carbonic acid gas; but as the liberated common air presses on that remaining in the water, according to the proportion it bears to the superincumbent carbonic acid, the gas thus employed must be removed, and fresh and pure portions used in succession.

4thly, By applying the same general law, we are taught how to effect the highest attainable impregnation of water with any gas. There could be no difficulty in accomplishing this object if the gas and water were both absolutely uncontaminated by admixture with other gases. But when pure carbonic acid is agitated with water, atmospherical air is extricated; which, mingling with the carbonic acid, lessens its density. To obviate this difficulty as much as possible, a quantity of water, to be impregnated fully with carbonic acid, should be agitated with several successive portions of the purest possible gas. The unabsorbed residuum should also be very large, in order that the carbonic acid may bear a large proportion to other aëriform substances accidentally mixed with it.

These are, doubtless, only a few of the phænomena, to the explanation of which your theory may be successfully applied; and I confidently expect that many facts hitherto referred to chemical principles will be brought, in consequence of your discoveries, within the department of mechanical philosophy. I am, dear sir, yours very truly,

Manchester, June 20, 1804. WILLIAM HENRY.

XXXIV. *Area*

XXXIV. *Area of the several Counties of England and Wales, in square Statute Miles and Acres, as measured on the Maps in* C. Smith's *"New English Atlas,* 1804;" *the Scale given on each Map having been examined, and Correction applied to such of the Scales aswere found to be erroneous. The Population of each County is annexed, and the Number of Persons to each square Mile.*

COUNTIES IN ALPHABETICAL ORDER.

COUNTIES.	Sq. Stat. Miles.	Acres.	Population, 1801.	No. of Persons in a Sq. Mile.
Bedford - - -	430	275,200	63,393	147
Berks - -	744	476,160	109,215	147
Bucks - -	748	478,720	107,444	144
Cambridge - -	686	439,040	89,346	130
Chester - -	1017	650,880	191,751	189
Cornwall - -	1407	900,480	188,269	134
Cumberland -	1497	958,080	117,230	78
Derby - -	1077	689,280	161,142	149
Devon - -	2488	1,592,320	343,001	138
Dorset - -	1129	722,560	115,319	102
Durham - -	1040	665,600	160,361	154
Essex - -	1525	976000	226,437	148
Gloucester - -	1122	718,080	250,809	224
Hereford - -	971	621,440	89,191	92
Hertford - -	602	385,280	97,577	162
Huntingdon -	345	220,800	37,568	110
Kent - -	1462	935,680	307,624	210
Lancashire - -	1806	1,155,840	672,731	372
Leicester - -	816	522,240	130,081	159
Lincoln - -	2787	1,783,680	208,557	75
Middlesex - -	297	190,080	818,129	2754
Monmouth - -	516	330,240	45,582	88
Norfolk - -	2013	1,288,320	273,371	136
Northampton -	965	617,600	131,757	137
Nothumberland -	1809	1,157,760	157,101	87
Nottingham -	774	495,360	140,350	181
Oxford - -	742	474,880	109,620	148
Rutland - -	200	128,000	16,356	82
Salop - -	1403	897,920	167,639	119
Somerset - -	1549	991,360	273,750	177
Southampton -	1533	981,120	219,656	143

Stafford

COUNTIES.	Sq. Stat. Miles.	Acres.	Population, 1801.	No. of Persons in a Sq. Mile.
Stafford - -	1196	765,440	239,153	199
Suffolk - -	1566	1,002,240	210,431	134
Surry - -	811	519,040	269,043	332
Sussex - -	1461	935,040	159,311	109
Warwick - -	984	629,760	208,190	212
Westmorland -	722	462,080	41,617	57
Wilts - -	1283	821,120	185,107	144
Worcester - -	674	431,360	139,333	207
York, East Riding	1268	811,520	139,433	
—— North Riding	2112	1,351,680	155,506	143
—— West Riding	2633	1,685,120	563,953	
ENGLAND	50,210	32,134,400	8,331,434	166
Anglesey - -	402	257,280	33,806	84
Brecon - -	731	467,840	31,633	43
Cardigan - -	726	464,640	42,956	59
Carmarthen - -	926	592,640	67,317	73
Carnarvon - -	775	496,000	41,521	54
Denbigh - -	731	467,840	60,352	83
Flint - -	309	197,760	39,622	128
Glamorgan - -	822	526,080	71,525	87
Merioneth - -	691	442,240	29,506	43
Montgomery -	982	628,480	47,978	49
Pembroke - -	575	368,000	56,280	98
Radnor - -	455	291,200	19,050	42
WALES	8,125	5,200,000	541,546	67
England and Wales	58,335	37,334,400	8,872,980	152

COUNTIES ACCORDING TO THEIR EXTENT.

York, West Riding	2633	1,685,120	563,953	
—— North Riding	2112	1,351,680	155,506	
—— East Riding -	1268	811,520	139,433	
1. York - -	6013	3,848,320	858,892	143
2. Lincoln - -	2787	1,783,680	208,557	75
3. Devon - -	2488	1,592,320	343,001	138
4. Norfolk -	2013	1,288,320	273,371	136
5. Northumber. -	1809	1,157,760	157,101	87

6. Lancashire

COUNTIES.	Sq. Stat. Miles.	Acres.	Population, 1801.	No. of Persons in a Sq. Mile.
6. Lancashire -	1806	1,155,840	672,731	372
7. Suffolk - -	1566	1,002,240	210,431	134
8. Somerset -	1549	991,360	273,750	177
9. Southampton -	1533	981,120	219,656	143
10. Essex - -	1525	976,000	226,437	148
11. Cumberland -	1497	958,080	117,230	78
12. Kent - -	1462	935,680	307,624	210
13. Sussex - -	1461	935,040	159,311	109
14. Cornwall -	1407	900,480	188,269	134
15. Salop - -	1403	897,920	167,639	119
16. Wilts - -	1283	821,120	185,107	144
17. Stafford - -	1196	765,440	239,153	199
18. Dorset - -	1129	722,560	115,319	102
19. Gloucester -	1122	718,080	250,809	224
20. Derby - -	1077	689,280	161,142	149
21. Durham -	1040	665,600	160,361	154
22. Chester - -	1017	650,880	191,751	189
23. Warwick -	984	629,760	208,190	212
24. Hereford -	971	621,440	89,191	92
25. Northampton -	965	617,600	131,757	137
26. Leicester -	816	522,240	130,081	159
27. Surry - -	811	519,040	269,043	332
28. Nottingham -	774	495,360	140,350	181
29. Bucks - -	748	478,720	107,444	144
30. Berks - -	744	476,160	109,215	147
31. Oxford - -	742	474,880	109,620	148
32. Westmorland -	722	462,080	41,617	57
33. Cambridge -	686	439,040	89,346	130
34. Worcester -	674	431,360	139,333	207
35. Hertford -	602	385,280	97,577	162
36. Monmouth -	516	330,240	45,582	88
37. Bedford - -	430	275,200	63,393	147
38. Huntingdon -	345	220,800	37,568	110
39. Middlesex -	297	190,080	818,129	2754
40. Rutland - -	200	128,000	16,356	82
ENGLAND	50,210	32,134,400	8,331,434	166
1. Montgomery -	982	628,480	47,978	49
2. Carmarthen -	926	592,640	67,317	73
3. Glamorgan -	822	526,080	71,525	87
4. Carnarvon -	775	496,000	41,521	54

COUNTIES.	Sq. Stat. Miles.	Acres.	Population, 1801.	No. of Persons in a Sq. Mile.
5. Brecon - -	731	467,840	31,633	43
6. Denbigh -	731	467,840	60,352	83
7. Cardigan -	726	464,640	42,956	59
8. Merioneth -	691	442,240	29,506	43
9. Pembroke -	575	368,000	56,280	98
10. Radnor - -	455	291,200	19,050	42
11. Anglesey -	402	257,280	33,806	84
12. Flint - -	309	197,760	39,622	128
WALES	8,125	5,200,000	541,546	67
England and Wales	58,335	37,334,400	8,872,980	152

Scotland and Ireland are nearly equal to each other in area, and together are equal to England and Wales: wherefore the population of Scotland being 1,600,000, averages at 55 to a square mile; and the population of Ireland being about 4,250,000, averages at 146 to a square British mile. The United Kingdom averages at 130 to a square mile, including about 470,000 soldiers and sailors.

N. B. The area of a square statute mile is to the area of a square geographical mile as three to four.

XXXV. *Notice respecting New Books.*

The Philosophical Transactions for 1804. Part I, 208 Pages, with Five Plates.

The contents are: 1. The Bakerian Lecture, Experiments and Calculations relative to Physical Optics; by Thomas Young, M.D. F.R.S.—2. Continuation of an Account of a peculiar Arrangement in the Arteries distributed on the Muscles of slow moving Animals, &c.; in a Letter from Mr. Anthony Carlisle to John Symmons, Esq. F.R.S.—3. An Account of a curious Phenomenon observed on the Glaciers of Chamouny; together with some occasional Observations concerning the Propagation of Heat in Fluids; by Benjamin Count Rumford, V.P.R.S. Foreign Associate of the National Institute of France, &c.&c.—4. Description of a triple Sulphuret of Lead, Antimony, and Copper, from Cornwall; with some Observations upon the various Modes of Attraction which influence the Formation of Mineral Substances, and upon the different Kinds of Sulphuret of of Copper; by the Count de Bournon, F.R.S. and L.S. 5. Analysis of a triple Sulphuret of Lead, Antimony, and Copper from Cornwall, by Charles Hatchett, Esq. F.R.S. —6. Observations on the Orifices found in certain poisonous Snakes, situated between the Nostril and the Eye; by Patrick Russell, M.D. F.R.S.: with some Remarks on the Structure of those Orifices, and the Description of a Bag connected with the Eye met with in the same Snakes; by Everard Home, Esq. F.R.S.—7. An Inquiry concerning the Nature of Heat, and the Mode of its Communication; by Benjamin Count Rumford, V.P.F.R.S. Foreign Associate of the National Institute of France, &c.—8. Experiments and Observations on the Motion of the Sap in Trees; in a Letter from Thomas Andrew Knight, Esq. to the Right Hon. Sir Joseph Banks, Bart. K.B. P.R.S. Appendix, Meteological Journal kept at the Apartments of the Royal Society, by Order of the President and Council.

Analytical Essays towards promoting the Chemical Knowledge of Mineral Substances. By Martin Henry Klaproth, *Professor of Chemistry, &c. &c.* Vol. II. 8vo. translated from the German.

This valuable volume is translated by the same learned chemist who favoured us with a translation of the first. Its contents are: 73. Examination of the Auriferous Ores from Transylvania.—74. Analysis of the sulphated Oxide of Manganese from Transylvania.—75. Examination of Tungstate of Lime (Scheelium).—76. Gadolinite.—77. Examination of the Egyptian Natrum (Soda).—78. Striated Soda.—79. Analysis of the native Muriate of Ammoniac.—80. Examination of Saffolin.—81. Examination of the Plumose Alum from Freyenwalde.—82. Capillary Salt (Halotrichium) from Idria.—83. Elastic Bitumen from Derbyshire.—84. Examination of Mellilito.—85. Umbra (Umber).—86. Examination of the muriated Lead Ore.—87. Phosphated Lead Ores.—88. Sulphated Lead Ores.—89. Tabular, White Lead Ore, from Leadhills.—90. Examination of the native Reguline Antimony, from Andreasberg.—91. Antimoniated Silver, from Andreasberg.—92. Fibrous *red* Antimonial Ore.—93. *White* Ore of Antimony.—94. *Arseniated* Olive Copper Ore.—95. *Muriated* Copper Ore.—96. *Phosphated* Copper Ore.—97. *Kryolite.*—98. Beryl.—99. Emerald.—100. Examination of Klingstone (Echodolite).—101. Basalt (Figurate Trapp).—102. Pitch Stone.—103. Addition to the Analysis of Pumice Stone (Essay 33).—104. Examination of the Jargon (Zircon) from Norway,

Norway.—105. Examination of Madreporite.—106. Pharmacolite.—107. Scorza.—108. Examination of the Fibrous Sulphate of Barytes.—109. Tabular Spar (Safel-spath).—110. Examination of Miemite.—111. Examination of the *prismatic Magnesian Spar*, from the Territory of *Gotha*.—112. Examination of the striated gray Ore of Manganese.—113. Earthy, black Oxide of Manganese.—114. Examination of the Asphaltum from Albania.—115. Earthy brown Coal.—116. The Hungarian Pearl Stone.

XXXVI. *Proceedings of Learned Societies.*

ROYAL SOCIETY OF LONDON.

Mr. Smithson Tennant has discovered two new metals in the black powder which remains after dissolving platina, of which he has given an account in a paper communicated to the society. Mr. Tennant's first experiments were made last summer, when they were communicated to the learned president, after which an account of one of these metals appeared in France by M. Descotil and M. Vauquelin, who ascribe to it the following properties:—1. That it reddens the precipitates of platina made by sal-ammoniac: 2. That it dissolves in marine acid: 3. That it is precipitated by galls and prussiate of potash. The properties mentioned by Mr. Tennant are, that it dissolves in all the acids, but least in marine acid, with which it forms octaedral crystals. The solution with much oxygen is deep red, with a smaller proportion green or deep blue. It is partially precipitated by the three alkalies when pure. All the metals, excepting gold and platina, precipitate it. Galls and precipitate of potash take away the colour of this solution, but without any precipitate, and afford an easy test of its presence. The oxide therefore loses its oxygen by water alone. When combined with gold or silver, it cannot be separated by the usual process of refining these metals. As the French chemists have not given a name to the metal, Mr. Tennant inclines to call it *iridium*, from the various colours of it in solution.

The second new metal is obtained by heating the black powder with pure alkali in a silver crucible. The oxide of this metal unites with the alkali, and may be expelled by an acid and obtained by distillation, being very volatile. The oxide has a very strong smell, from which Mr. Tennant has called it *osmium*. It does not redden vegetable

blues,

blues, but stains the skin of a deep red or black. The oxide in solution with water has no colour, but by combining with alkali or lime becomes yellow. With galls it gives a very vivid blue colour. All the metals, excepting gold and platina, precipitate this metal. If mercury is agitated with the aqueous solution of the oxide, an amalgam is formed, which, by heat, loses the mercury, and leaves the osmium pure as a black powder.

THE BOARD OF AGRICULTURE*
Has offered the following premiums:

Culture of Plants.—To the persons who shall make the most satisfactory experiments, tending to the improvement of the culture of each of the following plants respectively, viz. wheat, rye, barley, oats, pease, beans, tares, buckwheat, turnips, cabbages, rutabaga, potatoes, carrots, parsnips, clover, lucern, sainfoin, chicory, hemp, flax, hops,—*the silver medal.*

Accounts, verified by certificates, to be produced on or before the second Tuesday in May 1805.

The same premium for 1806.

The same premium for 1807.

Soiling Cattle.—To the person who shall, through the entire summer of 1805, keep the greatest number of cattle in stalls, houses, or confined yards, and fed entirely in the soiling method, with green food,—*the gold medal.*

Certificates of the number of cattle, and acres of food, and sorts eaten, the quantity of dung made, with other circumstances of the experiment, to be produced on or before the first Tuesday in December 1805.

The same premium for 1806.

The same premium for 1807.

Comparison of Food to different Animals.—To the person who shall, by experiments, ascertain in the most satisfactory manner, and report to the board, the comparative effect of certain articles of food when given to various kinds of live stock,—*the gold medal.*

Grasses, natural and artificial, mown and weighed; hay, cut chaff, corn or pulse, oil-cake, turnips, cabbages, carrots, parsnips, potatoes, &c. compared, in the production of mutton, beef, butter, and cheese; artificial grasses, cabbages, roots, and corn or pulse, in the production of mutton, beef, pork, or the flesh of poultry. It is required that the food be weighed and registered, and the animals also, with the increased weight noted from every sort of food.

* See our 17th volume, p. 285 and 273.

Accounts to be produced on or before the first Tuesday in March 1806.

Waste Land.—To the person who shall improve, and bring to the annual value of not less than 10s. an acre, the greatest number of acres heretofore waste, not less than fifty,—*the gold medal.*

Accounts of the improvement, verified by certificates, including the state of the land before the experiment, and of the cultivation, expenses, and produce, to be laid before the board on or before the first Tuesday in March 1805.

Notice of the intended improvement to be sent to the board, and therefore secrecy cannot be required.

The same premium for 1806.

The same premium for 1807.

Waste Land.—To the person who shall describe to the board, in the most satisfactory manner, from actual experiment on not less than one acre, the most profitable mode, without the use of lime, of bringing heath land (the spontaneous growth of which is long or short ling, or heath) into cultivation, and a state of improvement,—*twenty guineas.*

Accounts of the soil previous to the improvement, and the means of effecting it, verified by certificates, to be produced on or before the first Tuesday in March 1806.

SOCIETY OF ATHENIAN TRAVELLERS.

A new literary society has lately been established, which promises to be of great service to science: it is denominated "The Society of Athenian Travellers." The following is a correct list of the original members. Future ones, who have visited Athens, are to be admitted by ballot, according to the rules of the society.

Earl of Aberdeen.	Mr. Morritt.
Lord Brooke.	Mr. Randal Wilbraham.
Mr. Drummond.	Mr. Neave.
Mr. Hawkins.	Mr. Hamilton.
Mr. Thos. Hope.	Mr. Leake.
Mr. Henry Phil. Hope.	Mr. Squire.
Dr. Clarke.	Mr. Aug. Foster.
Mr. Cripps.	Mr. J. L. Foster.
Mr. Gell.	Mr. Wilkins.

FRENCH NATIONAL INSTITUTE.

The following prize questions were proposed by the Class of the Mathematical and Physical Sciences in the public sitting of June 25th.

5 *Mathematics.*

Mathematics.

"To give a theory of the perturbations of the planet Pallas, discovered by Dr. Olbers."

Geometricians have given, with sufficient exactness and extent, the theory of the perturbations of all the old planets, and of those which may be still discovered if confined within the same zodiac, and if they have only a very small eccentricity. Mercury till the present time was considered as the most eccentric of all the planets, and at the same time that which had the greatest inclination; but the smallness of its mass, and its position at one of the limits of the planetary system, render it very little calculated to produce very sensible alterations in the motion of the other planets. Uranus, discovered twenty years ago by Dr. Herschel, is placed at the other limit of the system, with a small mass and little eccentricity: it has also the smallest of all the inclinations known; so that the formulæ employed for Jupiter and Saturn have been more than sufficient for that new planet. Ceres, discovered a few years ago by M. Piazzi, having a considerable eccentricity and an inclination of 10° 38′, must be subject to strong and numerous inequalities. It, however, appears that all the astronomers who have endeavoured to determine them have been contented with known formulæ, the development of which does not exceed the products of the three dimensions of the inclinations and eccentricities. Those of five dimensions have been employed in the *Mécanique Céleste* for a particular case, according to a formula of M. Burckhardt. The same astronomer has since presented to the National Institute the general and complete development of the third, fourth, and fifth orders; but this degree of precision would certainly not be sufficient for the planet Pallas, whose eccentricity is even greater than that of Mercury, and inclination 34° 37′; that is to say, five times greater than that of any other known planet. It is even difficult to conjecture what will be the powers and the dimensions of the products which it may be allowable to neglect; and the calculations may be of such length, and the formulæ so complex, that they might frighten astronomers the best qualified to execute them. This consideration has induced the Class of the Mathematical and Philosophical Sciences to propose this subject as the question for which it will adjudge a prize on the first Monday of Messidor, year 14. It therefore requests geometricians and astronomers to discuss completely all the inequalities of this theory,

theory, and to omit none of them which may be found entirely negligible; and as these inequalities might vary very sensibly if the elliptic elements were not exactly known, it is indispensably necessary that the competitors should not confine themselves to giving the numerical co-efficients of the equations: they must also give the analytical co-efficients, in order that one may be able to affix to them the most exact values of the mean distance of the aphelion and inclination, when these elements shall be better known. Another advantage will result from these analytical co-efficients:—As there is so little difference between the distances of the planets Ceres and Pallas from the sun, that it is even very difficult at present to say which of the two is the nearest to that body, the formula given for Pallas may, without much change, serve also for Ceres, as well as for any other planet which may be discovered hereafter, and of which, by these means, a more certain and complete theory will be obtained. The class hopes that the question will appear interesting enough to astronomers to induce them to bestow upon it a care equal to the difficulty of the subject.

The answers must be written in French or in Latin, and will not be received after the 1st of Germinal, year 14.

Natural Philosophy.

The class had proposed as the subject of a prize the following question:—"To determine, by experiment, the different sources of the carbon of vegetables."

It continues the competition till the 1st of Germinal, year 13.

The class continues also till the 1st of Germinal, year 13, the competition on the following question:—"To determine, by anatomical and chemical observations and experiments, what are the phænomena of the torpidity which certain animals, such as the marmot, dormouse, &c., experience during winter in regard to the circulation of the blood, respiration, and irritability: to inquire what are the causes of sleep, and why it is peculiar to animals."

The value of the two prizes is doubled: it consists in two kilogrammes of gold, about 6800 francs each.

The class had proposed for the second time, on the 15th of Germinal, year 10, as the subject of a prize, to be adjudged in the public sitting of Messidor, year 12, the following question:—"What are the characters which distinguish in animal and vegetable matters, those which serve as ferment from those which they cause to undergo fermentation?"

As

As the answers sent in did not fulfil the required conditions, and the class considering that this question has been proposed during four years, it decrees that the subject shall be withdrawn.

Astronomy.

The decree of government, dated Floreal 13th, year 10, which authorizes the National Institute to accept the gift of a capital of 10,000 francs offered by C. Lalande, states, " that, agreeably to the intentions of the donor, the annual product of the capital shall be employed by the Institute to give each year a gold medal, of the weight which the amount of the revenue will permit, or the value of that medal, to the person who in France or elsewhere, the members of the National Institute excepted, shall have made the observation most interesting, or published the memoir most useful, to the progress of astronomy."

On a report by the commissioners named for that purpose, the Class of the Mathematical and Physical Sciences of the National Institute decreed the prize to M. Joseph Piazzi, professor royal of astronomy and director of the observatory at Palermo, for a work he has published under the title of *Præcipuarum Stellarum inerrantium Positiones mediæ ineunte Sæculo XIX. ex Observationibus habitis in Specula Panormitana.* Panormi 1803, one vol. fol.

This work, which contains the positions of about six thousand stars, determined with the greatest care and the best instruments, is the fruit of ten years assiduous observations and calculations, which must ensure to the author the esteem and gratitude of all astronomers. It was while employed on this catalogue that M. Piazzi discovered, on the 1st of January 1801, the planet to which he gave the name of Ceres Ferdinandea; but even before this interesting discovery he was well known by the publication of two volumes of observations, which contain the foundations of his catalogue, and a long series of observations exceedingly useful to the theory of refractions.

Conditions.

All persons, the members of the Institute excepted, are admitted as competitors.

No answer must have the name of the author, but only a sentence or device: the author, if he chooses, may affix to it a separate billet, sealed, and containing, besides the sentence or device, the name and address of the author. This billet cannot be opened unless the paper has gained the prize.

The

The papers must be transmitted to the secretary's office of the Institute, free of postage, or to the perpetual secretary of the Class of the Mathematical and Physical Sciences.

None of the papers will be returned, but the authors may take copies of them if they think proper.

A vacancy having occurred, by the death of Dr. Priestley, among the foreign associates of the National Institute, M. Klaproth, chemist of Berlin, who is known as the discoverer of three new metals and four earths, was elected to that place. The other candidates proposed were: M. Piazzi, astronomer, of Palermo; Jacquin, botanist, of Vienna; Scarpa, anatomist, of Pavia; Vahl, botanist, of Copenhagen; Mascagni, anatomist, of Sienna; Mr. Watt, of Birmingham; Verner, mineralogist, of Freyberg; Mr. Dalrymple, the geographer; and the celebrated traveller Humboldt.

THE ROYAL SOCIETY OF THE SCIENCES AT PRAGUE

Has proposed the two following prize questions:

"I. To discover the means, besides those of the police, for putting an end to, or at least lessening, the various kinds of adulteration practised in regard to provisions."

It is well known that there are three principal causes of adulteration: the mixture of corrupted matters; the introduction of foreign and prejudicial matters; the preparing and keeping food in dangerous or unhealthful vessels. The society is therefore of opinion that it will be doing a great service to mankind to collect all the means already known and published by chemists for remedying these inconveniences, provided they be accompanied with simpler, less expensive, and more certain processes; and that they be described in such a manner as to render them practicable and intelligible to peasants. The competitors, however, will still be at liberty to propose means of their own invention. The memoirs must be written in German. The prize will be 500 florins, and 400 copies of the successful memoir, which will be printed at the expense of the society.

"II. To examine and appreciate all the sources from which materials may be drawn to throw light on the history of Bohemia, and to point out and give a character of the principal historical works which treat of that country." The prize will be 300 florins, and 400 copies of the successful memoir, printed as the preceding. The memoirs must be written in German, and transmitted, free of postage, to the secretary of the society before the 1st of January 1806.

XXXVII. *In-*

XXXVII. *Intelligence and Miscellaneous Articles.*

VOYAGE OF DISCOVERY.

It will be remembered that some time in the spring of 1802, the ship named the Investigator was completely fitted up in the Thames, and amply stored and provided, and put under the command of captain Flinders, in order to proceed to the South Sea for the purpose of exploring the coasts and the interior of New Holland; and that, besides the officers and crew, there were embarked persons skilled in practical astronomy, natural history in all its departments, and others accomplished in the art of drawing and painting.

By a Danish ship arrived very lately at Dover, letters have been received from Canton, in China, by which it appears that the Investigator arrived at Port Jackson on the 5th or 6th of June last year, after having finished a part of the intended survey of New Holland; by which time she had received such injury in the course of her voyage, and was so rotten, that, on examination then made, she was condemned as unfit for further service.

The same accounts further add, that the Porpoise, a small armed vessel then at Port Jackson, under the direction of governor King, was pitched on to complete this voyage of discovery: but that, being surveyed, she was also found unfit for so dangerous a service. It was then determined that the Porpoise should proceed to England with the officers of the Investigator. To the men of science an offer was made of either stopping at Port Jackson till captain Flinders should return from England with another ship, or taking a passage home, as many as could be accommodated, in the Porpoise; the rest to follow by the first proper conveyance that might offer.

The Porpoise sailed from Port Jackson about the 10th of August 1803, having under her convoy the merchantmen Cato and Bridgewater, bound to Batavia. The intended track was through Forrest's Straights, between the north coast of New Holland and New Guinea, and so, getting into the Indian seas, to follow the usual track of the Indiamen, instead of the circuitous route by Cape Horn.

The public has lately been informed of the unfortunate result of this voyage. The accounts now received are to the following purpose:—About 10 o'clock at night, on the 17th or 18th of August 1803, the Porpoise being a little a-head of the Cato and Bridgewater, who were on the larboard and starboard quarter, breakers were suddenly seen from

from the forecastle. The vessel was at that time going right before the wind at the rate of eight miles per hour; and it was so exceedingly dark, that the breakers, though tremendously high, were not discerned till they were within a quarter of a mile. The helm was instantly put down, and an attempt made to brace round the yards, but before the ship could be brought about she was amongst the reefs or shelves. It was expected she would go down the instant she struck; but, providentially drifting on one of the reefs broadsideways, she heeled a little, and then remained immovable. The situation now was dreadful: so remote from land, the night so dark and stormy, with the breakers driving over the deck, and the vessel expected every moment to go to pieces. Yet, for all this, the accounts add, that the officers and ship's company, having taken every precaution in their power, remained as composed as if the vessel had been riding at anchor.

The people of the Cato and Bridgewater did not discern the breakers so soon as those in the Porpoise. When they did, they instantly hauled for the wind; but unfortunately on opposite tacks, and so must have inevitably met one another. To avoid this destruction there was no alternative but for one of them to give way. This was done by the commander of the Cato, the lesser vessel, under the assurance of immediate assistance from the other; which accordingly poised and was saved, whilst the Cato went stern on the reefs, and immediately sunk. The people clung to the rigging till the morning, when they found themselves about half a mile distant from a coral sand bank, nearly as much in circumference. This miserable asylum they all reached, except two or three who perished; as also did the company from the Porpoise, who found means of conveying hither the ship's provisions and part of the stores. Afterwards, captain Flinders and the commander of the Cato, with eight or nine hands, left the reef in the cutter which belonged to the Porpoise, and reached Port Jackson, a distance of more than 900 miles, in safety. From thence the ship Rolla, in company with two schooners, one of them commanded by captain Flinders, weighed on the 20th of September, and made the fatal reef on the 8th of October, and relieved those who had remained there. On the 6th of December the Rolla and schooners anchored safely at Macao, where they found fifteen or sixteen Indiamen nearly ready to sail, waiting for intelligence from Europe; in some of which the gentlemen belonging to the Investigator proposed taking their passage home.

PHOSPHATE

PHOSPHATE OF POTASH FOUND IN VEGETABLES.

Th. de Saussure has found in the ashes of the seeds of maize, wheat, beans, and several other plants, a large quantity of the phosphate of potash united to a small quantity of lime or magnesia.

ANALYSIS OF DOLOMITE.

M. Klaproth, in a letter to M. Vauquelin, dated Berlin, January 22, 1804, says: "The object of my last analysis was a more exact knowledge of the constituent parts of dolomite. The analysis of this stone of the St. Gothard, by Saussure, is false; and the division of Haüy, founded on this analysis of aluminiferous carbonated lime, can no longer subsist, as this stone does not contain an atom of alumine. It is composed of carbonated lime 52, carbonated magnesia 0·25. The case is the same with the primitive lime which constitutes the mass of the Alps (of Juliers and Rhætica): it contains 48 per cent. of the carbonate of magnesia, and 52 of the carbonate of lime. All these different stones form only one family with the bitter spar and miemite.

"We have not yet been able to succeed in the synthesis of the palladium announced by Mr. Chenevix."

SUBERIC ACID.

When nitric acid is made to act upon paper, a large quantity of suberic acid mixed with oxalic acid is obtained, which seems to prove that Fourcroy was right in placing cork among the immediate principles of vegetables. For this discovery we are indebted to Brugnatelli.

VACCINATION.

By letters from Russia we learn that this practice is making a rapid progress in that country. In the year 1803 about 15,000 children were inoculated in Lesser Russia, not one of which died. Drs. Ramm and Hahn have lately published an account of the progress of their vaccine institution at Riga; by which it appears, that in the course of five months they inoculated 444 children and adults, none of whom died, nor were exposed afterwards to the least illness. The exertions of these meritorious physicians to introduce this practice in Livonia are entitled to the greater praise, as in one parish alone of 436 children born, 196 were carried off by the small-pox. Above a thousand children belonging to the peasants have been inoculated in Livonia, Esthonia, and Courland, with matter distributed by these physicians, and all with the best success.

METEOROLOGICAL TABLE *

For July 1804.

Days of the Month.	Thermometer. 8 o'Clock, Morning.	Noon.	11 o'Clock, Night.	Height of the Barom. Inches.	Degreees of Evaporation by Mr. Lester's Hygrometer.	Weather.
June 26	58°	70°	59°	30·18		Fair
27	60	65	47	·01		Fair, with wind
28	51	59	50	·11		Cloudy
29	53	69	56	·05		Fair
30	59	70	60	29·98		Fair
July 1	65	76	60	·80		Fair, with wind
2	62	73	60	·83		Fair
3	61	63	55	·74		Small rain
4	57	69	57	·82		Fair
5	60	65	55	·82		Cloudy
6	55	61	59	·76		Rain
7	58	60	59	·78		Rain
8	60	70	61	·70		Showery
9	61	72	60	·80		Fair
10	60	60	52	·69	15°	Rain
11	52	59	50	30·02	51	Cloudy
12	52	62	51	·21	55	Fair
13	60	69	61	·21	53	Fair
14	55	64	56	·12	45	Cloudy
15	60	69	61	·08	62	Fair
16	64	76	67	·13	91	Fair
17	68	77	66	·13	65	Fair
18	70	75	60	29·88	55	Cloudy
19	61	70	55	·56	52	Showers, with thunder
20	58	60	56	·65	25	Cloudy
21	56	66	61	·80	55	Fair
22	60	68	57	·68	26	Showery
23	60	66	58	·45	30	Showery
24	61	73	59	·64	71	Fair
25	60	68	58	·55	64	Fair
26	58	69	60	·51	64	Fair

* By Mr. Carey, of the Strand.

XXXVIII. *On the Mensuration of Timber. By Mr.* JOHN FAREY.

To the Editor of the Philosophical Magazine.

SIR,

THE following paper was written at the particular request of the very intelligent nobleman to whom it is addressed, and who has since expressed a wish that I would publish it, on account of the importance of the subject to land-owners and growers of timber. By giving it a place in your Magazine, you will greatly oblige, sir,

Your obedient humble servant,

June 15, 1804. JOHN FAREY.

To the Right Honourable Lord SHEFFIELD, *President of the Board of Agriculture, &c.*

MY LORD,

IN complying with the wish which your lordship did me the honour to express, to receive a communication from me on the subject of timber, and particularly on the customary modes of measuring it for sale, it is necessary I should apologize for enumerating many things, for the sake of connecting the subject, which have been often before published, and are too well known to your lordship and most other growers of timber, to have otherwise required repeating. Timber in large quantities is generally sold by the load, and in smaller quantities by the foot, without its being generally understood or adverted to, that in reality three different quantities pass under the denomination of foot, and the same of load: first, the cubic foot of 1728 cubic inches; second, the foot round measure, varying, according to the shape or dimensions of the different parts of the tree, from about 2200 to about 2500 cubic inches; and third, the foot square measure, varying also, according to the shape of the tree, from about 1360 to about 2000 cubic inches. In each of these cases the load is equal to 50 of the respective feet.

The first or cubic foot occurs in measuring square sawed timber, or what is called die-square timber, and plank, scantling, &c. (as also in the measure of hewn or sawn stone-work), and is found by taking the length, breadth, and depth of the piece, and multiplying these three dimensions together. For example: suppose a piece of square timber, as fig. 1, (Plate V.) to be in length, AB or CE, 25 feet; in breadth, AC or BE, 24 inches; and in depth, AD or EF, 12 inches; then the breadth 24 multiplied by the depth 12, gives 288 superficial inches (144 of which make a superficial or plane foot) for the area or measure of the end, which being divided* by 144 gives two superficial feet, which, multiplied by the length 25, gives 50 cubic feet, or one load, for the measure or content. Planks and boards are also reduced to this measure by taking their length, breadth, and thickness.

The second, or foot round measure, occurs in the common method used in measuring round timber, or whole trees, either while standing or after being felled. If the tree tapers regularly from the bottom or but, to the top or smaller end, as in fig. 2, it is measured by taking the length AB, and thereby finding the middle C, and then by a string taking the circumference or girt at C and applying the same to a carpenter's rule to take the inches †, one quarter of which is called the quarter girt, or more commonly the girt; then the girt is multiplied by itself, divided by 144 to reduce it to feet, and these multiplied by the length, to obtain the content. For example: suppose a tree to be in length AB 25 feet, and that its circumference in the middle at C is 68 inches; then the fourth of this, or 17 inches, is the girt, and the girt 17 inches multiplied by 17 is 289 inches, and this divided by 144 is two feet, (neglecting the small fraction 1-144th of a foot,) which multiplied by 25 feet, the length, gives the measure or content 50 feet round measure, or one load. Now since the girt in the middle at C remaining the same, the circumferences at the two ends may and do in practice vary, in all proportions, from that of being only 6 inches girt or 24 inches circumference at the smallest end B, fig. 3; the but A at the same time being very large, and the tree then differing but little from the cone AD, to the case in which the two ends A and B are

* In this and the following examples, I have reduced the area into feet (by dividing by 144) previous to multiplying by the length, as better calculated for showing the reason of the operation; but in practice it is more usual and ready to multiply by the length previous to dividing by 144.

† A string is constantly used by the buyers of timber: but the graduated tapes invented for the purpose, and made by Cary, optician, in the Strand, are more exact, and much more expeditious and easy in practice; and here I would remark, that the allowance of the girt for the bark ought to be 6½ times the thickness of the bark, and not any certain proportion of the girt, much less a fixed number of inches, as some buyers will contend.

equal,

equal, or the tree a cylinder, as fig. 4; a source of uncertainty and error hereby arises, besides the other source of error in taking 1-4th of the circumference to be the side of the square equal to the circle: these causes operate differently in different trees, so as to cause the real content of a foot of timber round measure to vary, as before stated, from about 2200 to about 2500 cubic inches, always exceeding the truth by more than one-fourth part of the whole.

In case the tree does not taper regularly as above described, but owing to knots or branches tapers irregularly in different parts, as in fig. 5, having at the points B and D what are called stops or knots, occasioning the tree to lessen suddenly at these places; in such case the tree is measured at three lengths; first taking the length AB and girt at C, then the length BD and girt at E, and lastly the length DF and girt at G; and calculating the three pieces separately by the above method, the three contents are added together for the content or measure of the whole tree*.

The third, or foot square measure, occurs in measuring timber which has been hewn or sided in part, as in fig. 6; the transverse section of such a tree being in fact an eight-sided figure, contained under four straight lines and four curved ones, part of the circumference of the tree; and trees are never so much hewn or sided as to take out the corners entirely, for then they would be called die-square, as in the first case. The method of measuring here is to take the length AB, and thereby to determine the middle point C, and, instead of girting it there, its depth DE is taken with a pair of calliper compasses, which are afterwards applied to a carpenter's rule to get the inches therein: in like manner its breadth FG is taken; and if these differ, they are added together and the half of their sum taken as

* In the above tree, if the larger piece is in length AB 17 feet and its girt at C 24 inches, the middle piece in length BD 17 feet and its girt at E be 15 inches, and the smaller piece in length DF 17 feet and its girt at G be 6 inches, then the whole length, or three times 17, being 51 feet, and the girt at its middle 15 inches, (being also in this case the third of the sum of the three girts, or $\frac{24 \times 15 \times 6}{3}$); therefore 15 multiplied by 15, this divided by 144, and then multiplied by 51, gives $79\frac{1}{2}$ feet as the content when measured in one piece: but if this tree be measured in three lengths as above directed, then $24 \times 24 \div 144 \times 17 = 68$ feet the content of the greater piece, also $15 \times 15 \div 144 \times 17 = 26\frac{1}{2}$ feet the content of the middle piece, and $6 \times 6 \div 144 \times 17 = 4\frac{1}{4}$ feet the content of the smaller piece; the sum of these three or $68 + 26\frac{1}{2} + 4\frac{1}{4} = 98\frac{3}{4}$ feet for the content, when measured as three pieces, exceeding the other by $19\frac{1}{4}$ feet.

the calliper of the tree: this calliper is multiplied by itself, divided by 144 to reduce it to feet, and these multiplied by the length to get the content or measure of the tree. For example: suppose a hewn tree to be in length A B 25 feet, and at the middle C to calliper in depth 17½ inches, and in breadth 16½ inches, then is 17 inches the calliper: this multiplied by 17 gives 289, and this divided by 144 gives two feet (neglecting a small fraction), which multiplied by the length 25 feet, gives 50 feet square measure, or one load. On account of the tapering or unequal dimensions of the two ends, also on account of the unequal manner in which timber is hewn, some trees having only just a chip taken off their sides, and others being hewn till nearly die-square, and in all the intermediate degrees; and further, on account of the loss of the corners, the real quantity of the foot square measure is still more uncertain and vague than the foot round measure, for it varies from about 1360 to about 2000 cubic inches, being sometimes below and sometimes above the truth: but it should be remarked, that the cubic inches mentioned above, as the limits within which the foot round measure and the foot square measure vary, is only on a supposition that the sides of the tree are regular, or that it has no particular swelling in the middle or girting place to cause it to girt or calliper more, or hollow to cause it to girt or calliper less, than it would if the tree were regular; for in these cases (which too frequently occur in practice) the round measure and square measure are often still more wide of the truth.

If a sided or hewn tree does not taper regularly throughout, or has the knots or stops described above in the case of round timber, then the tree is measured in different lengths, and the contents of the parts are added together for the content of the whole tree, as in the case of round timber. In like manner, the branches reserved and sold for knees or braces in ships, barges, &c. either round or hewn, are measured in two lengths.

The first of the above, or cubic measure, will prove consistent with the weight; thus, if 10 cubic feet of a tree weigh 578 lb., 30 cubic feet of the same tree will weigh 1734 lb.; but in either of the other measures it is but in some very rare cases that 30 feet of a tree will be found to weigh three times as much as 10 feet of the same tree even when measured by the same mode! The difference in the weights of the round measure and the square measure is so considerable, that for the purposes of freight or carriage it is an established custom that 40 feet of round timber make

a load,

a load, but of square or hewn timber fifty feet make a load.

Notwithstanding the glaring inconsistencies of the two last methods, they are established, and from their facility in practice, especially to those who are expert at operating with duodecimals, and to others when aided by Hoppus' tables and others in use for casting up or performing the numerical operation, or by the still more facile operations of the slide rule, I have no hopes of speedily seeing them laid aside and more correct methods introduced; they will in all probability continue as long as the other heterogeneous, multifarious, and absurd denominations of our measures and weights *. In the mean time it is of importance to the grower, of oak timber in particular, to be able to calculate, in a lot containing a certain number of loads or feet of timber, measured in the round, or as it is generally sold by the grower, how many loads or feet the same lot will measure when hewn in any determinate manner (*i. e.* when the ratio or proportion between A a and B b, fig. 7, is known), and afterwards measured by callipering it, being the mode in which it is measured when purchased in his majesty's dock-yards, and by the private ship and barge builders, &c. in London. As I am not aware that any rules have been laid down, or that any table for this purpose has been published, I have constructed the following table, consisting of four columns; the first containing the calliper A a or *Aa* of hewn timber at the middle or girting place, (see fig. 7,) wherein the diameter B b or *Bb* is 1 or 1·00; the numbers herein begin at ·70 or 70-100dths of the diameter, (which is something less than a tree can be hewn without absolute waste,) increasing in a regular order by 1-100dths to 1·00, or the case in which the least possible thickness is hewn off the tree: but it must be remarked in this column, that between this regular series of numbers, ·70, ·71, ·72, &c. other numbers are inserted in their proper places, but carried to a greater number of places of decimals, for showing more exactly the proportions in some particular cases mentioned in the

* The true content of any round tree might be found by the help of tapes and tables constructed for the purpose, in as short a time as it can be measured by the present mode with a string and rule; and simple tables might be made for the allowance for the corners generally wanting in hewn timber, and for showing its true or cubic content. Improved slide-rules might also be used for the above purposes, instead of tables. A very simple instrument has been made, and used with great success by a friend of mine, Mr. Bevan of Leighton Buzzard, for finding the true content, or the customary content, allowing for the bark, &c.

the fourth column; thus ·7071068, or $\frac{7071068}{10000000}$ of the diameter Bb will be the calliper Aa, when the tree is hewn to the inscribed square, or the most that it can be hewn without waste.

The second column shows the ratio or proportion, expressed in decimals, between the content of any tree measured in the round by girting it, expressed by 1, or unity, and the same tree hewn in any proportion, expressed by its calliper in the first column, and then measured as square timber by callipering it, or the ratio between the foot square measure and the foot round measure, or between the loads of the same denominations. The third column shows the proportionate price that the same timber, measured by the two methods, ought to bear (exclusive of the expense of hewing, carriage, &c.), expressed in shillings and decimals, assuming the price of round timber to be 100 shillings (5l.) for the convenience of calculating. In the fourth and last column are mentioned the particular proportions of the numbers before mentioned against which they stand: thus the "side of the inscribed square" is also "1-4th of the perimeter;" and when the calliper Aa is ·8040316, the side A or *A* is "1-5th of the perimeter," or sum of all the sides A, B, *A*, *b*, a, b, *a*, *B*, or outline of the figure; also "decrease of 1-5th in content" against ·7024815, shows that in this case the square measure of any tree is 1-5th part less than the round measure of that same tree; at ·7853982 they are equal, and at ·9619124 the square measure exceeds the round measure by half! In little more than in this last proportion is the small timber generally hewn, which is used by the barge-builders, carpenters, coopers and others in London; and in the trade, the prices per load or foot of round and hewn timber vary nearly in proportion thereto.

The

The calliper (Aa) of hewn Timber, the diameter (Bb) being = 1·00.	The Content square Measure, its Content round Measure being 1.	Price of hewn Timber, that of round, being 100.	Proportions, &c.
·70	·7943579	125·88784	
·7024815	·8	125·00000	decrease of 1-5th in content
·7071068	·8105694	123·37006	side of inscribed square, and
·71	·8172162	122·36662	side = 1-4th of perimeter
·7169672	·8333333	120·00000	decrease of 1-6th
·72	·8403984	118·99116	
·7271375	·8571429	116·66667	decrease of 1-7th
·73	·8639050	115·75345	
·7346727	·875	114·28568	decrease of 1-8th
·74	·8877354	112·64618	
·7404805	·888888	112·50000	decrease of 1-9th
·7450940	·9	111·11111	decrease of 1-10th
·75	·9118906	109·66228	
·76	·9363696	106·79540	
·77	·9611730	104·03958	
·78	·9863010	101·38893	
·7853982	1·000000	100·00000	calliper = 1-4th of circumference, and equal contents
·79	1·011753	98·83839	
·80	1·037529	96·38287	
·8040316	1·048013	95·41872	side = 1-5th of perimeter
·81	1·063629	94·01774	
·82	1·090054	91·73856	
·8237824	1·1	90·90909	1-10th increase
·8278824	1·111111	90·00000	1-9th increase
·83	1·116803	89·54134	
·8330404	1·125	88·88889	1-8th increase
·8396260	1·142857	87·50000	1-7th increase
·84	1·143875	87·42210	
·8483270	1·166667	85·71428	1-6th increase
·85	1·171272	85·37722	
·86	1·198995	83·40322	
·8603606	1·2	83·33333	1-5th increase
·8618760	1·204231	83·04054	side = 1-6th of perimeter
·87	1·227040	81·49692	
·8781018	1·25	80·00000	1-4th increase
·88	1·255410	79·65525	
·8862271	1·273240	78·53980	side of square equal to the circle
·89	1·284104	77·87530	
·8980504	1·307439	76·48537	side = 1-7th of perimeter
·90	1·313122	76·15437	
·9068998	1·333333	75·00000	1-3d increase
·91	1·342465	74·48983	
·92	1·372132	72·87930	
·9218736	1·377726	72·58335	side = 1-8th of perimeter
·93	1·402123	71·32042	
·9382994	1·427259	70·06433	side = 1-9th of perimeter
·94	1·432438	69·81105	
·95	1·463078	68·34906	
·9500692	1·463291	68·33913	side = 1-10th of perimeter
·96	1·494041	66·93255	
·9619124	1·5	66·66666	½ increase
·97	1·525329	65·55962	
·98	1·556942	64·22847	
·99	1·588878	62·93749	
1·00	1·621139	61·68503	side = 0, or circumscribing square

For

For example: suppose a hewn tree of any length, and that when callipered in the middle, on the angles or corners, or in the directions Bb and *Bb*, fig. 7, the same are shown by the rule to be $26\frac{1}{4}$ and $25\frac{3}{4}$ inches; add these together and take the half thereof, and we have 26 inches for the

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The mathematical reader will readily perceive the mode of calculating the content of a tree, either by the round or girt method or by the square or calliper method, to be the same, except in determining the area of the section at the girting place; and that the numbers in the second column of the above table, expressing the content square measure in different cases when the round measure is unity, do express also the ratio of the areas of the girting or middle sections in each case: thus, in the first line of the table $\cdot70 \times \cdot70 = \cdot49$ is the calliper area, and $\frac{3\cdot141593 \times 3\cdot141593}{4 \times 4} \times \cdot6168503$ is the girt area; whence, as $\cdot6168503 : 1 :: \cdot49 : \cdot7943579$ the number in column the second: and thus the numbers answering to ·71, ·72, ·73, &c. were determined. In the second line of the table, as there is to be a decrease of 1-5th or 2-10ths in the content, we have given ·8 for the number in the second column; whence, as $1 : \cdot6168503 :: \cdot8 : \cdot4934802$ the calliper area, whose square root is ·7024815 as in the first column; and thus, when there is a decrease of 1-6th, 1-7th, or an increase of 1-10th, 1-9th, &c. are the numbers determined.

Let fig. 8 represent one quarter of the end of a hewn tree, (as fig. 7 delineated the whole end,) draw the line CG, making the angle ECG (= GCH) = 45°, and join FC; then in the 20th line of the table, since the side is to be "1-5th of the perimeter," half the side (or DF) is to be equal to 4-5ths of the 1-8th part of the perimeter (or DF + FG), and DF is equal to 4 FG; whence we have required to divide an angle of 45° into two such parts, that the sine of the greater part may be equal to four times the arc of the lesser part. By the help of Dr. Hutton's or Callet's tables, and the method of trial and error, the greater angle will in this case be found = 36° 28′ 59·42″ = DCF, whose natural cosine is ·8040316, the number in the first column; and in like manner we proceed when the side is to be 1-6th, 1-7th, &c. of the perimeter. The methods of procedure in the remaining cases are sufficiently evident. It may, however, be proper to state, that the prices being reciprocally as the quantities, we have, in the second line, as ·8 : 1 :: 100 : 125 shillings per load, as in the last column, the diameter Bb: in like manner let the tree be callipered in the same place, but on the sides or in the directions Aa and *Aa*, and suppose them $22\frac{1}{4}$ and $22\frac{3}{4}$. Then say, by the rule of three, as 26 : 1 : : $22\frac{3}{4}$: ·875 : looking for this number in the first column, we find the nearest number thereto to be ·8781018, and answering thereto in the second column is 1·25, ("1-4th increase,") showing that the square measure of this tree is 1·25 times that of its round measure, or 1-4th part more; and by the third column it appears that the price per load square measure should be 80-100dths or 8-10ths times that of the price of the same tree per load round measure, exclusive of the cost of hewing, carriage, &c. Suppose, therefore, the price of the tree in question per load round measure to be 5l. 10s. or 5·5, this multiplied by ·8 gives 4·4, or 4l. 8s. for the price per load square measure or when hewn. For another example: suppose a tree callipered in the middle, on its angles or corners, gave 24 and 24 inches, then 24 inches is the diameter Bb; and that the tree callipered in the same place on its sides gave 19 and $18\frac{3}{4}$ inches; the half of the sum of these being $18\frac{7}{8}$, or 18·875 inches, is the calliper Aa, then as 24 : 1 : : 18·875 : : ·786 : the nearest number to this in column the first is ·7853982, in which case it appears from column the second that the round measure and square measure are equal, the calliper being equal to 1-4th of the circumference or to the girt; the prices per load should not in this case therefore vary.

Suppose the price per load of hewn timber or of the square measure to be given, and also the proportion which the calliper bears to the diameter, or how many per cent. the former is of the latter; the second column will in that case give the proportionate price of the same timber round measure: thus, if hewn timber measured by callipering it be at 7l. 2s. 6d., or in decimals 7·125 pounds per load; that the cost of hewing and carriage is 2l. 0s. 6d. or 2·025 pounds per load; the difference of these or the net price being 5·1 pounds, and that it be so hewn that the calliper Aa is 90 per cent. or 90-100dths of the diameter Bb: looking for ·90 in the first column of the table, I find against it in the second column 1·313122, which multiplied by 5·1 gives 6·697 pounds, or 6l. 13s. $11\frac{1}{4}$d., the price which this timber ought, independent of profit, to have borne at the place of its growth when round and measured by girting it. A gentleman or his agent having oak timber to dispose of, and being unacquainted with the difference of measures, if offered 5l. 2s. per load by a timber dealer, who stated at the

the same time, "it will cost me 2l. 0s. 6d. to hew this timber and carry it to London, where it will only fetch 7l. 2s. 6d. per load," he would instantly conclude what he would think a good bargain; not suspecting that the difference of measure (if hewn, as in the last example,) could put nearly 1l. 12s. per load, or 31 per cent. into the pocket of the dealer.

It may be proper to add, that the way to examine any lot of hewn timber, with the view of determining to which line of the above table it should be referred, is to take the calliper in inches of several of the trees indiscriminately chosen in the middle or girting place, first on each of their sides, or in the directions Aa and *Aa*, and place the results under each other in a column, and next callipering them in the same place but at the corners or in the directions Bb and *Bb*, placing these likewise in a column; then dividing the sum of the first column by the sum of the second column, and carrying the division to three or four places of decimals, the quotient or result is to be sought for in the first column of the table.

Hoping that I have made the above intelligible, and that the table will not be unacceptable to the growers of timber, their agents, and others.

I remain, my lord, your lordship's
most obedient and humble servant,

Crown-street, Wesminster, JOHN FAREY.
May 30, 1803.

XXXIX. *Parallel of* ROME DE L'ISLE'S *and the Abbé* HAUY'S *Theories of Crystallography.*

[Continued from p. 172.]

SYNTHESIS is grounded, as I mentioned, on the fact, that all well formed crystals are terminated by plane surfaces.

Since there exist primitive forms, there must also be secondary forms, for the one supposes the existence of the other. The secondary forms are such, that sections can be made only parallel to the sides of the primitive; and when the primitive has been produced by these sections, the division being continued the integrant particles are obtained.

The mineralogical analysis descends from the secondary to the primitive form, and from the latter to the integrant particle; just so the mineralogical synthesis ascends from the integrant particle to the primitive, and from thence to the

the secondary forms. A crystalline edifice is therefore raised by means of the integrant particles. What are the laws of this extraordinary architecture? By laws I mean the disposition of the laminæ, not the means employed by nature to execute the curious structure.

Laws must exist, 1st, For the formation of the primitive; and, 2dly, For the construction of the secondary form. The primitives are either similar to their integrant particles, or they are not. If they are, their forms must be parallelopipedons, and their laws of formation very simple; for there will be the same number of integrant particles in each row, as there are rows in each lamina, as there are laminæ in the primitive form. It is easy to conceive that all the joints perfectly coincide with each other and form continued planes; neither will there be any vacuity left between the particles. If the primitive be not similar to the integrant particle, then the simplicity of the former case disappears. I have already stated that there are three forms of integrant particles; the tetraëdron, the triangular prism, and the parallelopipedon. There are also six primitive forms; the parallelopipedon, the octaëdron, the tetraëdron, the regular hexaëdral prism, the dodecaëdron bounded by rhombs all equal and similar, and the dodecaëdron with triangular sides and formed by two right pyramids united base to base. Of these six primitive forms there are only the parallelopipedon and the regular hexaëdral prism that can exactly fill up a space without leaving any vacuity. The integrant particles of the former are parallelopipedons; of the latter, triangular prisms. As to the other four primitive forms, their integrant particles are tetraëdrons. The dodecaëdron bounded by rhombs is produced by twenty-four similar tetraëdrons without any vacuity between them; the octaëdron and tetraëdron are formed by tetraëdrons leaving octaëdral vacuities; and the dodecaëdron bounded by triangles, to be formed of tetraëdrons, must imply sections parallel to more than six planes; which perfectly coincides with observation.

These vacuities, whose existence must be admitted in the integrant particles, as well as between those particles when forming a primitive, give rise to the following reflections:

When the elements of a substance are chemically combined, that substance is homogeneous. Let us suppose a crystal of such a substance to be subdivided into small parallelopipedons equal and similar: as the substance is homogeneous, and these little parallelopipedons leaving no vacuities between them, it is evident the elements that compose

pose them are equal in number and proportion. We will next suppose the crystals of this substance can be divided by sections parallel to six planes. In that supposition, nineteen or twenty different species of parallelopipedons can be produced. Among these species some will be similar, others not; but none of the species will be exactly parallel to each other. We will proceed on two similar crystals of the same substance and equal in solidity; dividing the first into one species, the other into a different species, of parallelopipedons, equal in solidity but not in surface; and let the division of each be pushed to its last term. But as we are come by smooth sections to parallelopipedons of different species, those sections have also produced their differences: but by supposition these parallelopipedons are the result of the last possible term of division without destroying the chemical composition, and being equal in solidity, though not in surface, they cannot contain each other; therefore if their differences are not integrant parts of both, these differences must cease to be homogeneous, and we come to a sort of chemical decomposition. It is true we cannot execute this excessive division, but we can form a very correct idea of it. If the little parallelopipedons contain two sorts of elements, their differences will also, but in different proportions; and, sir, if you will turn to Berthollet's *Researches on the Laws of Affinities*, you will see him in all his experiments proving, that however perfectly a chemical decomposition may have been made, the results will always contain a certain portion of those substances from which it was the object of the operation to separate them. If these reflections, sir, are well grounded, do they not give us hopes, and perhaps show the possibility, of descending from the integrant particles to the constituent particles? This second research is of the same nature as the first. It is more than probable that the constituent particles themselves are divisible, having no determined figure, but are aggregations, subject to the same laws as the integrant particles. The object of the natural philosopher is not to discover the forms of the ultimate particles, but to determine their respective positions; which, if ever they could be determined in the integrant particles and their component parts, the grand problem of chemical affinities would be fully solved; and should such ever be the case, to the Abbé Haüy's theory would be due the merit. The *Encyclopædia Britannica*, under the article *Chemistry*, in the Supplement, p. 396, says:

"This theory, to say no more of it, is, in point of ingenuity,

genuity, inferior to few; and the mathematical skill and industry of its author are entitled to the greatest applause.

"But what we consider as the most important part of that philosopher's labours, is the method which they point out of discovering the figure of the integrant particles of crystals; because it may pave the way for calculating the affinities of bodies, which is certainly by far the most important part of chemistry. This part of the subject, therefore, deserves to be investigated with the greatest care."

But I return to the point whence this digression carried me,—to the vacuities left between the integrant particles in the construction of a primitive form. The Abbé considers them as filled either by the water of crystallization or by some other substance. Is it not an admissible supposition that this other substance is composed of the same elements as the integrant particles, but in different proportions? At least, such is the conclusion I should be tempted to draw after reading Berthollet's excellent Researches on Affinities.

I shall now proceed to the laws of formation in secondary crystals. It is easy to deduce them from these two facts: viz. 1st, That the sides of the secondary crystals are planes; 2dly, That they divide by smooth sections parallel to the sides of their primitive form.

Let us take a rhomboid of carbonate of lime for example. If on one of the sides of the rhomboid I wished to raise a pyramid, I should lay laminæ of rhomboidal particles upon each other. These laminæ would decrease in surface until the last is reduced to a single rhomboid. Thus the second lamina contains fewer particles than the first, the third fewer than the second, and so on. As the faces of these pyramids are always to be planes, the successive decrements of the laminæ must be equal; that is to say, the second lamina is less by one range in every direction than the first, and the third than the second, &c. If the decrement is more rapid; that is to say, if two or three ranges are subtracted in the second lamina, the same number will be subtracted from the third, and so on successively till the pyramid is completed. As the sections are to be smooth, the joints must form one continued plane; therefore the ranges and even the particles at the joints must not encroach on each other: hence it follows *that the number of ranges successively subtracted from each lamina can never be incommensurable*; that is to say, the decrement may be 1, 2, 3, 4, &c.; but never $\sqrt{2}$, $\sqrt{3}$, &c.

These are the decrements parallel to the edges, or, as the Abbé calls them, *decrements on the edges*. But they may take

take place in a parallel with the diagonal of the faces of the primitive; they are then called *decrements on the angles*; because the diagonals are drawn from one angle to the opposite angle. This second species of decrement follows the same laws as the first.

There is a third species, called by our author *intermediate decrements*. In this case they are neither parallel to the edges nor to the diagonals of the faces, but to intermediate lines, which if prolonged would intersect both the edges and diagonals, but otherwise they follow the same laws as the two first. It is a general law, therefore, *that in all cases the laminæ decrease in arithmetical progression, and its ratio or the number of ranges subtracted is always commensurable.*

The particles of which the laminæ are composed are to be considered as parallelopipedons; not that the integrant particles always have this figure; but if they have it not, they must leave vacuities between them, and each vacuity being added to its corresponding particle, will complete the parallelopipedon. If this was not the case, the faces of the secondary crystals would not be planes, nor could they be split smoothly in any direction. These little parallelopipedons which compose the subtracted ranges are what I called above, after our author, *subtractive particles.*

I supposed the construction of the secondary form only to take place on one of the faces of the rhomboid; but what was said relative to that face is applicable to all the others. It is also to be remarked that different laws of decrement may affect the different faces; even further, different laws may successively affect the same face. Hence a diversity of forms arise scarcely credible to a person unacquainted with the doctrine of combinations. The Abbé Haüy has calculated, "that confining oneself to decrements by 1, 2, 3, or 4 ranges, and not taking intermediate or mixt decrements into account, the rhomboid is capable of 8,324,604 varieties of crystalline forms.

It is an important remark, that whatever may be the variety of form, the forms (in complete crystals) will always be symmetrical. There are two sorts of symmetry, the perfect and imperfect. In the perfect, the right is symmetrical with the left, and the top with the bottom; but in the imperfect, the top is not symmetrical with the bottom. This latter species of symmetry appears, by general observation, to be exclusively appropriated to crystals that become electrical by heat; that is to say, which being exposed to the heat of the fire, or plunged into hot water,

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acquire the electric power. These crystals, the tourmaenli for example, acquire a positive electricity on one side, while on the side diametrically opposite their electricity becomes negative; and all observations hitherto made give us reason to conclude that these sides are never symmetrical, and are always produced by different or fewer laws of decrement. "Hence," says the Abbé, "by mere inspection it is easy to point out which is the side that will give the positive and which the negative electricity." (Vol. i. p. 237.)

The astonishing variety in the crstalline forms leads us naturally to ask, What can be the cause of this variety? This question has not been treated by the Abbé: allow me, sir, to submit a few ideas on the subject for the opinion of mathematicians.

First causes, I repeat, are not the object of this discussion. I state the question thus: Why does the same substance crystallize in such a variety of forms, always symmetrical and always terminated by planes?

The solution of this question seems to require three conditions: 1st, That the particles of the substance dissolved in the fluid all leave the state of rest at the same instant, to form the crystal by their aggregation: 2dly, That, while these particles are in the act of drawing near to each other, no foreign power shall imprint on them any other motion than a common motion, whether it be in a straight line, or rotary round their common centre of gravity: 3dly, That the particles all arrive at the state of rest at the same instant, which takes place when the act of crystallization is finished. The second condition is necessary, and infers the first and third. The natural consequence of these conditions will be, that the aggregation of the particles will only take place conformably to a law acting equally on all of them, whatever may be the law.

Since they all leave the state of rest at the same instant, they are in equilibrio previous to that instant. Since they all arrive at the state of rest at the same instant, they are in equilibrio after that instant: but when particles that are acted upon by no other force than that which they exercise on each other, are in equilibrio, they are in the closest possible union that concomitant circumstances will permit. If the particles were in equilibrio previous to their leaving the state of rest, something must have obstructed their approach. Let us suppose that *something* to be the interposition of another substance, and that so long as the interposition remains equilibrium is maintained. But this can only be the case, in as much as the whole of the particles of the in-

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terposed substance are in equilibrio with the whole of the particles dissolved and about to leave the state of rest, which in the future I shall call the *proper particles.* If by any cause which acts uniformly on the whole surface of the dissolving fluid any of the interposed particles are subtracted, the proper particles must cease to be in equilibrio. A step toward aggregation will immediately take place, and the equilibrium will be restored. A further subtraction will produce a further step toward aggregation, and a consequent equilibrium; and these operations will be repeated so long as the cause of subtraction continues, and the longer its duration the larger will be the resulting crystalline mass. If the above mode of reasoning be admitted, it will suffice to apply the laws of equilibrium to deduce the laws of crystalline forms. The laws of equilibrium to which I allude are those of the equilibrium of fluids, with certain modifications which shall hereafter be explained. According to these laws, that the preceding conditions may take place in the formation of a crystal, it will be necessary that they take place in the formation of each and every part of it, whatever may be the figure or the smallness of those parts. They must also take place in those last crystals which contain the least possible number of particles; and as these particles are in equilibrio, and in the greatest possible state of proximity to each other which circumstances will permit, it must follow, to fulfil all the conditions, that these particles form a symmetrical polyëdron. This peculiar disposition of the crystalline particles constitutes the modification, to which I alluded, in the laws of the equilibrium of fluids; it being necessary in this case to take the number of crystalline particles into account, which is not the case when treating of the particles of a fluid. In a fluid, the particles and their reciprocal distances are supposed infinitely small; but the crystalline particles and their distances to each other must be supposed finite. This material difference will necessarily cause a difference between the forms of their aggregates. Those formed with the particles of a fluid will be bounded by curved lines: the crystalline aggregates, on the contrary, will be terminated by straight lines; and when these straight lines are not too small, the boundaries will be sensibly rectilinear.

To ascertain what the power is that holds the particles in the state of rest, though not in close contact, is not the question; but the form of the polyëdrons which they produce. The closer adhesion of the particles to be obtained by the subtraction of caloric sufficiently demonstrates that the particles are not in close contact with each other, and the constancy of the crystalline forms equally proves that they are in equilibrio. We will now proceed to the construction of a crystal with these crystalline particles. That the constancy of the form in the large crystal be preserved, the particles must be in equilibrio. That the equilibrium be preserved, the forces that solicit the particles to motion must mutually destroy each other. That the mutual destruction of these forces be effected, those forces after having been decomposed into other relatively parallel to three axes perpendicular to each other, and having a common point of intersection, must each meet in its direction another force equal and diametrically opposed to it. This will be obtained if the similar particles are arranged on straight lines parallel two and two at equal opposite distances from the common centre, and bisected by lines passing through that centre; but if the particles are thus arranged they must produce symmetrical solids bounded by planes; and they are thus arranged: for if a foreign force, an excess of caloric for example, does not impede the free arrangement of the particles in the formation of the crystal, their exterior disposition will follow as much as possible their interior arrangement; but their interior arrangement must be on straight lines, or the crystal would cease to be homogeneous; their exterior disposition will therefore be on straight lines.

As the circumstances giving rise to the approach of the particles may be in the highest degree variable, it must follow that the forms produced may be diversified in the extreme. Such, sir, is the answer I should submit for the solution of the question proposed.

When speaking of the approach of the proper particles, I said that it might be occasioned by the subtraction of certain interposed particles which obstructed the approach of the proper particles. The former are generally water, caloric, or any fluid elastic or not. Their exit may perhaps make place for others, such as light, electricity, &c. &c. But the essential point is, that whatever these particles may be, they are in perfect equilibrio with the proper particles, otherwise they would become perturbing forces. Hence it follows, that not only the integrant particles of the crystal, but all those that are mixed with them, the chemical or component particles, and even the vacuities, must follow the same laws. It also follows, that if each species of particle (even the chemical) that enters into the formation of the crystal be separately considered, each species will have its distinct symmetrical and polyëdral form. The forms will penetrate each other, while the particles will not only not penetrate, but not even touch each other. All forms would stand in the same predicament as the regular octaëdron, which contains, as the Abbé Haüy has demonstrated, six regular octaëdrons and eight regular tetraëdrons, each tetraëdron containing one octaëdron and four tetraëdrons. It will further follow, if the chemical elements can be looked upon as particles which are not in contact with each other, that we may from thence mathematically determine chemical affinities.

I have now, sir, but one task left; to speak of the application our author has made of algebra and geometry to crystallography. Many persons complain of the difficulty necessarily resulting from it in the study of mineralogy; and dare not engage in it, uncertain whether they will find a compensation for their trouble. Our author has therefore adopted a double plan, and begins by exposing his theory by a series of reasonings and arguments which will suffice to make the reader understand it, or any discoveries made in consequence of it. He then exposes the theory in the most correct of all languages—mathematical analysis; by far the most interesting, and the only means of making discoveries oneself: and who can be callous to the pleasure of discovering an unknown truth? If the solution of a problem gives so much satisfaction, though the data be only imaginary, what must be the sensations of those who are happy enough to solve problems whose data are set by *Him* whom the greatest of pagan philosophers calls the *eternal Geometrician?* This recalls reflections to my mind which I cannot suppress. Conversing one day with the Abbé Haüy, he was taking a cursory view of all the modern discoveries; when he could not help remarking, that there was not one of them but what furnished victorious arms to the cause of religion. My answer was, that in future the name of God would be as distinctly written on a crystal as it had hitherto been in the heavens. The observation of this most religious and ingenious man reminds me of the saying of lord Bacon: "A little philosophy estranges us from religion, but a great deal reclaims us again." Even d'Alembert could not help saying: "An atheist in the Cartesian system is a philosopher mistaken in the principles; but an atheist in the Newtonian system is something worse, an inconsequent philosopher."

But to return to the mathematical part of our author's theory: the branch of mathematics, and the manner in which he treats it, are almost new. The theory of polyëdrons

drons had been nearly neglected by geometers, both on account of the difficulty to represent a polyëdron on a plane, and because they did not feel the utility of the pursuit. Nevertheless, strange to say, all the regular figures that are to be found in one of the three kingdoms of nature are polyëdrons. In this point of view, the branch of mathematics illustrated by the Abbé becomes very interesting; and it is not a little so, to see with what ingenuity he extricates himself from the difficulties he meets with in his researches. He forms all the polyëdrons, however complicated, of little equal rhomboids or parallelopipedons, and by that means he reduces the theories of every possible polyëdron to that of the rhomboid, which is extremely simplified by two very simple remarks: 1st, That in all equilateral rhomboids, whatever may be the species, their projection on a plane perpendicular to their axes will always be a regular hexagon: 2dly, That the axes will always be trisected by perpendiculars drawn from all the lateral solid angles. His theory has also led him to discover in a variety of crystals geometrical properties, which must be highly gratifying to geometers. But the great advantage to be derived from it is, that it enables us with the fewest possible data to calculate the crystalline forms just as astronomers do the motions of the heavens. By the very means by which the latter determine the future motions of the heavens, the Abbé decides which forms are possible and which are impossible. It is thus by his simple and general law of crystallization, "the number of the ranges of the subtractive particles must always be a commensurable quantity," that he has demonstrated the regular dodecaëdron and the regular icosaëdron to be impossible forms in mineralogy. As the immortal Newton, by having discovered the law of attraction to be "in the inverse ratio of the squares of the distances," explained and calculated every thing in the vast regions of the firmament; so at the other extremity of the creation the Abbé Haüy, by means of a single law which he has discovered, explains the irregularities and calculates those problematic formations with which the mineral kingdom had hitherto astonished the natural philosopher.

Laws, sir, that result from the study of nature enjoy this inestimable advantage, that they always lead to *equations*; and it is only by the help of equations (expressed or understood) that questions can be solved which relate to objects that can be either counted or measured.

Of late, sir, the word *nature* has been so much abused, that I must beg leave to state the precise sense in which I

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wish to be understood whenever I have made use of that word in the course of this letter. The Abbé Haüy found it necessary to take a similar precaution at the beginning of the excellent work (*Traité de Physique*) he has lately published. He says: "This word NATURE, so frequently in our mouths, can only be looked upon as an abridged expression, either for the result of those laws which the GREAT CREATOR has imprinted on the universe, or for that aggregate of beings the works of his hands. Nature, thus viewed in its true light, is no longer a subject of cold and sterile speculation. The study of its productions, of its phænomena, ceases to be a mere exercise of the mind; it moves the heart, and strengthens the moral virtues in man, by awakening in his mind sentiments of respect and admiration at the sight of so many wonders bearing the visible characters of infinite power and wisdom."

With these sentiments I remain, sir, yours,

July 13, 1804. A. Q. BUEE.

XL. *On the Catoptrical and Dioptrical Instruments of the Antients.*

LETTER III.

[Continued from p. 190.]

"PART SECOND. *Conjectures on the Existence and the Reality of the Mirror of Ptolemy*.*

49. "IT is by no means so easy for us to satisfy ourselves with respect to the reality of the fact which we are examining, as to demonstrate its possibility. The proofs of the possibility of facts subsist throughout all ages; time cannot destroy them; and they may always be discovered by diligent search. But when the question concerns things which have existed formerly, but do not now exist, we have only remaining monuments, or the testimonies of historians, to convince us of their past existence. If such monuments and testimonies have not come down to us, we have no other means whatever of establishing such facts.

50. "Hence, in our researches concerning the possibility of facts, we may find complete evidence. But, in inquiring into their real existence, we are frequently obliged to stop

* The reader is requested to correct the numbers of the paragraphs in the first part, which are 48 in all.

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in uncertainty and doubts which we cannot resolve. We are often obliged to content ourselves with probabilities; and at best we can only arrive at a degree of certainty proportional to the number, quality, and circumstances of monuments and historical testimonies.

51. " The testimonies of the existence of Ptolemy's mirror on the Pharos, are not commonly thought to have the authenticity necessary for the solid establishment of a historical fact. Two reasons, which at first sight appear plausible, may be alleged for the rejection of those testimonies.

52. " The first reason is, that some authors attribute this mirror to *Ptolemy*, and others to Alexander the Great. *John Baptista Porta*, father *Kircher*, and father *Gaspard Schottus*, are among those who place the construction of this mirror in the time of *Ptolemy*. *M. de la Martiniere*, in his Geographical Dictionary, cites *Martin Crusius*, who in his *Turco-Græcia* says, on the authority of the Arabians, that " *Alexander* the Great caused to be placed on the top of the Pharos tower, a mirror made with such art, that in it might be seen 500 parasangas, or above 100 leagues off, hostile fleets coming against Alexandria or against Egypt, and that after the death of Alexander, this mirror was broken by a Greek named *Sodor*, who watched his opportunity when the soldiers in the fort were asleep:

53. " But this difference of opinion respecting the origin of the mirror cannot affect the truth of the fact. For it often happens in history, that different authors attribute the same fact to different men, without our regarding the fact itself as fabulous. Of this we have an example in the erection of this very tower, the Pharos, which is ascribed by some to *Alexander*, and by others to *Ptolemy*. It would seem that they who have spoken of the mirror, have thought that it was constructed by the very person who built so wonderful an edifice.

54. " The second, and the strongest, reason against the existence of this mirror, is the impossible circumstances and properties which historians ascribe to it. *Paul Aresa*, bishop of Tortona, in his *Impresa Sacra*, Impr. 54. n. 1 and 2, cited by *Scarabelli* in his *Museo Settaliano*, says: " He knew that *Ptolemy* saw, 600 miles off, fleets coming to the port of Alexandria, not by strength of sight, but by the virtue of a crystal or glass." But he adds, " that he suspected the truth of this fact, on account of the rotundity of the earth, which rendered it impossible."

55. " But I maintain, that this circumstance of seeing 600,000 paces, or 500 parasangas off, totally impossible as

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it is *, does not derogate a tittle from the probability of the fact in question. For, if this mirror existed, it is probable that it was the only one of its kind, and that no other mean had then been found of viewing distant objects distinctly. It must therefore have been considered as a great wonder in those times, and must have filled with astonishment those who saw its effects. Even though its effects had not been greater than those of a small telescope, it could not fail to be regarded as a prodigy. Hence it is natural to think that those effects were exaggerated beyond all probability, and even possibility, as commonly happens to rare and admirable machines and inventions †. If we abstract then, from the accounts of the mirror of Ptolemy, the evident exaggerations of ignorance, nothing will remain, but that at *some* distance, provided nothing was interposed between the objects and the mirror, those objects were seen more distinctly than with the naked eye; and that with the mirror many objects were seen, which, because of their distance, were imperceptible without it. Here is nothing but what is both possible and probable.

56. "Let us next inquire whether the knowledge which the antients had of dioptrics and catoptrics, and especially of

* It is certain, however, that, under some circumstances, objects may be seen at a greater distance than is generally supposed. For example: it is said that the Isle of Man is clearly visible from the summit of Ben Lomond, in Dumbartonshire, which cannot be less than a direct distance of 120 miles. *Mr. Glas*, in his History of the Canary Islands, affirms, that the Peak of Teneriffe is visible 120 miles in approaching it, and 150 in leaving it. The difference, no doubt, arises from the difficulty a man has to distinguish from a cloud the first appearance of a mountain he is approaching, and the ease with which in leaving the mountain he can keep it in view till it gradually disappear. *Brydone*, if I mistake not, says that, from the summit of Etna, mountains may be distinguished at the distance of even 200 miles. Whether in this instance any mention is made of glasses I do not recollect. But the most extraordinary fact of this kind I have met with, if it be a fact, is to be found in the Encycl. Britan. art. *London*, § 22, where we are told that the illumination of the atmosphere by the great fire at London in 1666, is said to have been visible at Jedburgh, in Scotland.—*Translator.*

† Witness the strange stories propagated about the barometer possessed by *David Gregory*, of Kinardie. See Hutton's Dict. art. *Gregory*; or the Suppl. to the Encycl. Brit. same article. Here I cannot help expressing my satisfaction at finding that, in dissenting from *Sir Isaac Newton*, which I did with a trembling pen, respecting the effects of *Gregory's* warlike engine, I have the learned editor of this last excellent work on my side. I need scarcely add, that the same opinion extends to *Mr. Gillespie's* new invented revolving battery; which, as a powerful, cheap, and compendious instrument of defence, attracts more and more the attention of officers of distinction both naval and military. See my first Letter, towards the end.—*Translator.*

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the art of working mirrors, was sufficient to enable them to invent, or to find out by chance, a mirror which could produce such effects; or whether this kind of knowledge was in such a state among the antients as to put the fabrication of such a mirror beyond the limits of probability, or make it fit to be considered as morally impossible.

57. "The antients certainly possessed a great variety of knowledge which has not come down to us; and, among those parts of their science of which we have still some vestiges in the authors of antiquity, some are not sufficiently intelligible for want of attention in the readers, or because they have not been clearly enough explained by the writers. Hence it is that we discover, from time to time, in those antient writers many things which we have been accustomed to consider as new discoveries. Consequently we run much greater risk of being mistaken, by averring that the antients did not possess certain parts of science known to us, than by endeavouring to prove that they did possess them. For the testimony of one antient author is sufficient to prove that they had the knowledge of a particular thing; whereas, to prove the contrary, it would be necessary to consult all the antient authors who may have spoken of that thing, and to be very sure that we rightly understand them.

58. "As to catoptrics and dioptrics, I say, that the science of the antients went somewhat further than is generally believed. Of this assertion I shall give some proofs, and chiefly such as may contribute to give probability to the existence of the mirror of Ptolemy.

59. "*M. de Fontenelle*, in the Hist. of the Acad. of Sc. for 1708, says, that "burning mirrors were undoubtedly known to the antients; for some historians allege that Archimedes used them in burning a fleet; and, although they attributed to them an *impossible effect* *, even this circumstance proves them to have been known. But it is certain that those mirrors which they contrived must have been of

* The actual production of this "impossible effect," by *Buffon*, in the year 1747 (not to mention what had been done by *Leonard Digges* and father *Kircher* in the two preceding centuries) proves how very cautious philosophers ought to be in dogmatically applying the epithet *impossible* to natural effects which they have never seen or experimented. About the same period another *impossibility* was performed, when *Franklin* drew lightning from a thunder cloud. *Fontenelle* lived to see both these discoveries, and no doubt to be convinced that such language from men of eminence tends exceedingly to retard the progress of knowledge, by discouraging the attempts of persons of less celebrity perhaps, but often of equal or superior ability.—*Translator.*

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metal, and concave, having a *focus* by reflection; and it is the common opinion, that the antients knew nothing of the *foci* by refraction of convex glasses."

60. "*M. de Fontenelle* and *M. de la Hire* prove satisfactorily*, by several passages from *Aristophanes* and his scholiast, and from *Pliny* and *Lactantius*, that the antients also knew the effects of convex glasses and globes of glass in burning. In the History (of the Acad. of Sc.) which I have quoted, we find all these passages; to which I may add another, from *S. Clemens Alexandrinus*, *Stromatum* lib. vi. cited by father *Feijoo*, *Theat. Crit.* tom. 9. p. 146: "*Viam excogitat, qua lux, quæ a sole procedit, per vas vitreum, aqua plenum, ignescat* †. He devises a way by which the light, proceeding from the sun through a glass vessel filled with water, excites fire." Here also I may add another passage from *S. Isidore*, of *Seville* ‡, in his *Etymol.* lib. xvi. cap. 13, where, speaking of crystal, he says: "*Hic oppositus radiis solis, adeo rapit flammam, ut aridis fungis vel foliis ignem præbeat.* When opposed to the rays of the sun, it so urges flame as to set fire to dry agaric, or leaves."

61. "But *M. de Fontenelle*, in the place above cited, and other philosophers with him, suppose the antients to have been ignorant of several things which they certainly knew, as I shall prove in the following articles.

62. "In the first place, it is by no means certain, as *M. de Fontenelle* alleges, that the mirrors of the antients must have been concave. There is nothing to induce us to believe that they did not know the manner of burning with an assemblage of *plane* mirrors; and, if they had this knowledge, it is plain that their mirrors were not *necessarily* concave.

63. "Although this invention of burning with plane mirrors be regarded by some as very recent, yet it is, in truth, very antient. According to several modern authors, the burning mirrors of *Proclus* and *Archimedes* were composed of plane ones. If this opinion be correct, the anti-

* In *Hist. de l'Acad. R. des Sc.* 1708, p. 137, &c. Amst. edit. See also Encycl. Brit. or Hutton's Dict. art. *Burning Glass* or *Burning Mirror.—Translator.*

† The same passage is quoted by *Regnault* in his *Orig. Ancien. de la Phys. Nouv.* tom. 1. p. 275, with this difference, that he begins it, "*Ars viam excogitat*, &c. Art devises a way," &c.—*Translator.*

‡ Isidore of Seville, otherwise called *Isidorus Hispalensis*, the latest of those called antients in this memoir, flourished about the middle of the seventh century. See *Vallemont*, *Elem. de l'Hist.* t. iii. p. 350. *Abat*, in the work now before me, p. 458, says, that this *Isidore* died A. D. 636.—*Translator.*

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quity of this invention stands established. I shall examine it further on. Only I now remark, that the first author, as far as I know, who held this opinion was father *Kircher*, who, in his *Ars magna Lucis et Umbræ*, l. x. p. 3. c. i. prob. 7, expresses his belief that Proclus, who lived in the fifth century, used plane mirrors to burn the enemies' fleet at the siege of Constantinople. Several authors have adopted *Kircher's* opinion, not only with regard to the mirrors of *Proclus*, but those also of *Archimedes*. All the learned, before that reverend father, and several since his time, believed that all those antient burning mirrors were parabolical.

64. "This invention of plane burning mirrors is so fine, and has for some years made so much noise in the learned world, that it well deserves some detail of its history and origin; which will show that we do injustice to the antients, when we deny that they had this knowledge.

65. "Among the catoptricians of these last ages, father *Kircher* was the first who asserted, that, with plane glasses, it was practicable to compose burning mirrors superior to any before known, &c.*

66. "After *Kircher*, father *Gaspard Schottus* gave (in his *Magia Universalis*, tom. i.) the solution of a problem concerning plane burning mirrors, in two different ways. He has, however, done nothing more than copy the former, without adding aught of his own, either in theory or practice.

67. "It is astonishing that so fine an instrument, explained so neatly and precisely in the works of these celebrated men, which are well known to the learned, should have lain dormant above a century, before any one thought of bringing it into use. *Fontenelle*, it is true, in his Eulogy on *Hartsoeker* †, tells that this philosopher, in his observatory at Amsterdam, attempted a large burning mirror, composed of several pieces connected together, like that, which, according to some, was used by *Archimedes*. But *M. de Fontenelle* does not tell us, whether or not those connected pieces were plane mirrors, or what was the success of the attempt.

* Here my learned author goes on to sate, from *Kircher*, the facts which I have already given, in my first letter (concerning Lord *Napier's* Memoir, &c.) in vol. xviii. p. 53, &c. of this magazine. Almost the only difference is, that he cites *Kircher's Ars Magna Lucis et Umbræ*, lib. 10. par. 3. p. 765, 771 et 772. edit. Amst.; and I cite that father's *Magia Catoptrica*, as quoted by *Paulian*.—*Translator*.

† The celebrated Dutch philosopher, *Hartsoeker*, died in the year 1725. See *Paulian's Diction. de Physique*, article *Hartsoeker*.—*Translator*.

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68. "It was reserved for the genius and ability of *M. de Buffon*, to execute these machines with such happy success, that he ought to be regarded as the inventor of them; especially since we know, that, before the execution of these plane mirrors, he had not read father *Kircher**; that he used methods of his own; that he has given them some advantages; and has brought them to such a high point of perfection as was formerly unknown, and has left us nothing to wish for on the subject.

69. "What we have said only regards the recent history of this invention. If we now examine its antient vestiges, we shall find, that although it had been neglected for above 1000 years, when *Kircher* revived it in the last century, it is not on this account the less antient.

70. "*Anthemius*, who lived under the emperor *Justinian*, in the sixth century, not only contrived a way of making burning mirrors with plane ones, but found that twenty-four

* From something in the manner in which *Buffon* mentions *Kircher*, I took it for granted (Lett. I. § 1.) I thought naturally enough, that he had seen that father's book before he entered on his experiments. But, as my ingenious author thinks differently, I beg leave to lay before the reader a translation of *Buffon's* own words; of the fidelity of which he may satisfy himself by comparing it with the original (for which I have not room) in the *Mem. de l'Acad. des Sc.* 1747. pp. 144, &c. Amst. edit. "While I was employed," says that celebrated philosopher, "on these mirrors, I was ignorant of the detail of what the antients had said of them; but I was not displeased to gain information in this respect, after I had succeeded in making them. *M. Melot* of the Acad. of *Belles Lettres*, and one of the king's librarians, whose great erudition and talents are known to all the learned, had the goodness to communicate to me an excellent dissertation, which he composed on this subject, and in which he gives the testimonies of all the authors who have spoken of the burning mirrors of *Archimedes*."—"In the same dissertation of *M. Melot*, I found that *Kircher* had written, that *Archimedes* had been able to burn, at a great distance, with plane mirrors."—"In fine, in the *Mem. de l'Acad.* 1726, *M. du Fay*, whose memory and talents I shall always honour, appears to have touched on this discovery. At the end of his Memoir, he says, that some authors (he means no doubt father *Kircher*) have proposed to form a mirror of a very great focal distance, with a great number of small plain mirrors, &c."—Now I must fairly confess, that it would not be easy to convince me, that *Buffon*, a celebrated philosopher, in habits of intimacy with very many other celebrated philosophers, was unacquainted not only with the works of *Kircher*, which, as my author observes above, "are well known to the learned," but with a transaction better known to common fame than any other work of the renowned Archimedes; a transaction, I had almost said, which every school-boy has heard of. Was it not sufficiently creditable to *Buffon* to have verified that famous experiment, after it had been pronounced incredible, and even impossible, by some of the greatest judges in Europe; without aspiring at an entire originality of idea, by putting the credulity of his readers to so severe a trial?—*Translator.*

of

of these last were sufficient to produce fire. *Vitellio* assures us of this fact, in the fifth book of his optics. This passage, then, proves, that the invention is at least 1200 years old.

71. "This antiquity will be increased by 800 years, if *Archimedes* really used plane mirrors to set on fire the Roman fleet at the siege of Syracuse. Although this circumstance cannot be directly proved by any positive passage in any antient author; yet, from the words of *Tzetzes*, when speaking of this fact, we may draw arguments which will enable us to conjecture with much probability. For he says precisely, that the apparatus of Archimedes was composed of many mirrors, and that those mirrors were moveable, by means of certain planks.

72. "On this circumstance, I observe in the *first* place, that although a compound burning mirror may be formed of concave mirrors, as well as of plane ones, while it does not appear that *Archimedes* used the one rather than the other; yet we have at least as good a right to say, that his mirrors were plane, as that they were concave. A machine is more simple and more easily executed with plane mirrors than with concave ones: it is therefore more natural to think, that Archimedes composed his machine of the former than of the latter.

73. "Add to this, that to compose a burning mirror of concaves, it is by no means necessary that they be moveable; though this property be of great utility if the component mirrors be plane. For the making concave mirrors moveable will not alter their common focus, or carry it to many different distances, and consequently by their means flame cannot be produced at more than a determinate distance. Hence it follows, that when the burning point was to be carried either nearer or further off, a new and totally different machine would have been necessary, which could not but be attended with great difficulties in practice.

74. "But if the machine were composed of plane mirrors, all these difficulties would disappear: even inconveniences would vanish; the burning point might have been carried to very different distances, greater or less, as might have been required, merely by a greater or less inclination to each of the plane mirrors.

75. "The object of *Archimedes* was to produce fire at a great distance. For this end, it was necessary for him to construct it in such a manner, that he might easily make the burning point fall exactly on the Roman ships, to which he wished to set fire. The distance of those ships was always uncertain,

uncertain, and might change every minute. In order then, that *Archimedes* might succeed, it was absolutely necessary, either that he should be provided with a great number of burning mirrors of different focal distances, or with one only, the focal distance of whch he could augment or diminish at pleasure. Otherwise his success would have been left to accident; for, if the distance of the ships changed while he was directing his mirror towards them, he ran the risk of embarrassment, if he could not have altered its focal distance. Now the focal distance of concave mirrors being invariable, it is plain that if *Archimedes* had wished to use such, and had not made the distance of the focus exactly equal to that of the ships from the mirror, he would have lost all his time, trouble, and expense.

76. "But by using plane mirrors, his machine would have always answered equally well. If he had mistaken the distance of his object, he could have easily remedied the error, by only changing the position of his component plane mirrors.

77. "From what has now been said, it follows, that if it be true, as *Tzetzes* assures us it is, that the component mirrors of *Archimedes* were moveable, it is also proved that they were plane; and consequently the invention of raising flame by plane mirrors is as antient as the days of that philosopher*.

78. "In the *second* place, it is not certain, that the burning mirrors of the antients were necessarily metallic; for I shall presently prove, that they might have been of glass.

79. "*Thirdly, M. de Fontenelle* positively affirms that the antients were ignorant of the power of glass globes to magnify objects. So much indeed was he persuaded of this, that he labours to prove why they were unacquainted with this property of glass globes, while they knew their power of burning. The truth is, that they were equally well acquainted with both these properties; as is proved by this passage from *Seneca* (*Natural Quest*. lib. i. cap. 6.) *Literæ, quamvis minutæ et obscuræ, per vitream pilam, aquæ ple-*

* This argument, which I could not put into fewer words, without entirely departing from the original, is, as I take it, perfectly conclusive. It is, however, natural for me to think so; for as far as motion is concerned, the reasoning is the same, *mutatis mutandis*, with that by which I endeavoured to prove (§ 24 of my 2d lett.) that when *R. Bacon* talks of making the sun, &c. appear to us to be over the heads of our enemies, any optical instrument contrived to produce this effect on an enemy always in motion, must itself be moveable.—*Translator*.

 nam,

nam, majores, clarioresque cernuntur: Letters, although minute and obscure, are seen larger and clearer through a glass globe filled with water *."

80. "I prove also, by a passage in Pliny, that the antients were acquainted with the property of concave transparent bodies, in rendering vision more clear, and also that they possessed the art of producing this figure. What *Pliny* (lib. 37. cap. 5.) says of the emerald, appears to me decisive on this point. "*Iidem,*" (Smaragdi) "*plerumque et concavi, ut visum colligant. Quapropter decreto hominum, iis parcitur, scalpi vetitis. Quorum vero corpus extensum est, eadem qua specula ratione, supini, imagines rerum reddunt.* Emeralds are mostly concave, that they may collect the sight. Hence, by the common consent of men, they are spared, and the engraving of them is forbidden. But those which have a plane surface, being held up, reflect the images of things like mirrors."

81. "On this passage I observe, 1st, That concave emeralds were common in the time of *Pliny*; as the adverb *plerumque* (mostly) proves.—2dly, That this concavity must have been artificial; for emeralds are not naturally concave; or, if by accident one should be so, this could only happen very rarely. For the same reason, then, that concave emeralds were common, their concave figure must have been artificial; so that the cotemporaries of *Pliny* must have possessed the art of rendering emeralds concave, and of polishing them. —3dly, The phrase, *ut visum colligant*, can have no other sense in this place, than that concave emeralds were proper for rendering vision more distinct. What *Pliny* says a few lines lower (when speaking of plane emeralds, he only attributes to them the representation of images in the way of mirrors) proves that he knew that concave emeralds could assist the sight in virtue of their concavity only; and in a manner which those of other figures did not do.—4thly, If the antients knew the property of concave emeralds in assisting the sight, it was very just and reasonable to prohibit the engraving of those to which they had once given this figure. But if they were ignorant of this property, and if *Pliny's* words, *ut visum colligant,* had meant something

* In the same chapter of this first book, Seneca has these words: "*Quidquid videtur per humorem, longe amplius vero est*; Whatever is seen through a liquid is far larger than the truth." And, cap. 3 ibid. the same antient philosopher says: "*Poma per vitrum aspicientibus, multo majora sunt,* Apples are much larger to those who view them through a glass." See *Regnault, Orig. Ancien. de la Phys. Nov.* t. 1. p. 174.—*Translator.*

common to emeralds of other figures, the prohibition to engrave concave emeralds in particular, would have been ridiculous and without any reason. It is therefore established by the authority of *Pliny*, that the antients knew that the concave figure of transparent bodies gave them the property of rendering the sight more clear and distinct; and that they knew how to give them this figure, and how to polish them.

82. "Further: the antients were acquainted with the property by which concave mirrors enlarge bodies by reflection. They made such mirrors from pure curiosity, and in order to have the pleasure of seeing objects magnified by them. They even made very large ones for this purpose. To be convinced of this fact, we have only to read attentively the 16th chapter of the 1st book of *Seneca's* Natural Questions. It is also evident from the 5th chapter of the same book, that the property of concave mirrors in inverting the images of objects was known to the antients. They knew likewise, that a spectator may stand before a concave mirror, in such a position, as to see the image in the air between the mirror and the eye. For *Artemidorus* of Parinum, cited by *Seneca*, in the same book, chapter 4th, says: "*Si speculum concavum feceris, quod sit sectæ pilæ pars, si extra medium constiteris, quicunque juxta te steterint, universi a te videbuntur propiores tibi quam speculo*: that is, "If you make a concave speculum, which is the portion of a sphere, and if you stand beyond the middle of it (or further from the mirror than the centre) you will see those who stand by you nearer to you than the speculum.

83. "The art of making large mirrors was not unknown to the antients. For *Quintilian*, in the last chapter of his 2d book *De Oratore*, and *Plutarch*, in the life of *Demosthenes*, tell us, that this famous Athenian orator, when young, used to declaim before a large mirror, in order the better to regulate his gestures. *Seneca* also, towards the end of the 17th chapter of his above-cited book, says, that mirrors were made as large as the human body.

84. "The antient Peruvians, in the time of the Incas, had the art of making mirrors plane, convex, and concave, of two kinds of stone, capable of receiving a fine polish; and also, according to some, of a composition of several metals now unknown. They were all plane on one side, and concave or convex on the other. *Don Antonio de Ulloa*, who saw a great number of them in South America, says, "They were as well finished as if those Peruvians had had all the necessary machinery, and great knowledge in optics." He saw

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one whose principal surface was concave, and a foot and a half over. He says that "this mirror greatly enlarged objects, and that it was as well worked, as well polished, and as perfect, as if it had been made by one of our present skilful artists."

85. "These, however, having no immediate connexion with my principal subject, I shall not now dwell on them, but pass to other indications of the knowledge which the antient inhabitants of our own continent had of mirrors. The antients, in addition to what we have stated, possessed the art of making mirrors of glass, as is evident from a passage in *Pliny*, lib. xxxvi. cap. 26. where speaking of glass, he says, "*Aliud flatu figuratur, aliud torno teritur, aliud argenti modo cœlatur, Sydone quondam iis officinis nobili, siquidem etiam specula excogitaverat.* Some of it is figured by blowing, some turned in a lathe, some embossed like silver; Sidon having been formerly famous for such manufactures, since even *specula* had been contrived there." If we had more particular accounts of the glass-works and the manufactures of Sidon, and their arts of forming and polishing mirrors plane, concave or convex, of glass and metal, we should perhaps find out some secrets, as well as antient inventions, which we believe to be modern; and should see that the limits of their knowledge were not quite so narrow as we arbitrarily prescribe.

86. "But be this as it may, I shall now prove, that the antients possessed more than sufficient knowledge of mirrors to have furnished *Ptolemy* with that of which we speak. —We learn from experience, that the mirrors which we call plane, are not really so when strictly examined. They are almost always irregularly concave or convex, or both; and this is a necessary consequence of the manner of working them. Every intelligent artist, in preparing large object-glasses for telescopes, has frequent occasion to be convinced of this fact *. It is true that the concavities and convexities in mirrors intended to be plane, are commonly portions of very large spheres, and do not enlarge or diminish objects; so that, as to sense, they produce the same effects as if they were perfectly plane.

* I have heard that intelligent and philosophical artist, and worthy man, *Mr. Samuel Varley*, explain the cause of this inequality of plane mirrors, and indeed the whole process of grinding and polishing glasses, in a very satisfactory manner; while he was performing with his hands the work which he was describing. This method of illustrating by actual performance, the nicer mechanical operations which occur in experimental philosophy, *Mr. Varley* practises in other instances; which renders his lectures uncommonly interesting and instructive.—*Translator*.

87. "Among

87. "Among the great number of mirrors considered as plane, there are some so sufficiently and regularly concave, as to produce the effect of concaves, when the mirror, the object, and the spectator happen to be properly situated. Father *Zahn*, in his *Oculus Artificialis Teledioptricus Fundam.* 3. *Syntag.* 3. cap. 4. Prob. 6. mentions a singular occurrence which happened to a canon of Erfurt, and which proves my assertion. This canon walking one day in his apartment, happening to look at a mirror hanging on the wall, saw a crucifix as large as life, which seemed to be the same with that on the altar in his church. On changing his situation it disappeared, but when he returned to the same spot he saw it again. Looking around he could see nothing to which he could ascribe so large a figure; but at last he perceived, in an elevated situation, a small image of a crucifix; on removing which, and returning to his first situation, he no longer saw the image in the looking-glass. Not being able to account for so small an image appearing so large in a mirror, which he had always considered as a plane one, he mentioned the phænomenon to father *Zahn*, who very properly told him, that his pretended plane mirror was really concave; that the diameter of its concavity being great, it did not sensibly enlarge the faces of those who stood near it, but that, at a considerable distance, they must of course be magnified. He added, that "Plura similia, &c. Many such things occur, which appear altogether astonishing to those who are ignorant of their causes."

88. "I never yet met with a mirror, which, being accurately examined, turned out to be perfectly plane; but I have met with more than one supposed plane mirror, which were not only concave, but of a tolerably regular concavity; so that when, from a considerable distance, I viewed remote objects in them, I saw those objects sensibly enlarged without being disfigured.

89. "It is evident from *Zahn's* observations and my own, that among mirrors given to us as plane ones, we may happen to find some which are concave, whose focal distance is 30, 40, 50, &c. feet, and whose curvature is at the same time regular. I will add, that there is a greater chance of our meeting with mirrors of a regular concavity or convexity than with those which are perfectly plane. For artists, who have been long employed on large object-glasses for telescopes, know that it is much easier to make glasses perfectly spherical than perfectly plane. If necessary, it would even be easy to demonstrate rigorously, that let mirrors intended to be plane, be worked how they may, they

must

must of necessity degenerate into concavity or convexity. Yet when the diameter of their curvature is very great, and their spherical figure perfect, they ought to be considered as perfectly plane. An easy and sensible proof of this is, that none of our mirrors can be considered as more plane, even, and regular, than the surface of perfectly tranquil water. Yet this surface is really convex, the diameter of its convexity being the same with that of the globe. But a diameter of convexity of some hundred fathoms, is sufficient to denominate our spherical mirrors, plane ones.

90. "Let us now endeavour to make it appear, from what has been said in this memoir, that the existence of the mirror of *Ptolemy* is very probable; and for this purpose, each of the two following considerations is more than sufficient.

91. "*First,* It cannot be doubted, that in a city so powerful, opulent, and flourishing as Alexandria was in the days of the *Ptolemys,* mirrors were very numerous, and even very large*. It appears from history that Alexandria was then the centre of the arts and sciences; the liberality of the *Ptolemys* having attracted to it the most learned men and the most skilful artists.

92. "Without either granting or refusing to the Alexandrian arts and sciences, such perfection as the intentional fabrication of such a mirror would require, I say that it is no way contrary to probability, that in the great number of mirrors in that city, some one should be found of a concavity sufficiently regular, and whose focus, in some circumstances, might become sensible by its effects.

93. "This being so, there is nothing extraordinary in conceiving, that some philosopher or artist, happening to stand favourably with regard to the mirror and distant objects, should see those objects larger, and more clearly and distinctly, than with his naked eye; and that, after several trials, he should find the spot from which the effect was the greatest.

94. "Whether the cause of this phænomenon was known or not, is a matter of indifference, and could not hinder the knowledge of the effect, which must have been regarded as wonderful; especially if the cause was unknown. Such a mirror must have been looked upon as a present worthy of *Ptolemy Euergetes,* who having been so great a protector of the sciences, and a lover of curiosities, would recompense the donor magnificently. And it is extremely natural to suppose, that he would place it in that superb edifice, the Pharos,

* See § 83, above.

ros, where it would be more useful than in any other situation.

95. " *Secondly*, The learned of Alexandria might come to the knowledge of such a mirror, in a way which is yet more probable. It is indisputable, that the antients were acquainted with burning concaves, and with their property of magnifying objects, which was to them a source of amusement; as appears from the 16th chapter of *Seneca's* book, above quoted. Is it then impossible or even improbable, that some Alexandrian philosopher or artist, in amusing himself with viewing objects in a well-finished concave mirror, six, eight, or more inches in diameter, and eight or ten feet focal distance, should place his eye in the point from whence distant objects could be seen to the best advantage? This appears to me so clear, that I do not think any one will dispute its probability. What very much augments this probability is, that a good effect may be produced by a mirror of not more than six or seven inches in diameter, and five or six feet in focal distance.

96. " Corollary. *From what has been said, then, I conclude, that historians having positively affirmed that this admirable mirror existed, and was placed on the Pharos; and the fact, in itself, being neither impossible nor difficult, but on the contrary very probable; we have no reason whatever to condemn this piece of history as fabulous; and this is the point which I proposed to prove* *."

97. With this corollary my author closes this his sixth recreation or memoir, and I shall close the present communication. In my next, I propose to give a brief sketch of his eighth and ninth memoirs, and to conclude with some inferences from the whole of the premises. In the mean time, dear sir, I remain, very truly,

Yours, &c. *D.

* It is observable that *Abat* takes no notice of the opinion of some of the learned, (whether well founded or not I shall not inquire,) that *transparent* glass was unknown to the antient Egyptians. But this circumstance, *even if proved*, would not affect his reasonings respecting the concave mirror of the Pharos.—*Translator.*

XLI. *Six-*

XLI. *Sixteenth Communication from Dr.* Thornton, *relative to Pneumatic Medicine.*

To Mr. Tilloch.

June 15, 1804.
No. 1, Hind-street, Manchester-square.

Sir,

There is a very prevailing notion that the aërial practice is excellently suited for the cure of asthma, as the medicated airs go to the part supposed to be affected, and the common air in different places and times has a most extraordinary and undoubted operation on persons labouring under this cruel disorder.

Case of Asthma.

William Exall, æt. 44, formerly a coachmaker in Welbeck-street, residing at Headley, near Farnham, Surry, was afflicted with a most distressing asthma, as the paroxysms which came upon first going to bed would continue the whole of the night, and it was towards morning before any expectoration arose, when an hour or two of sleep might be obtained: his breathing was excessively laborious; nor did the wheezing completely go off during the following day, being more or less perceptible, and very much so upon drawing in a deep inspiration. This disease increasing in violence made Mr. Exall come up to London to be under my care; and as different asthmas require different airs, but from no very accurate criterion that I have hitherto obtained, I wished him to inhale the hydro-azotic gas equally diluted with atmospheric air, and to take some of the usual tonic medicines. From this plan the asthma was relieved in less than four days, and disappeared totally in the course of a fortnight. Upon making a deep inspiration no wheezing was perceptible; and having returned home, six months after, he again called upon me in London, and says "he has had no return of asthma, and enjoys now a better state of health than he remembers for many years past."

Observations on this Case by Dr. Thornton.

1. Some cases of asthma arise, I suppose, from a morbid irritability of the membrane which coats the lungs and adjoining parts; hence the commencement of some asthmas is shown by a continual sneezing.

2. Where this is the case, to lessen the quantity of oxygen in the air, and take off the morbid irritability of the system by tonic medicine, as bark and bitters, is the philo-

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sophic way of remedying such a complaint, and was attempted here.

3. The hydro-azotic gas is made by burning a table-spoonful of vitriolic æther under a bell-glass suspended over water, when the oxygen gets destroyed, and some of the hydrogen or inflammable gas mixes with the remaining azotic gas, producing an air of a lower standard.

4. About forty pints of this air, the nostrils being free, was inhaled daily, and always produced a great relief.

5. In another case of asthma (I hope shortly to publish) an equal advantage was derived from the vital air; but the disorder was of longer duration, and another theory of the disease will be then attempted.

In the interim, I have the honour to remain, sir,

Your much obliged and faithful servant,

ROBERT JOHN THORNTON.

XLII. *Dr.* THORNTON'S *Third Letter to Mr.* ARTHUR AIKIN, *Editor of the Annual Review.*

August 10, 1804.
SIR, No. 1. Hind-street, Manchester-square.

WE both of us stand upon the same ground, being able to boast of fathers whose celebrity is already allowed; and following their footsteps, "haud passibus æquis," when we come forward to the public view we are "*tremblingly alive*" not to sully a name they have honoured. As public lecturers, both of us cannot but be sensible how distressing it must be to be publicly accused "of not understanding the sciences we pretend to teach:" also, as your brother Mr. Charles Aikin, surgeon, has compiled a book, like myself, in favour of vaccine inoculation *, undoubtedly with the same disinterested motive, and is, with myself, an honorary member of Guy's Medical and Physical Society, and probably, we may boast also of having had him as a pupil to that medical school, where I now have the honour of being one of the teachers,—it must have been doubly galling for me to see your name affixed as editor to an attempt to hold me forth to the world "as a man of the weakest memory," p. 876; "of the most impetuous and desultory imagination," p. 876; "of judgment

* Had I been previously acquainted with this little work, I might have spoken in mine in praise of its utility, and as such recommended it to the public.

ment the most deficient," p. 876; " the inventor of an unheard-of moon," p. 880; " vain," p. 882; " insufficient," p. 882; " ignorant of botany;" passim; my whole labours " a national dishonour," p. 880; and other such passages of personal abuse, disgracing, I presume, the character of a review *. More than twice did I turn to the title, to see whether your name was really affixed as the editor; and when I contemplated the weakness, or rather ignorance, of the sneers, I cannot call any part of this review, argument, but the whole as designed and ignorant abuse, I was astonished!—So public, so open, so violent an attack, either demands your assent or dissent; and I am persuaded you possess too much justice in your character not freely and chearfully to retract all such charges of "ignorance" against me, as I shall be able satisfactorily to prove to you to be completely groundless. The duties of an editor certainly make you in this affair a party concerned, and my only anxiety has been, I assure you, to see myself so attacked in a work wherein your respectable name was prefixed to it as the editor; and it would, I am persuaded, redound more to your honour, to acknowledge " hits," when these are fairly obtained, and for you afterwards to come handsomely forward and " repair" the injury occasioned, than to continue to *lessen the fortune*, and *wound the feelings*, of one who hopes and trusts he deserves from the family of the Aikins † a far different treatment.

* Nothing can be better drawn up than the imperfections of a review, p. 648, of the Retrospect of Domestic Literature, in the supplementary number of the Monthly Magazine for July, so easily do we see the moat in our neighbour's eye. " The *Anti-Jacobin Review* gives offence to the moderate, the well-meaning, and the well-mannered of both parties. They make no distinction between the calm investigations of a philosopher and the factious philippics of a demagogue. The *Edinburgh Reviewers* are also unsparing in severity and bitterness of expression. They seem to take delight in saying severe and ill-natured things, and the feelings of an author are wounded by them with the most frigid and callous indifference. The palpable partiality uniformly shown by the Edinburgh reviewers towards Scotch authors, is an evidence that they are not above the influence of personal feelings!!"

† Dr. Aikin, the celebrated biographer, is the *editor* of the Monthly Magazine. In the supplementary number, published July 28, p. 649, the writer of the Retrospect of Domestic Literature, with, I suppose, the approbation of Dr. Aikin, says: " This work (The Temple of Flora, with the New Illustration) was not intended for the common class of readers. It is dressed out for the levee and the drawing-room of princes and nobility. The *plates* are finished with *exquisite delicacy*, and will *immortalize* the *vanity* and *insufficiency* of Dr. Thornton." Compare what was previously said in the same magazine for May, p. 349. Speaking of this work, it was there declared, " that it encouraged the fine arts;

 that

ment. From a critic I do not sue for lenity. This character (who guides the balance betwixt the author and the public) I hold as sacred, and we all bow before the tribunal. But previous to judgment being awarded, and sentence of condemnation on the author passed, the mind of the critic should be unclouded by prejudices, and the equity of the decision certain. Much honour, otherwise, must be lost; and when it is said, "that to acknowledge an *error* is an acquisition of *glory*," it is only when with such confession a becoming apology is given, and then the honour is in the apology,—which has not been made, nor do I expect it from the reviewer you engaged,—but it would come handsomely from you, if you think, *in foro conscientiæ*, that I have refuted the charges against me.

In my last letter I might have mentioned, that my Temple of Flora, or Garden of Nature, was intended partly as a supplement to Dr. Darwin's beautiful poem, The Botanic Garden. In this part of my work will be found, 1. the Passifloras Cœrulea; 2. Alata; 3. Quadrangularis; 4. Renealmia; 5. Dragon Arum; 6. Oblique-leaved Begonia; 7. Pontic Rhododendron; 8. Hirsute Stapelia; 9. Carnations; 10. Auriculas; 11. Hyacinths; 12. Meadia; 13. Limodorum; 14. Strelitzia Regina; 15. Narrow-leaved Kalmia; 16. Nelumbium speciosum; 17. Nymphæa Lotos; 18. Pitcher-plant; 19. Superb Lily; 20. American Aloe, &c. flowers not so much as named by Dr. Darwin in his immortal poem. To each description of these flowers by me, some friendly muse has kindly furnished appropriate verses. Besides the contributions of the late Dr. Darwin, Dr. Shaw, of the British Museum, the Rev. Mr. Maurice, of the British Museum, Miss Sheeles, George Dyer, &c., I have just received some beautiful lines, on the Strelitzia Regina, from the Poet Laureate. "*I wish*," says Mr. Pye, "*they were more worthy of your splendid work, and the illustrious company of poets who have contributed their labours to it.*"—In order to blend the "utile" with the "dulci," each flower there represented has been carefully dissected by me, and faithfully delineated under my own eyes; and

that the arts and sciences having a kind of relationship, and being connected, as Cicero expresses it, by a chain, explain and mutually assist each other; and further, that such productions are monuments of the state and progress of the arts in any given period: as such it was recommended to persons who, with a taste for the polite arts, possess also the means of indulging it; and to public libraries, the archives of what is curious in a country; and even as a *shew-book* of the two universities, to foreigners who might visit the head seats of science."

these

these dissections have met with the full encouragement of professors Martyn, Rutherford, and Dr. Smith—in short, with the approbation of all who are conversant with art and science. The rest of my botanical plates are, I believe, superior to those of any former work. Am I accused of "vanity" because these have met with universal approbation? I acknowledge the crime; and as St. Paul boasted what he had undergone for the cause of religion, so I feel an exultation in what I have attempted for the cause of botany. I am proud that, when Dr. Smith quitted the chair at Guy's Hospital, he kindly said, "that so handsomely elected to this station, he would not have quitted the duties of it unless he had found one fully adequate to fulfill them." I am proud when such a man as the Rev. Mr. Martyn, the professor of botany at Cambridge, equally incapable of false flattery, writes to me, that "all my botanical works are admirably adapted to improve our favourite science, and meet with his approbation." I am proud when Dr. Rutherford, the professor of botany at Edinburgh, also writes to me, "anxiously do I wish that you shall meet with suitable encouragement, and enjoy health and leisure to enable you to finish your noble undertaking." I am proud of the testimonies of men of sterling merit, "Laudari bonis viris est vera laus;" nor do I refuse the pleasure that even any part of my works, for the plates constitute some part, are capable of extorting from your reviewer more than faint praise. My father, Bonnell Thornton, was the first who persuaded Churchill to write; and unless I had brought forward these choice representations of select flowers, the lyres of several of our first English poets on subjects of botany might have remained unstrung: and as a Laura produced the sonnets of a Petrarch, so my work has drawn forth the most charming effusions on the sweetest flowers from heaven-born poets; sounds which, if they cannot touch the strings of your reviewer's heart, might even rejoice his "dancing cows." I am proud that such a man as Dr. Thomson, speaking publicly of my medical work, should say, "Thus have we given a brief analysis of the *Philosophy of Medicine*, or *Medical Extracts*, which will be found of the highest use to all those who are desirous of *preserving or regaining the invaluable blessing of health.* It is the *best work* on the subject in *any language:* it is the production of a mind, learned, comprehensive, candid, open to, and desirous of, information; cautious in investigation, yet resolute to embrace the truth; a friend to mankind, ardent in his hopes, as in his efforts, for increasing the stores of knowledge; and particularly inte-

 rested

rested in the general adoption and success of *Pneumatic Medicine:* of the advantages of which the author (for he has drawn from the facts of others his own conclusions, and incorporated his own observations) entertains almost unbounded expectations, showing evidently that temperament which accompanies *genius*." (English Review.) Afterwards, when dining at the veterinary professor's, the Doctor acknowledged he did not know at the time who was the author, but imagined it to "have proceeded from the masterly pen of a Beddoes or a Darwin." I am proud that the late Dr. Cruickshank proclaimed this work as one "that would do credit to the knowledge of the first medical character in England," (see his work on Perspiration;) and he was astonished at my period of life, when I afterwards informed him I was the author. I am proud that this work still continues to be recommended from the chairs in the different universities. I am also proud that my earliest production, the *Philosophy of Politics*, or *Political Extracts*, was handsomely spoken of in the Critical Review. "When we took up this work, we expected," say they, "to find it an *ephemeral* production, devoted, as usual, to some party or other, and we were agreeably disappointed in our expectations, and with pleasure discovered it to be a work planned *with the best designs possible*, executed *with the greatest propriety*; and noticed throughout *the traces of a sound, discerning mind, neither led away by the delusive theories of modern times, nor yet a slave to antiquated prejudices*. The author has made a very *excellent use* of the writings of the *best politicians*, and brings the most *valuable parts* of their *several works* to bear on the subjects most deserving political inquiry; thus constituting, upon the whole, a most *excellent compendium* of *general political science*." I am even proud that I have stemmed, in part, the difficulties of the most adverse times, and though greatly reduced in my patrimony from my works, and hourly sinking yet more of my principal in my unprofitable, yet grand, botanical undertaking, that under these losses I still persevere*, and ultimately

* After the publication of the Annual Review, every one cried out that my work was ruined,—as Linnæus reports, "That it was in the mouth of every one, that Sigesbeck had overthrown him." "He has been unfortunate enough," says Dr. Smith, president of the Linnean Society, "to be always held forth as the botanic Zoilus; but I think there have been some critics, even in our own country, who for futility, ignorance, and malevolence, would have much greater claims to that title, if they were of consequence enough to claim any title at all." It is unfortunate for science when such men can influence the public opinion and guide their

timately hope that, from the kind countenance of the public, my *Temple of Flora* and *Philosophy of Botany* will surmount the assaults of my enemies, and pass down to posterity approved. Yet am I still conscious that I have no other merit but that of patient industry, and that my works will be found to be established chiefly by the genius of others; and all I assume is taste, sufficient to feel, and judgment, to discriminate where true merit lies, and a capacity, to blend it with my labours. Those, sir, who know me personally, see nothing in me of the arrogant coxcomb, nothing of empty vanity, but only a laudable zeal, such as have inspired the Aikins *, to *amuse* and *instruct*

their taste. Sorry am I to say, that in consequence of this review, many of my subscribers have relinquished my work, many impertinent anonymous letters have been written to me, and I am reluctantly obliged to come forward in my own vindication, and claim a merit which I had much rather leave to others than publish myself. But the occasion demands some answer, and I endeavour to acquit myself as well as I am able. Thus it was Pope overcame by his *Dunciad* his rancorous and numerous enemies.

* Dr. Aikin has even lately condescended to publish a Series of Letters to a young Lady on a Course of English Poetry. "To the *many* and *substantial obligations* which the rising generation owes to Dr. Aikin, he has now added *another*, namely, this publication. The correctness of Dr. Aikin's *taste*, poetical and moral, united to his sound and discriminating *judgment*, admirably qualifies him as a guide through the mazy and seductive paths of poetry. The *utility* of such a work as the present must forcibly impress any one who reflects on the vast and increasing number of English poets, whose volumes solicit the perusal of young persons. To have the best authors pointed out, their beauties and defects examined and unfolded, and the tendency of their works exposed, are *immense advantages* to young persons who are entering on a course of English poetry. Dr. Aikin does not assume the office of a *master*, requiring that his pupils should damn where he censures, and extol when he approves: his object is to *form* their *judgment* and *improve* their *taste*, in order that they may themselves be trusted with the delicate task of selection; at the same time pointing out those sources from which the finest sentiments may be imbibed, and the most pure, harmonious, and appropriate language learnt."—From the *Retrospect of Domestic Literature in the Monthly Magazine for July* 1804.—To all which praise I cordially assent, and, from my heart, have the highest opinion of Dr. Aikin and his family. It has ever been a privilege allowed to authors so sell their publications, for reports to be made on them, and these to be circulated, without vanity being imputed on that score. Also it may be said:

> Sweet is the concord of harmonious sounds,
> When the soft lute or pealing organ strikes
> The well-attemper'd ear; sweet is the breath
> Of honest love, when nymph and gentle swain
> Waft sighs alternate to each other's heart:
> But not the concord of harmonious sounds,
> When the soft lute or pealing organ strikes
> The well-attemper'd ear; nor the sweet breath

Of

struct mankind; and posterity will determine how far my labours will have attached to them "national infamy," or some small degree of praise.

Quitting the "*dancing cows*," a story designed to humble my vanity, I shall descend now to your reviewer's remarks on my *pig story*, which may lessen his boastings as to pretensions to knowledge in natural history. I leave my Botany to the last, as the public will, for the present, allow me some credit for that.

After having traced the analogy of the seed in the seed-vessel, fixed to it by a cord resembling the umbilical cord, attaching the fœtus to the uterus, I compared the lobes, or seminal leaves, in their office, after the most celebrated botanists, to the mammæ, or dugs of animals. Here your reviewer observes: "But no *absurdity*, or *opposition to fact*, can stop the doctor in his ardent pursuit of analogies *. As the number of cotyledons, we beg his pardon, [*a sneer*] of mammæ or breasts, is different in different seeds, 'it is thus,' he observes, 'with the parent animal which possesses one or more dugs.' This all the world knew. But *we*, *at least*, *did not know* that 'the number of dugs is always *proportioned* † by nature to the offspring to be produced; and that it may be remarked, as, in a litter of pigs, each pig always goes to its own dug and never usurps that of another, so children, when first born, show the same partiality towards one breast.' If this were strictly and universally true, the *cow* must have at one birth *at least double the young* of the *human mother*; whereas both of them

Of honest love, when nymph and gentle swain
Waft sighs alternate to each other's heart,
So charm with ravishment the raptur'd sense,
As does the voice of well-deserv'd *report*
Strike with sweet melody the conscious soul!

Dr. ROBERTS.

* The reviewer should have added, "that Dr. Thornton makes these lobes or seminal leaves of the greatest importance to the young plant; for, when removed, this indeed grows, but is dwarfish, weak, and steril. In his note to these experiments, he remarks, this vegetable fact may teach us a truth respecting the rearing of our own children: the babe requiring that food which nature has kindly provided for him. It is in vain, he continues, that *this analogy* be shown to the *inconsiderate*.

For *you* no Dryads dress the roseate bower,
For *you* no Nymphs their sparkling vases pour,
Unmarked by *you*, light Graces swim the green.

It cannot, however, fail to strike *those*

———Whose mind the well-attemper'd ray
Of *taste* and *virtue* lights with purer day;
Whose *finer sense* each soft vibrat on owns,
With sweet responsive sympathy of tones." DARWIN.

† I never said, *exactly proportioned*.

have

have generally only *one*, and the woman, we believe, has *twins* more frequently than the *cow*. We have *consulted* * those who have had more experience in these matters than ourselves, and are assured that new-born children do not show a partiality for one breast, but, which may easily be explained on *other* principles, *are often found to incline to that which they sucked last*. Were we even to admit the doctor's assumption as a *fact*, to make it harmonize with his system, a woman should always bear *twins*, each of which should have exclusively its own breast."

I would here beg your reviewer to read what is said in the Elements of Natural History, (published for Cadell jun. and W. Davies, and William Creech, Edinburgh, 1801,) p. 66:—" The breasts or dugs (*mammæ*) of these animals, in which the milk is secreted from the blood, are furnished with teats or nipples, which the young suck. The dugs are

* As this reviewer is extremely fond, in all difficulties, of *consultation*, the philosophic world would wish to know a little of the nature of these wise men he consults, as described by the reviewer himself, p. 834. When reviewing Dr. Shaw's work, the writer says: " It is pleasant after a short separation to rejoin an intelligent fellow-traveller, from whose extensive acquaintance with the country, and liberal communications concerning it, we have already derived much entertainment and instruction; and though we are not likely to accompany him again through scenes equally luxuriant and romantic, we still associate with his person the prospects which we have formerly enjoyed, and find something to delight us in our passage over many a dreary heath. With sensations of this kind we take up the fourth volume of Dr. Shaw's General Zoology. We recognize the countenance and manners of an old friend. We enter at once into his style of composition; and though his present subject may not promise us all the satisfaction which the former part of his work afforded, *we are persuaded* that we *shall not rise* from it *disappointed* and *displeased*." This consistent reviewer, in a page or two after, coming to the genus *Holocentrus* and *Bodianus*: " Here," cries the reviewer, " we confess *ourselves* to be completely *posed*. We had learnt, indeed, something concerning the size and colour of the scales; but as far as relates to these, any one of the species might be placed with equal propriety under either of the genera; and with respect to their roughness or smoothness, we were still as much at a loss as ever. Conceiving that we must have overlooked some part of the description, and attributing the oversight to the infirmity of eyes impaired by the midnight watchings of many years, we first *trimmed our lamp*; then *wiped our spectacles*; and then took down *a pair of greater magnifying power*, which we use only *to mend our pen* and on other *special occasions*: (he should have added, and blew *our* noses, to *clear our heads*;) but all to no purpose. As our last resort, we applied to all our fellow critics " in solemn divan assembled:" but still in vain. The difficulty was no sooner stated, than every one, as if animated by one soul, rapidly exclaimed, *Davus sum, non Œdipus: it is a knot which none but a god, or one inspired by the gods, can untie*. To be serious; generic characters *so constructed* are a *disgrace* to *science*. They assume a *scientific appearance*, but they teach *nothing*."

in pairs, either at the breast (*mammæ pectorales*), or on the belly (*abdominales*), or between the hind feet (*inguinales*). *In general, their number is equal to the number of young which are commonly brought forth at a time.*" Your reviewer even, though bred a cockney, in some of the environs of London might have observed the fact. The first pig born is the largest, and assumes the foremost rank in sucking; the last pig born is the least, and has a particular name, and takes the rear. Every pig, therefore, demands and fights for his own dug; and when any one pig is killed for a roaster, that very dug then dries up, and only so many swollen dugs furnishing milk remain as there are living pigs. How sightless it would have appeared had the beautiful human form been, like the figure of Isis, furnished, like the mother sow, with breasts down the whole body! The word *dug* means the breast of a beast, and when applied to the woman it is in derision, and to excite disgust. Thus Spenser:

> ——————————Of her there bred
> A thousand young ones, which she daily fed,
> Sucking upon her poisonous *dugs*; each one
> Of sundry shape, yet all ill favoured.

So Cowley:

> *Envy* at last crawls forth from that dire throng,
> Of all the direfull'st; her black locks hung long,
> Attir'd with curling serpents; her pale skin
> Was almost dropp'd from the sharp bones within;
> And at her *dugs* stuck vipers, which did prey
> Upon her panting heart both night and day,
> Sucking black blood from thence, which to repair,
> Both night and day they left fresh poison there;
> Her garments were deep stain'd in human gore,
> And torn by her own hands, in which she bore
> A knotted whip and bowl, that to the brim
> Did with green gall and juice of wormwood swim;
> With which when she was drunk she furious grew,
> And lash'd herself. Thus from the accursed crew,
> *Envy*, the worst of fiends, herself presents;
> *Envy* *, good only when she herself torments.

* The Rev. Dr. Milne, author of the Botanical Dictionary, writing to me on this controversy, says: "Dr. Thornton will console himself on this and other such invidious occurrences, which men of talent must expect to encounter from the conjoined efforts of ignorance, malevolence, and a narrow mind, with the fine observation of the poet:

> "*Envy* does merit as its shade pursue,
> "But, like the *shadow*, proves the *substance* true." Pope.

Now,

Now, your reviewer has described the *cow* as having four dugs or breasts, whereas the *cow*, in fact, has only one stock, or udder, and four teats. The word dug, as the Elements before mentioned would have taught him, is the breast of a beast, and teat is its appendage; for, when applied, as above, to the female form, it is in derision; and the word breast is used for the human subject, and its appendage is the nipple. The *cow* and the *woman* here are not therefore at all objects of comparison; and he might have learnt, p. 123 of the same Elements, "that when a cow happens to have two calves, one of them a male the other a female, the former is a perfect animal, but the latter is incapable of propagation, and is called by farmers a *free-martin*."

When speaking of the undoubted instinct of young pigs, I only casually mentioned, in the same note, that infants oftentimes showed the like partiality for one breast, and probably from the same instinct.

As your cockney reviewer seems as ignorant as the London painter, who represented his partridges billing, and perched upon a spreading oak-tree, I must, for his sake, trace a little further this subject.

When a ewe dies, leaving the bleating lamb, the other ewes would beat this off, even the one that had lately lost its own. Shepherds under such circumstances take off the skin of the dead lamb, and sewing it on the body of the living orphan bring it to the ewe so habited; who smelling the fleece, supposes its dead one restored, and cherishes the orphan whom otherwise she would have rejected.

So with fowls; one brood is put under a hen with another brood, and the first hen kept out of the way. This is impracticable in the day-time; the second hen would kill all the stranger chickens: but not seeing them at night, they partake by morning of the smell of the first, and she knows not the difference.

It would be endless to give instances of my own and others' observations of the prodigious sagacity of divers animals in hunting, particularly hounds, setting-dogs, &c. one therefore shall suffice of Mr. Boyle's, viz. "A person of quality, to make a trial whether a young bloodhound was well instructed, caused one of his servants to walk to a town four miles off, and then to a market-town three miles from thence. The dog, without seeing the man he was to pursue, followed him by the scent to the above-mentioned places, notwithstanding the multitude of market-people that went along in the same way, and of travellers that had occasion to cross it. And when the bloodhound came to the chief market-town he passed through the streets without taking notice of any of the people there, and left not till he had gone to the house, where the man he sought rested himself, and found him in an upper room, to the wonder of those that followed him."—*Boyle determ. Nat. of Effluv.* c. 4."

That most accurate observer of nature, Linnæus, has remarked "that the cow eats 276 species of plants, and rejects 218; the goat eats 449, and rejects 126; the sheep eats 387, and rejects 141; the horse eats 262, and rejects 212; but the hog, more nice in its taste than any of the former, eats but 72 plants, and rejects all the rest."

The wonderful narrative of Galen is familiar to every physician. "Nature," says this author, "forming, fashioning, and perfecting the parts of the body, hath so brought it to pass, that they should of themselves, without any teaching, set about and perform their proper actions; and of this I once made a great experiment, bringing up a kid without ever seeing its dam. For, dissecting some goats big with young, to resolve some questions made by anatomists concerning the œconomy of nature in the formation of the fœtus in the womb, and finding a brisk embryon (young one), I loosened it from the matrix after our usual manner, and snatching it away, before it saw its dam, I brought it into a certain room having many vessels full, some of wine, some of oil, some of honey, some of milk, or some other liquor; and others, not a few, filled with all sorts of grain, as also with several fruits, and there laid it. This embryon we saw first of all getting up on its feet and walking, as if it had heard that its legs were given it for that purpose; next shaking off the slime it was besmeared with from the womb; and moreover, thirdly, scratching its side with one of his feet: then we saw it smelling to every one of those things that were set in the room, and when it had *smelt* to them all, it supped up *the milk*; whereupon we all for admiration cried out, seeing clearly the truth of what Hippocrates saith, that the natures and actions of animals are not taught, but by *instinct*. Hereupon I nourished and reared this kid, and observed it afterwards not only to eat milk but some other things that stood by it. And the time when this kid was taken out of the womb being about the vernal equinox, after some two months were brought unto it the tender sprouts of shrubs and plants, and it again *smelling* of all of them, instantly refused some, but was pleased to taste others; and after it had tasted, began to eat

of

of such as are the usual food of goats."—*Galen*, lib. vi. cap. 6.*

By smell the dog discovers the truffle, although the root be buried deep under ground.

The huntsman who means to surprise the wild boar, is obliged always to proceed in a contrary direction to the wind.

Crows are said to smell gunpowder half a mile off.

If a moth be put into a box, and the top be covered with gauze, and placed any where in a garden, other moths of the same species are sure to be conducted there and taken in the place.

Having the Hirsute Stapelia in my drawing-room, which smells like carrion, the window being opened, in less than five minutes above ten blow-flies were killed on the plant in the act of blowing it.

In a place where there is a decoy for ducks, the master approaches it with a piece of burning peat on a fork before his mouth, or every duck would at once rise, by knowing the enemy's advance from his breath. Out of revenge a man, half a mile off, put a little assafœtida in his pipe, and not a duck but took flight, and left the decoy-yard from a dislike to the smell.

The attachment, on the contrary, of cats for valerian, and their perception of it at a distance, is a well known fact.

The agency of smells in the animal œconomy has been too little considered.

Haller, whose authority is great, says "that infants are first conducted to the breast from *instinct* alone, before they possess the least understanding."

* Ἡ διαπλασασα τε και τελειωσασα φυσις ειργασατο χωρις διδασκαλιας επι οικειαν ενεργειαν ερχεσθαι· και βασανον γε τουτου μεγιστην εποιησαμην ποτε θρεψας εριφον, ανευ του θεασασθαι ποτε την κυησασαν· αιγας γαρ εγκυμονας ανατεμνων ἑνεκα των εζητημενων θεωρηματων τοις ανατομικοις ανδρασι περι της κατα το κυουμενον οικονομιας, ἑυρων ποτε γενναιον το εμβρυον, ἀπελυσα μεν της μητρας ὡσπερ ειωθαμεν· ἁρπασας δε πριν θεασασθαι την κυησασαν εις οικον μεν τινα κομισας κατεθηκα, πολλα μεν εχοντα λεκανια· το μεν οινου, το δε ελαιου, το δε μελιτος, το δε γαλακτος, ἠ αλλου τινος ὑγρου πληρες, ουκ ὀλιγα δ' αλλα των Δημητριων καρπων, ὡσπερ δε και των ακροδρυων· εθεασαμεθα δε το εμβρυον εκεινο, πρωτον μεν βαδιζον τοις ποσιν, ὡσπερ ακηκοως ἑνεκα βαδισεως εχειν τα σκελη· δευτερον δε αποσειομενον την εκ της μητρας ὑγροτητα, και τριτον επι τουτῳ κυσαμενον ἑνι των ποδων την πλευραν, ειτ' οσμωμενον ειδομεν αυτο των κειμενων κατα τον οικον ἑκαστου, ὡς δε παντων ωσφρατο του γαλακτος απεροφησεν, εν ᾧ και ανεκραγαμεν ἁπαντες, εναργως ὁρωντες ὁπερ Ἱπποκρατης εφη, φυσεις ζωων αδιδακτοι. Και τοινυν και ανεθρεψαμην εκεινο το εριφιον, ειδομεν τε προσφερομενον ὑστερον ου το γαλα μονον, αλλα και αλλα τινα των κειμενων· οντος δε του καιρου καθ' ὁν εξηρεθη της μητρος ὁ εριφος, εγγυς της εαρινης ἰσημεριας, μετα δυο που μηνας εισεκομισαμην αυτῳ μαλακους ακρεμονας θαμνων τε και φυτων, ὡν παλιν και αυτων οσμησαμενον ἁπαντων, ενιων μεν ευθεως απεστη, τινων δε ηξιωσε γευσασθαι, και γευσαμενον επι την εδωδην ετραπετο των και ταις μεγαλαις αιξι συνηθων εδεσματων.

"The

"The babe," says the illustrious Dr. Darwin, "soon after it is born into this cold world, is applied to its mother's bosom; its sense of perceiving warmth is first agreeably affected; next *its sense of smell is delighted with the odour of her milk*; then its taste is gratified by the flavour of it; afterwards the appetites of hunger and thirst afford pleasure by the possession of their object; and lastly, the sense of touch is delighted by the softness and smoothness of the milky fountain, the source of such a variety of happiness."

Unless smell directed, how should the calf immediately raise itself up, and at once fix where its nourishment is lodged?

Is it not more reasonable to suppose *instinct*, enabling to discriminate the difference of two breasts, in the child, than *understanding?*

Who taught it first how to suck?

For the child to *remember* the breast last sucked, is less credible than to be led on by *instinct*.

Analogy in matters of difficulty must be resorted to when we cannot prove it otherwise.

Surely what I have advanced is not deserving to be ranked as "absurd," and "contrary to fact;" and whenever your reviewer goes out of his way to attack me, (for it was only casually mentioned, like the satellite of Venus, in a note,) he is sure to stumble, and evince not mine, but his own "insufficiency."

I have the honour to remain, sir,
With respect and esteem,
Your faithful obedient servant,
ROBERT JOHN THORNTON.

XLIII. *Method of preparing the Chinese Soy, by M.* DE GRUBBENS: *extracted from the Memoirs of the Academy of Sciences at Stockholm for* 1803, *first Quarter, by M.* LINDBOM, *Captain of the Swedish Mines**.

THE Transactions of the Swedish Academy for the year 1764 contain a description of the method of preparing soy, by the late captain Ekeberg; but as this description is incomplete as well as incorrect, since the real Chinese soy will not be obtained by following it, I am fully persuaded that

* From the *Annales de Chimie*, No. 148.

that M. Ekeberg never saw, nor was acquainted with, the true process for preparing this substance. There is reason to believe that he gave his description from the accounts of the Chinese, who are not always ready to speak the truth, as I observed during the five years I resided in China, when I wished to obtain complete information in regard to the method of managing a certain kind of silkworm which spins five or six times every year; the method of dyeing silk and cotton, and various other particulars in regard to the Chinese œconomy.

Having since obtained, for a very high price, certain information in regard to these points, I have seen how much their accounts differed from the truth. The case was the same when I wished to be made acquainted with the preparation of soy; but as I have now procured a very correct account of it, I think it my duty to communicate it to the Academy.

Soy is prepared from a kind of beans which are whiter and smaller than those of Turkey, the farina of wheat, salt, and water. The proportions are, 50 pounds of beans, 50 pounds of salt, 60 pounds of the farina of wheat, and 250 pounds of water.

After the beans have been well washed they are boiled with well water in an open pot for some hours, or until they become soft enough to be kneaded with the fingers. During the boiling they must be always covered with water that they may not be burnt. Care must be taken not to boil them too much: if they are diluted, too much of the substance remains in the juice. When the beans are boiled they are put into large flat wooden tubs, or, as the Chinese do, into vessels made of thin broad splinters of bambou, two inches and a half in depth and five feet in diameter. In the latter they are spread out to the depth of two inches. When they are sufficiently cooled to be touched with the hand, the farina of wheat is added, and well mixed with them; and this is continued till the whole farina is exhausted. When the mass becomes too dry for the farina to adhere to the beans, a little warm juice is added.

When the whole is well mixed the mass is spread out in the tubs above mentioned, taking care that the strata are not more than an inch or an inch and a half in thickness. The mass is then covered by placing over it a lid which exactly closes it. When it is observed that the mass becomes mouldy, and that heat is disengaged from it, which takes place in the course of two or three days, the cover must be raised up by placing two rods below it in order that the air may have freer access. In the mean time a rancid odour is exhaled. If the mass assumes a green colour, it is a sign that every thing goes on well; if it begins to grow black, the cover is raised a little more, in order that the mass may be more in contact with the air. When the mass becomes completely black it is entirely spoiled.

As soon as it is observed that the whole mass is green and mouldy, which is generally the case in eight or ten days, the cover is removed, and the mass is exposed for some days to the air and the sun.

When the whole mass has become hard like a stone, it is cut into small fragments, which are thrown into an earthen pitcher, and 250 pounds of water, in which 50 pounds of salt are dissolved, are poured over them. The whole is well stirred; and the height which the water occupies in the pitcher is noted. In case one pitcher is not sufficient, the mass is put into several, taking care that each be proportioned to the quantity of the matter.

When the pitcher is thus filled it is placed in the sun. The matter must be regularly stirred and shaken every morning and evening, but at night care must be taken to put the cover on it to preserve the mass from the cold. This cover is made convex on the outside that the rain may more readily run off from it, and it is employed also in the day time when it rains. The greater the heat of the sun, the more the preparation of the soy is accelerated. This operation in general is undertaken only in summer, and yet it continues for two or three months.

In proportion as the mass decreases by evaporation, well water is added, and this is continued till the salt water has entirely dissolved both the farina and the beans. The pitcher is then left some days longer in the sun, in order that the solution may be so much the more perfect, as on this depends the good quality of the soy, and even during this time the matter must be stirred every day.

When the mass has become very succulent and oily, the whole is poured into bags, which are pressed to squeeze out the soy, which is then pure, and ready to be employed. It is not boiled, as M. Ekeberg asserts. It is then put into bottles, which are well closed. The Chinese who deal in this article put it into large pitchers. The soy before it is squeezed out is of a dark brown colour, but it afterwards becomes black.

The Chinese prepare from the refuse that remains two other kinds of soy. The first time they add 150 pounds of water and 30 pounds of salt: having squeezed this mass, they again pour over it 100 pounds of water and 20 pounds of salt, proceeding always in the same manner as above described.

The last two kinds are not strong, but very salt; especially that of the last extraction, the colour of which is also clear. These two kinds are the commonest in China. The difference between them is as 8, 4, 1.

In the year 1759 I prepared in this manner, in my lodgings at Canton, all the soy which I employed. I even brought some bottles of it to Sweden: it was succulent, oily, moderately salt, and entirely different from that usually sold in Europe: in regard to its taste it was equal to that of Japan, which is generally considered as the best.

This description is the more certain, as I always executed the preparation myself: I will even venture to assert, that it is that used to obtain soy of the best quality.

M. Ekeberg asserts that the soy is boiled, and that sugar, ginger, and other spiceries are added: but this is void of foundation and cannot be true, since a Chinese pound of soy does not cost more than two *canderins* Chinese money, which are equal to $1\frac{1}{3}$ skilling Swedish*. This was the usual price during my residence in China, and there is no reason to believe that these ingredients were employed in the preparation of it. Besides, soy has no taste either of sugar or of spiceries; the prevailing taste is that of salt.

XLIV. *Memoir on some rare Fossils of Vestena Nova, in the Veronais, not yet described, which were given to the Museum of Natural History at Paris by* M. DE GAZOLA. *By* FAUJAS-SAINT-FOND†.

THE collection of fossil fish found at Vestena Nova, in the Veronais, with which the Museum of Natural History is enriched, must be considered as unique in its kind. To employ the same constancy and activity in research that M. de Gazola has done, one must be animated with a noble enthusiasm for the advancement of that knowledge which relates to the theory of the globe; one must possess the same fortune and disinterestedness to sacrifice large sums for the acquisition of cabinets, and to cause researches to be made for thirty years, in the bosom of a mountain covered with lava. It was in this manner that this naturalist

* A canderin is equal to about 3 sous $7\frac{1}{2}$ deniers French money.

† From *Annales du Museum National d'Histoire Naturelle*, No. 13.

 obtained

obtained the most numerous collection of this kind which an individual could procure; at present it forms one of the principal ornaments of one of the galleries of the Museum of Natural History; M. de Gazola still proposes to enlarge it, by generously adding to it the fruit of his new researches. Being desirous on the other hand to render his discoveries more generally useful, he has caused to be engraved the different and numerous species of these ichthyolites, in a work, the publication of which he has entrusted to the canon Volta, of Mantua, a learned naturalist, much versed in the knowledge of fish*. There are found in the stones which contain the fossil fish of Vestena, plants of the family of the ferns, the mimosa, and other terrestrial plants, which prove, that at the period when these fish were living, in the bosom of the sea, the waters did not cover the whole surface of the globe; and that there were parts of the earth, and perhaps even whole continents, more or less elevated, where vegetation was able to develope a part of its riches.

Does not this truth, proved not only at Vestena Nova, but at Ættingen, Pappenheim, Rochesauve, and by the argillaceous schists which cover the coal mines, clearly show, that, since plants and quadrupeds then existed, as is attested by several instances, there must at the same time have been birds? I know that the facility with which birds can fly, may often rescue them from the danger of perishing in the water, and that those which are aquatic are still in less dread of that element; *Ornitholites*, therefore, have hitherto been very rare, some naturalists even have denied their existence.

That in the cabinet of Darcet, a figure of which has been given in the *Journal de Physique*, along with a memoir of Lamanon, has not been admitted either by Camper or Fortis: I have examined it several times, but still entertain great doubts on the subject. The same Journal for the month of Thermidor, year 8, contains an engraving of an ornitholite, or rather the impression of a bird found in the plaster-quarries of Montmartre: this fragment belongs to M. Alluin of Abbeville. As no person, however, at Paris ever saw the original, and as M. Alluin has given no description along with this figure, it will be prudent to wait for further details; if the drawing, however, be correct, one cannot help observing the two legs of a bird.

† Ittiologia del Musco-Bozziano, ora nanesso a quello del conte Giovan Battista Gazola edi altri gabinetti di fosili Veronesi, con la versione Latina. Verona dalla stamperia Guilari, 1796, in fol. magno, with magnificent plates.

When

When we read in the same number of the *Journal de Physique* what professor Cuvier has written on the *foot of a bird*, the osseous parts of which are incrusted in gypsum, from the quarries of Clignancourt near Montmartre, there is no reason to doubt that real ornitholites exist, at a great depth, in old strata of gypseous matter.

On the other hand, Blumenbach, in his Manual of Natural History*, mentions bones of aquatic birds found in the marly schist of the quarries of Ættingen, and the bones of swimming birds, or *anseres*, discovered in the calcareous schist of Pappenheim.

I here annex a confirmation of these facts, in the figure of two feathers found in the middle of the quarries of Vestena Nova, in the same stones which contain the fish, and which I caused to be engraven of the natural size, to avoid details in regard to measures. (See Plate VI.)

That represented fig. 1, is in perfect preservation, and as it were amalgamated with thestone: what is most remarkable is, that it is of a very black colour; it is extended and flat, and except some barbs which cross each other, the rest are arranged in the most regular manner. It cannot be confounded with certain *fuci*, which have some apparent resemblance to feathers, because the barbs of the latter are furnished with other barbs. Professors Jussieu, Lamarck, Des Fontaines, and Thouin, who have examined it with attention, consider it as a real feather.

But if, notwithstanding the discussion of philosophers who are accustomed to acute observation, any doubts should be entertained of the identity of this fossil with a feather, a second feather found in the same quarry will serve to fix in an irrevocable manner the opinions of philosophers on this subject. The latter, of which we have a counter-part, is represented of the natural size, fig. 2, and 3. The stone broke so fortunately, that, like those containing the fish, it opened in the middle, in the part even containing the feather, which left its impression, while the body of the feather was found on the other; one might even say, that the feather as it were is divided in the middle.

This feather is smaller than the other, but in a preservation equally perfect; all the barbs on the left side, fig. 2, are in their natural position; those on the right side are divided into small bunches. From the middle almost to the extremity it is a little arched, and its colour, instead of being black, is grayish.

* P. 408, of the 11th vol. French Translation.

This feather was discovered in 1777, and came into the possession of I. I. Dionisi, canon of the cathedral of Verona, who is fond of the study of natural history. It was considered as a very rare object, for it was the first feather ever found in the quarries of Vestena Nova.

In regard to the first feather that is to say, the one represented fig. 1, it was sold, about ten years ago, to count Ignatius Ronconi, of Florence, then resident at Verona, by the workmen, who had taken it from that portion of the quarry of which M. de Gazola is proprietor. These workmen, tempted by the price which M. Ronconi, who was then forming a collection, set on this rare article, privately betrayed the confidence of the person who employed them as day-labourers. M. de Gazola, some time after, purchased from the heirs of M. Ronconi the feather with its double impression: there is seen on the stone of one of the counter-parts a small fish. M. de Gazola, when he gave the feather to the Museum which I have caused to be engraved, reserved that part to which the fish is attached; but being pleased with the reception given to him by the professors of the Museum, he has promised to deposit the second fragment in the galleries of geology, along with that which is already in it.

I have caused to be delineated on the same plate a small crab and a marine insect, presented by M. Gazola along with the stones which contain feathers: both of them were found in the quarrry of Vestena Nova.

The marine insect, fig. 4. seems to belong to the genus *pycnogonum* of Fabricius, or to a genus which must approach very near to it. It is not an *asilus* attached to the fish, for the *asili* have fourteen claws, and their mouth is not formed into a tube: whereas the *pycnogonum* has only eight claws, and its mouth is tubular: a character found in the insect of Vestena Nova, fig. 4. Rondelet has given the figure of an insect of the Mediterranean, which has a great relation to the one in question; he distinguishes it, after Aristotle, by the Greek name *οιστρος*, in Latin, *asilus*, and in French, *thon marin*. He has given an engraving and description of it from the insect which he found adhering under the fins of a tunny fish in the Mediterranean. The figure given by Rondelet* resembles, in regard to the character

* "Having seen the animal," says Rondelet, "I have added what follows, to the description of Aristotle: Instead of mouth it has a small long tube, and on both sides of the body there are, as it were, two hands which turn towards the mouth; then follows the hollow part of the body,

racter of the mouth, the insect of Vestena Nova, which differs from it only in the form and size of the body, but which, like the fishes of that quarry, belongs in all probability to an exotic insect; I have, however, published a very accurate figure of it. The zoölogists will be enabled to compare it with marine insects of the same genus, which we may receive in the course of time from the Indian seas or from New Holland.

Fig. 5. represents a fossil crustaceous animal of the same place, in good preservation: it resembles the crustacea known under the name of shrimps, which belong to the genus *Palæmon* and *Crangon* of Fabricius; *Cancer* (*artacus*) *squilla*, Herbst, Plate XXVII, fig. 1. *Cancer* (*artacus*) *crangon*, of the same, Plate XXIX, fig. 3 and 4. But the *Cancer squilla* being much smaller than the fossil, it would be more proper to refer it to the *crangon*, which is the opinion of M. Latreille, whom I consulted. However, notwithstanding the respect due to the opinion of a naturalist well versed in the knowledge of crustaceous animals, I should rather be inclined to consider the fossil crab in question, as nearer to the *Cancer pedunculatus* of Herbst, of which a representation has been given by that naturalist, in his 43d coloured plate, fig. 5. But as the latter, which is exotic, is rare, and not in the collection of the Museum, we can refer it only to the figure; it is therefore prudent to suspend our opinion till more favourable circumstances enable us to examine the insect in its natural state.

I might publish in the annals of the Museum a description of some other objects of Vestena Nova, confining myself to those which do not belong to the beautiful series of fish of the same place, destined to form the Ichthyology of the Veronais, undertaken by the canon Volta; I should even have considered it as a merit to glean in a field which belongs to him, and which he knows how to cultivate with so much benefit to natural history, had not M. Gazola assured me, that M. Volta's work will be exclusively consecrated to a description of the fossil fish of that mountain.

body, with indentations the end of which there are six feet; the two which are short at the end of the hollow part of the body are the largest and the longest; the two following a little less, and the other two which are more on the side, are the smallest of all. *Rondelet Hist. des Poissons*, 1558, folio. p. 78.

XLV. *Memoir respecting the State of Vegetation on high Mountains. Read in the National Institute, June* 1804.

The first thing which strikes an observer of plants at the entrance of high mountains in our temperate regions, is the vigour and luxuriance of vegetation: every thing he has seen in the adjacent plains suddenly changes its dimensions, its aspect, and its form; he scarcely knows the most common plants under the new dress which they have assumed. The stems are high, the flowers enlarged; and even the leaves of trees have acquired such an amplitude, as often excites some doubt in regard to the identity of their species. The groves are better clothed with foliage, the grass thicker as well as more abundant, its green colour livelier; in a word, every thing is enlivened with more brilliancy, from the depths of the valleys to those heights where the eye can discern nothing but bare rocks and eternal snow.

The plants being thus endowed with a vigour of vegetation unknown in other places, they tend with more energy to pass through the periods of their existence. Time, which regulates the periods of it, creeps on with a slow pace in our plains, but in the mountains it flies. Every thing hurries on along with it: meteors succeed each other with extreme rapidity; the air there is in continual agitation; all the determining causes act at once with their whole force; the signal of germination, floration, and fructification is given at the same time to all individuals placed under the same conditions. The decoration of the meadows and forests changes suddenly at the pleasure of the south wind, of a storm, or stroke of the sun, which uniformly affects the whole of certain kinds of species; and each day of the fine season is the spring of an order of vegetables, or of one of the regions in which they grow.

This first view is succeeded by another; in traversing the mountains and valleys, each situation has its own soil, and each region its climate. These particular regions have each their productions: each has its own characteristic vegetables, which are distinguished in the number of those cosmopolite plants, whose temperature, more robust or more flexible, seems to adapt themselves to every soil, and to triumph over every climate. In the plains these local distinctions occupy immense spaces, the limits of which are too extensive and too indeterminate to be easily perceptible. In the mountains every thing, on the other hand, is confined within narrow limits, which the eye often embraces

at

at one time: a humble hill continued between two valleys, a ridge of rocks, and some steps, which the traveller passes over in a few instants, are the insurmountable barriers which nature has raised between things which it has thought proper to separate.

Among these different causes of separation, one more apparent seems at first to direct all the rest: it is the elevation of the different stages of mountains; every hundred metres of height lower the temperature about half a degree of the common division of our thermometers; and if we take as the term of cold that which generally suspends the progress of vegetation, the eternal ice with which the summits are charged will represent the ice also eternal with which the pole is covered; and each hundred metres of vertical elevation will correspond to a degree of the distance of the mountain from the pole.

It is on this short scale that the phænomena of the climates which succeed each other on the surface of the earth are presented; the circumstances are different, but the results are nearly the same: on the one hand, the increase of the cold is accompanied with a shortening of the column of air; on the other, with an obliquity of the rays of the sun. The vegetables, however, are distributed in a manner nearly similar; and this conformity teaches us to exclude from the number of the causes which act on this distribution, those which are not common to the two scales on which they have been executed by nature. Thus, in the Alps and the Pyrenees trees stop at the absolute elevation of 2400 or 2500 metres, as they do about the 70th degree of latitude; and the band of the mountains occupied by these large vegetables is divided into as many particular bands as the trees constitute different species: oaks remain at the bottom; the beech occupies the mean heights; and above these are the pitch-pine and the yews, which soon give place to the pines, and these pines both in the Pyrenees and the Alps are those of Scotland and of Riga: while the latter chain possesses also the cembra and the larch, which are foreign to the former; but it wants the cedar which grows on the Lebanon, and which would, no doubt, thrive in our mountains of Europe, had nature placed them there, as it has done on the mountains of Asia. But such is the mystery of the original dissemination of vegetables, that nature seems, in turn, indifferent in regard to the similitude of places and the distances by which they are separated; sometimes placing in similar climates the plants of countries the most distant from each other, and sometimes

sometimes refusing this conformity of productions to regions which unite all the conformities of soil and of climate.

In the zone of trees is seen a shrub common to all the mountains of Europe, and which is at the same time peculiar to them: it is never found any where else. Intractable to cultivation, it languishes in our gardens: it requires the soil, air, water, and snow of its native place; it requires mountains, and it must even have a particular determinate situation. The plant here alluded to is the Rhododendron: nothing can be more brilliant than this shrub when in flower, but nothing is more delicate or intractable. It appears in the Pyrenees exactly at the absolute height of 1600 metres, and stops exactly at 2600; but between the limits within which it is confined it is so abundant and so vigorous, that it would almost be as difficult to extirpate as it is to transplant it.

The juniper traverses this band, and ascends much higher. I have found it at the altitude of 2900 metres above the level of the sea; but at each stage to which it rises it loses some part of those characters by which it is distinguished in our plains. In the high region it is the juniper of Sweden and Lapland, low and stunted, with its trunk creeping over the ground to seek for shelter between the quarters of the rock which are within its reach. There conducted by nature, as it would be by instinct, it searches for and finds, without ever being deceived, the faces of the rocks which are exposed to the south or the west; rises upon them, and expands its branches in the form of an espalier, with a regularity scarcely to be attained by art.

Higher up, the severity of the climate admits nothing but low shrubs, which can be entirely covered by the first snow; but still higher, this shelter is insufficient against the cold and the length of the winter: nothing exists but what is contained in the earth; the only vegetable productions found here are herbs with vivacious roots, and nature has almost entirely banished from these places the annual plants which would deceive its hopes, when in the course of a summer reduced to a few days, and often to a few hours, a gust of wind, or a frost, may blast its flowers scarcely expanded, bring back winter, and terminate the year.

On the other hand, no elevation checks those vivacious kinds which, on the approach of the intense cold, entirely re-enter under the double shelter of the snow and the earth, and revive from their roots on the first fine weather; their duration exhausts all the changes of the seasons to attain

attain sooner or later to the year favourable to the maturation of the seeds from which they are to be renewed.

At Neouvielle, at an elevation greater by 250 metres than thar of the *Pic du Midi,* and at which the thermometer rises in summer only to 8 degrees, I collected, during five excursions, twelve species, all vivacious.

On the summit of Mount Perdu, at the absolute elevation of 3500 metres, in the bosom even of the permanent snow, but under rocks freed from it by the inclination of their sides, I collected six species exceedingly vigorous. Here on one of the warmest days of a year remarkable for its heat, the thermometer rose only to 5·5°, above the freezing point, and it no doubt descends in winter to 25° and 30°; and is it certain, that the plants which I found here uncovered, in a year when the snow had undergone an extraordinary diminution, disengage themselves from it every year? Besides, I have seen some reappear, which existing on the edge of the permanent snow, remain almost always buried under its extension: they do not see the light perhaps ten times in a century, and then they pass through the circle of vegetation in the short space of some weeks, to sleep again during a winter of several years. It cannot be expected that plants subject to conditions of existence so singular should be found among the number of the species which we observe in the plains of our temperate climates: they belong either exclusively to the highest summits of the mountains, or they are represented merely in the polar countries of Europe. Norway, Lapland, and Greenland are countries which furnish plants analogous to those which grow on the summit of the Alps and the Pyrenees; they are not found in Siberia or Kamschatka, nor in the polar countries of America, though it is as difficult to conceive the diversity which prevails among the vegetable productions of countries so similar and so near to each other, as it is difficult to explain the conformity which exists between the vegetation of one of them and that of the summits of some mountains which are 40 degrees distant from them.

But we are informed by observation that the propagation of vegetables does not always take place parallel to the equator; that if a certain number of plants confined by their temperament to a determinate climate are found at some distance under the same latitudes, many others, on the contrary, seem to have been carried away in the direction in which our continents separate, and to be dispersed in the direction of the meridians. On the south, America, Africa, and Asia; on the north, Europe, Asia, and America, are far

4 from

from presenting the same vegetation on the same parallels; while a multitude of plants faithful to each of these parts of the world, faithful even to certain subdivisions of these grand divisions, brave all those obstacles which diversity of temperatures oppose to them, to propagate in a direction absolutely contrary to that to which they are called by the conformity of climate.

But, not to wander from the subject, it is thus, for example, that several remarkable vegetables of Sardinia, Sicily, and Italy, climb the Alps, pass over them, and spread to the Lower Germany, without yielding to the invitations of climate, which would carry them to the contrary side. It is thus that the Pyrenees receive from Spain a great number of the plants of Barbary, and convey them to the western part of France. The meadow saffron, which grows in the north of Africa, shows itself in Andalusia, Castile, Arragon, the Pyrenees, and descends even to the department of Landes: the *Hyacinthus tardisus*, the *Narcissus bulbocodium*, have the same origin and pursue the same route; the *Anthericum bicolor*, setting out from Algiers, traverses the same chain and arrives at Anjou; the *Scilla umbellifera*, the *Saffranum multifida*, go from the Pyrenees to England, without any of these plants proceeding laterally to meet those which the Alps receives in like manner from the south to proceed to the northern parts of Germany.

But it is in the large valleys of the Pyrenees hollowed out from north to south, that these directions assume a character altogether striking and singular.

I find the large *Dianthus plumarius* at the entrance of the valley of Canopan and that of Gavarnic. It traverses them entirely without entering any of the oblique valleys which open into it. The *verbascum miconi*, that beautiful and rare plant, which neither belongs to the genus in which Linnæus has placed it, nor perhaps even to any family of plants now established, and which having a foreign air amidst our vegetables of Europe, is distinguished among them as the alcyon is among our indigenous birds. The *verbascum miconi* affects the same preference for the same direction. It is found in all the large valleys of the Pyrenees, where it shows itself indifferent to all soils and all exposures; and the same soils and the same exposures do not attract it into any of the collateral valleys. I could quote a multitude of examples of the same fact; but it will be sufficient to mention only one, that of *box*. This shrub, so robust, grows in the mountains like the most delicate plants: on the first regions of the Pyrenees it covers all the hills both on the side towards France and towards Spain. These large valleys, lying north and south, open before it; there it enters, but never to issue from them: in vain do the ramifications of these valleys present it on all sides other valleys to people; it passes over these openings, and, continuing its route in the direction it has adopted, it ascends from north to south, stops at the bottom of the ridge of the chain at about 2000 metres of absolute elevation, and, reappearing on the other side at the same height, descends towards the south in the same direction from which it has constantly refused to deviate.

It is thus that the first designs of nature preserve more determinate tracts in the mountains, where each order of vegetables confines itself within limits better defined and more difficult to be passed, and where the influence of the places resists more powerfully the influence of secondary causes, which incessantly tend to confound what the primary causes had separated; and even these numberless modifications have been introduced by the lapse of ages, and in particular by the presence of man. I traverse the immense deserts of the lofty mountains: suddenly, among the rare plants which compose their herbage, I discover some of our trivial plants. The verdure assumes a darker tint, which forms a contrast with the bright green of the alpine turf. I advance: the ruins of a hut, or a rock blackened by the smoke, explain to me the mystery; around this asylum of man the plants which surround our rustic habitations have been naturalized; the common mallow, the nettle, the *Anagallis arvensis*, the *chenopodium*, and the common patience; with which is mixed the patience of the Alps, as the chamois are seen to approach the domestic goats. A shepherd has sojourned there several weeks, perhaps some years. In conducting his flocks he has carried thither, without knowing it, the birds and insects of the valleys, the seeds and germs of his village. He will, perhaps, never return thither; but these savage countries have received in a moment the indelible impression of the domination of man. So much weight has a being of this importance in the scale of nature!

In other places it is by destruction he has marked his presence: on approaching the mountains, he has torn in every part the immense veil of the forests which covered their bases. The woods are not the habitation of man. He dreads the windings of that vast labyrinth: he is suspicious of its shades: he regrets the want of the sun, towards which he turns a look of respectful hope: he never penetrates thither,

ther, but to carry with him fire and the axe. The germs of nemoral plants sleep in the dried earth, which is not proper for their development. Their place is supplied by other vegetables. The climate itself has changed, and attracts new species. The temperature rises; rain is less frequent, and more abundant; the winds more inconstant and impetuous; the torrents increase; the declivities become furrowed with ravines; the rocks are stripped of the earth which covered them, and of the plants with which they were ornamented. Every thing grows old with increasing rapidity: an age of man presses on the earth more than twenty ages of nature.

And, however, it is still there that places and their productions have preserved more of their original character. It is there that the primitive distribution of vegetables has been less interrupted; that circumscription has been less strongly traced out; that the influence of soil and climate is most perceptible. It is there that the comparison of objects shows in turn symmetry and contrasts, and that the eye can embrace at once every thing which attracts observation and determines the judgment. And if it be in the structure of the grand chains that the geologist ought to study the structure of the earth and the history of the grand catastrophes which imprinted on it its last form, it is in these mountains also that the botanist will attempt to penetrate the mystery of the original dissemination of vegetables and of their successive propagation.

XLVI. *New Method of preparing in a speedy Manner Nitrous Ether, without the Application of external Heat. By* BRUGNATELLI *.

PUT into a tubulated retort an ounce of sugar, and pour over it two ounces of pure alcohol: adapt to the retort a capacious receiver; wrap round it cloths moistened in water, and cover the joints with pieces of paper rolled round them. Then pour through the tubulure of the retort three ounces of concentrated fuming nitrous acid. An effervescence immediately takes place; the mixture becomes hot; the sugar dissolves; the solution seethes; and the alcohol converted into ether passes over into the receiver. By these means the whole of the alcohol, changed into excel-

* From *Annali di Chimia di Brugnatelli*, 1802, tom. xix. p. 99.

lent

lent ether, may be collected in a very short time. The ether has a weak orange colour, with a very agreeable smell: it does not change blue vegetable colour to red; and exhibits in general all the phænomena of the best nitrous ether.

During the formation of the ether there is disengaged some nitrous gas, which may be known by a red vapour diffused throughout the apparatus. When this vapour appears, the receiver must be changed. The sugar which remains in the retort may be easily converted into oxalic acid by treating it with a fresh quantity of nitrous acid.

XLVII. *Experiments to ascertain whether there exists any Affinity betwixt Carbon and Clay, Lime and Silex, separately or as Compounds united with the Oxide of Iron forming Iron Ores and Iron Stones. By* David Mushet, *Esq. of the Calder Iron-Works.*

[Continued from p. 141.]

Having thus ascertained certain peculiar affinities betwixt carbon and clay and silex, manifested by the disappearance of the former, when exposed to melting heats in contact with the latter, I now proceeded to investigate what effects would be produced in the revivification of iron from ores compounded with various proportions of mixture.

I combined malleable iron with oxygen, and thus formed a considerable portion of rich oxide. This was pounded, and afterwards mixed with various earths and proportions of carbon. Thus prepared, it was found to contain,

Iron	- -	74
Oxygen	- -	24
Moisture	- -	2
		100 parts

The following experiments were made with this oxide and carbon, to ascertain the proportions of carbon necessary to revive a given quantity of iron.

I. 200 grains of oxide were fused *per se*. A very dense glass of iron was obtained with a partially crystallized fracture. The surface contained some beautiful crystallizations of detached radii possessed of various shades of colour; but no appearance of revived iron.

II. 200 grains of oxide,
5 —— of carbon, or 1-40th.

The

The fusion of this mixture afforded glass of iron less perfect than the former. The fracture divided itself into two distinct beds. The under one was a smooth black shining glass: the upper possessed a similar fracture and appearance to what was obtained in No. I. This difference was evidently the result of the combination of the small portion of carbon: for in the smooth black glass a disposition of the metal to separate was manifested by the formation of a minute cell exactly in the centre of the glass. This cavity is uniformly obtained in all experiments of this nature, and is sometimes found containing beautiful prismatic colours and possessed of an uncommon degree of lustre.

III. 200 grains of oxide,
8 —— of carbon, or 1-25th part.

The fusion of this mixture afforded a very neat spherule of metal, which was found to weigh 8 grains or 4 per cent., or 1 grain of metal for 1 grain of carbon. The glass was black and shining throughout, resembling very much the lustre and polish of a highly finished razor. The iron obtained was soft and ductile. It easily flattened without cracking when cold, and exposed a fine gray spotted shale.

IV. 200 grains of oxide,
10 —— of carbon, or 1-20th.

The result of the fusion of this mixture was a minute though elegant spherule of iron, possessing some fine watery shades. It was found to weigh 10 grains, or equal to 5 per cent. This, as in No. III, is exactly 1 grain of iron for every grain of carbon added. The glass in this experiment was still more shining and perfect than in the former, and the quality of the iron was equally soft and malleable.

V. 200 grains of oxide,
20 —— of carbon, or 1-10th.

An elegant ovular button of iron was obtained in this experiment; the surface was possessed of an uncommon lustre and polish, contrasted by a variety of shades. It weighed exactly 56 grains, or equal to 28 per cent. The quantity of iron revived is nearly 2¾ grains for each grain of carbon in the mixture.

The glass was not perceptibly different from that of No. IV. The quality of the iron was malleable, though not so soft and ductile as in former experiments.

VI. 200 grains of oxide,
30 —— of carbon, nearly 1-7th.

From the fusion of this mixture a very smooth beautiful metallic button was obtained, which was found to weigh

94 grains, and equal to 47 per cent. The proportion of iron revived in this experiment exceeds 3 grains for each grain of carbon. The surface of the glass was striated, of a blueish white pearly colour. The fracture, however, resembled the glasses obtained in Experiments III, IV, and V. A few faint impressions of crystallization were observable upon the under surface of the metallic button. This always indicates a combination of carbon, and uniformly announces a change to the state of steel.

VII. 200 grains of oxide,
40 —— of carbon, or 1-5th.

This mixture was reduced in 15 minutes, and a perfect metallic button obtained, which weighed 123 grains, equal to 61½ per cent. The quantity of metal revived was nearly in the same proportion to charcoal as in the former experiments. The quantity of glass was now considerably diminished, and was not sufficient to cover the upper surface of the button. In point of colour and opacity, however, it was not materially different from Exp. V and VI. The quality of the revived iron was highly decarbonated, of a white crystalline fracture.

VIII. 200 grains of oxide,
50 —— of carbon, or 1-4th.

From the fusion of this mixture there resulted a partially crystallized button of crude iron which weighed 140 grains, or equal to 70 per cent. The glass had entirely disappeared, excepting a thin crust of a blackish green colour, attached to the edges of the button. The proportion of iron revived to carbon in this experiment is as 2¾ to 1.

IX. 200 grains of oxide,
60 —— of carbon.

The fusion of this mixture yielded a very perfect metallic

button which weighed - -	140 grs.
Globules of a silvery colour thrown against the sides of the crucible - -	4
	144

Equal to 72 per cent.

In this experiment only a very thin film of glass was found of a light lead blue colour; and, as there remained untaken up 4 grains of the charcoal, it is presumable that the whole contents in iron contained in the oxide, making allowance for unavoidable loss, was now revived and collected together. As the quality of the metal now obtained was still highly deficient in carbon, it appeared probable

 that

that by carbonating the product a larger quantity by weight would be obtained.

X. 200 grains of oxide,
100 —— of carbon.

This proportion of mixture was found but partially fusible. A considerable portion of iron was revived in large and small globules beautifully carburated. Part of the moleculæ of the oxide had lost its oxygen, and was either resolved into an imperfect carburet with the charcoal, or into minute malleable grains of iron.

XI. 400 grains of oxide,
200 —— of charcoal.

Although the proportions in this experiment were the same as in the former, yet a perfect reduction was effected, and a fine button of carbonated metal obtained which weighed - - - - - 280 grs.
Globules thrown up in the ebullition of the metal - - - - - 12

Equal to 73 per cent. 292

The under surface of the product now obtained was richly carburated, the top plain and smooth. The fracture open and gray, resembling No. I, (or smooth-faced) pig iron.

The different results of these two last experiments are one of the many instances which occur in this department of metallurgy, where the perfection of the operation depends more upon the quantity of matter used than the direct proportions of the mixture.

The deductions which are liable to be made, arising from this source of error, are sometimes most erroneous, and frequently beyond belief. For example:

XII. 1750 grains of oxide,
$87\frac{1}{2}$ —— of charcoal, or 1-20th.

This mixture was fused into a dead ponderous glass of iron wherein no trace of revived metal could be found: now in Experiment IV, the same proportion of mixture yielded 5 per cent. of iron. Again,

XIII. 1750 grains of oxide,
175 —— of charcoal, or 1-10th.

The fusion of this mixture afforded a black, shining, heavy glass, without the most minute particle of revived metal. In Experiment V, with the same proportions of oxide and carbon, 28 per cent. of iron was revived.

XIV. 1750 grains of oxide,
250 —— of charcoal, or 1-7th.

This

This mixture was perfectly fused, and equally destitute of revived iron as the former. In Experiment VI, the same proportion of mixture yielded 47 per cent. of iron. I afterwards found that, when this quantity of oxide was used, the first symptoms of separation took place with 1-5th its weight of charcoal.

I know of no satisfactory reason which can be given to solve the material difference of the results in these experiments, simply arising from quantity, unless the additional exposure requisite to reduce the large quantity destroys a greater portion of the charcoal uselessly than when the small portion of matter is operated upon. The process of separation divides itself into branches. The first consists in the action of a well known affinity,—the combination of the carbon with the oxygen of the oxide, which leaves the particles of metal highly disposed to become the subject of the second affinity, viz. the combination of the carbonaceous matter with the iron. Now, if we suppose that in both series of experiments there existed in each mixture a particle of carbon for every particle of metal, and one for every particle of oxygen (if I am allowed the expression), then we cannot see that in either operation a difference of result should take place, provided the experiments are alike accurately performed, and the time of exposure similar. The fact, however, turns out very differently, and, I make no doubt, is guided by some regular and well established cause. May not the last portions of oxygen be more difficult to remove from the large than from the small quantity? or, in other words, May they not require a greater dose of carbon to saturate them under the double circumstance of increased quantity and approximation to fusion?

Although I could not reduce the mixture operated upon in Exp. X, I found this easily effected by the addition of chalk.

XV.	Oxide of iron	-	-	-	200 grs.
	Charcoal	-	-	-	100
	Chalk	-	-	-	100

But in place of finding the revived iron carburated as in that experiment, I found it quite the reverse.

A review of these experiments performed with pure iron, oxygen, and carbon, will convey a pretty accurate idea of the real quantity of the latter necessary to revive certain portions of iron. It is however most difficult to decide what portion of the carbon unites to the oxygen of the oxide, and what to the metallic part. I have uniformly found that all iron ores and oxides take up a portion of carbon before any of the metal is separated. This combination brings the glass of iron more and more to the metallic state, undoubtedly by removing a portion of the oxygen. This appears most evident from Experiments III and IV, where only one grain of metal was revived by each grain of charcoal in the mixture. As the quantity of oxygen by this means became reduced, we find that the quantity of iron revived increased in a greater ratio, and at some times exceeded 3 to 1 of the charcoal. (See Experiments VI and VII.)

Recapitulation of these Experiments, and the Rate of Charcoal at which the metallic Particles become revived.

Exp. I.	Fusion *per se*, afforded no metal.			
II.	Oxide, and	1-40th of charcoal;	no metal.	
III.	ditto —	1-25th of ditto;	4 per cent. of iron revived	
IV.	ditto —	1-20th of ditto;	5 per cent.	
V.	ditto —	1-10th of ditto,	28	
VI.	ditto —	1-9th of ditto,	47	
VII.	ditto —	1-5th of ditto,	61½	
VIII.	ditto —	1-4th of ditto,	70	

In these eight experiments the charcoal had totally disappeared.

IX. ditto and 1-3d of ditto, 72

Along with which was found a residuum of 4 grains of carbon.

It is also worthy of remark, that in the early proportions of charcoal, when one-half of the metallic contents only are revived, the metal is then discharged from the oxide in a state of complete malleability, though highly red-short. This takes place in all experiments of this nature with a sufficient dose of carbon; and I have frequently taken advantage of this circumstance to form an opinion of the properties and strength of the malleable iron which any given ore was likely to afford from the manufacture of the pig.

Part of the metallic contents of any ore or oxide being thus precipitated by means of charcoal in a state of uncommon softness and ductility, we are led to infer that any additional portion of carbon would only increase the quantity of malleable iron, and ultimately produce the whole contents of the ore in a state of malleability. This, however, is by no means the case; for as soon as nearly one-half the metal is revived, a more powerful affinity is established betwixt it and the additional carbon. Steel or crude iron is formed through the whole mass by this extra combination, and every appearance of softness and malleability vanishes. This takes

place

place when nearly 3-4ths of the whole metal is revived, and decidedly proves a reverse of affinity to what at first existed.

At the beginning of the experiment we find that the charcoal prefers uniting with the general body of oxygen, rather than clearing a minute portion and reviving its appropriate metal. This takes place till a considerable part of the oxygen is dissipated. In the progress of this, the affinity betwixt the carbon and iron is gradually developed; and before it is fully established a portion of the iron is precipitated in a malleable state, not as a direct consequence of the union of the carbon with it, but in consequence of the oxygen of the oxide being removed, and the particles left in a metallic state. So long as this takes place, I look upon the affinities of carbon for the remaining oxygen of the ore, and for its metallic contents, as nearly balanced; and this will always have a direct reference to the proportion of each. When this equilibrium is destroyed by the addition of certain extra portions of carbon, a paramount affinity is immediately established betwixt these and the iron which had before been separated in the malleable state, and steel or crude iron of various degrees of saturation proportioned to the carbon is the result.

From another mode of operation it is pretty evident that this reverse of affinity is occasioned in a great measure by the temperature, particularly as in the above case, where it uniformly is productive of fusion. If the same oxide here operated upon, or indeed any ore, is exposed to a temperature in contact with charcoal considerably short of fusion, a deoxidation nearly complete will take place, provided the experiment as to proportion of mixture and time has been properly conducted. The matter thus exposed will be found to have lost considerably in weight by the loss of oxygen. If it is carefully freed from the surrounding charcoal, washed, and immediately dried and introduced into a clay crucible and exposed to a very high heat, a button of metal will be found, amounting to 8-10ths or 9-10ths, the whole produce in iron which the ore contained. This iron will be in the state of malleability nearly as soft as copper when cold, but uncommonly red-short when heated beyond a bright red. The deficient iron, amounting to 1 or 2-10ths, will be found in a small portion of glass of iron attached to the edges of the button, and which may be easily called to existence by the addition of a few grains of carbon.

This still proves that the temperature employed in cementation, though adequate to remove the greatest part of the oxygen, yet is insufficient to dissipate its last remains.

To effect this, a higher temperature and a more powerful affinity must be exerted. That this effect is complete we have no proof, but that a larger portion of metal is called into existence. If the affinity continues to increase in the ratio of the diminution of the quantity, then a much higher temperature and a more powerful affinity may be requisite to remove from iron the last portions of oxygen than any with which we are acquainted.

The external characters assumed by iron separated in this simple mode of assaying, are of much importance in understanding thoroughly the process. As long as malleable iron continues to be precipitated, the metal, if covered with glass, possesses a surface of the highest polish. The colours are frequently various, chiefly shades of blue and azure, sometimes black-watery inclining to rich deep brown. The union of carbon, even in small quantities, under the same pressure of glass, is immediately known by the fine crystalline form which begins to spread over the surface: sometimes the entire surface is thus elegantly marked. As the quantity of carbon increases to form steel, the crystallization assumes a radiated structure, convex upon the upper surface and concave below. This form continues through all the states of steel, but in approaching to crude iron the under surface loses the concave and crystallization, and assumes a smooth skin, sometimes marked with hollows equally smooth. When the combination of carbon is sufficient to change the fracture of the metal from white to mottled or gray, every trace of crystallization then vanishes, and a surface comparatively rough, but highly convex on all sides, succeeds.

XLVIII. *Notices respecting New Books.*

Mr. Parkinson, of Hoxton, to whom chemists are indebted for a very useful publication, the *Chemical Pocket Book*, of which we have more than once had occasion to speak, has just published the first volume of a new work, which will be found extremely interesting and useful to geologists and mineralogists. It is entitled, *An Examination of the mineralized Remains of the Vegetables and Animals of the Antediluvian World, generally termed extraneous Fossils.* 4to, 471 pages and an index.

This volume, which contains the vegetable kingdom, is embellished and illustrated with a frontispiece and nine plates,

plates, containing accurate delineations of a great number of curious fossil vegetable remains coloured after nature.

In a future number we shall give a further account of this useful and valuable work.

Shortly will be published a new Edition, with improvements, of

The Magnetic Atlas, or Variation Charts of the whole terraqueous Globe, comprising a System of the Variation and Dip of the Needle, on the Projection of the former Editions, by JOHN CHURCHMAN, *Fellow of the Russian Imperial Academy of Sciences.*

This plan represents on a plane as truly as on a globe the necessary proportions of every country, and the true nature of every curve. The improvements of the new edition will consist principally of Halleian lines drawn through all the different places where the degree both of variation and dip are the same, and thus avoiding the trouble of measuring angles. These charts will be found to possess great advantages, particularly in cloudy weather; for the darkest day at sea often shows the sun long enough at noon to observe the latitude. Or the dip alone (being easily found at all times) is sufficient near the land, as the lines of equal dip intersect every part of any coast in certain latitudes. Thus the difficult problem of the longitude may be determined at sea by two different methods: 1st. From a true knowledge of the latitude and variation: 2d. Of the latitude and dip. Perhaps no observation, except the dip, can be taken so frequently as the variation. That a mean of these observations can be found accurately enough at sea, many experienced navigators have already borne witness; the only difficulty arising from the iron on ship-board giving sometimes a false direction to the needle, may be overcome by ascertaining the magnetism of the ship.

XLIX. *Proceedings of Learned and Economical Societies.*

ROYAL INSTITUTION.

AT a special meeting of the managers and visitors, held the 17th day of May 1804,

The Duke of Somerset in the chair,

The following address to the proprietors, subscribers, and others, respecting a proposed mineralogical collection, and office of assay, was read, approved, and ordered to be circulated;

 In

In the progress of their labours for the improvement of the Royal Institution, the managers and visitors have lately had the pleasure of noticing the liberal donations already made towards a mineralogical collection. They have now the greatest satisfaction in announcing the receipt of a proposal to raise a fund of 4000l., in order to contribute further towards forming, and connecting with the Institution, an extensive and useful collection of minerals; so as to establish there, on a great scale, an assay office, for the improvement of mineralogy and metallurgy.

The gentlemen to whom the public at large, and the Royal Institution in particular, are indebted for this patriotic proposal, are the right honorable Charles Francis Greville, and Sir John St. Aubyn and Sir Abraham Hume, barts. They observe, that the mining concerns in this kingdom are conducted by individuals with such advantages of capital, and with such a degree of speculative enterprise, as to exhibit those effects of combined chemical and mechanical powers applied to them, which no other country in the world has hitherto been capable of producing; whilst, at the same time, no other state is so deficient in the proportionate means of rendering the knowledge of minerals accessible to persons desirous of instruction. This defect they impute "to the want of an adequate public fund, to be applicable, under the direction of mineralogists and chemists, to the following purposes;—viz. the formation of a scientific collection of minerals on such a scale as to include all the latest discoveries;—the arrangement of the collection in a manner to exhibit all the interesting series of mineralogical facts;—and the establishment of an assay office, to be exclusively employed for the advancement of mineralogy and metallurgy."

The formation of such a collection of minerals, and the foreign and domestic correspondence incidental to it, will, they conceive, afford sufficient employment for the whole time of a mineralogist of considerable talent; while the conduct of the assay office must require the continued attention of a chemist of approved abilities. Hence, they infer the expediency of a considerable fund for the improvement of mineralogy and metallurgy; and hence, the necessity of an union of men of science, talent, and practical experience, to direct the application of the fund to its appropriate object.

The proposal then proceeds to notice a suggestion, that private collections of minerals might answer the desired object; and that men of science have never been wanting to elucidate

elucidate those material facts which scientific inquiries or accidental circumstances have placed within the sphere of their observation. Upon this they remark, that "it must be obvious that the researches of private collectors seldom, or at least very gradually, extend beyond a limited circle; and that gentlemen who occupy their leisure hours in pursuing interesting inquiries in chemistry, cannot interrupt them, in order minutely to examine and investigate an incidental fact in mineralogy, which may, at the moment, be deemed a new discovery."

To corroborate this, it is further stated that specimens for analysis of corundum and muriate of lead had been given by Mr. Greville to Mr. Woulfe, Dr. Withering, and Mr. Kirwan, several years before they were sent by him to Mr. Klaproth; who immediately analysed them, and published the result thereof in the foreign journals. And they observe, "that the more perfect description of these and other rare minerals, in the joint papers of Count Bournon, Mr. Hatchett, and Mr. Chenevix, recently published in the Philosophical Transactions, cannot be taken to the credit of the private collections which contained them. Mr. Hatchett and Mr. Chenevix fortunately had peculiar leisure for the analysis; and the whole time of Count Bournon was at that period employed in forming one collection, and in arranging two others; a circumstance which gave him the same advantage as if the collections had been public. The joint papers of these three gentlemen may be proposed as the models of the plan to be followed in the examination of minerals in the British dominions in every quarter of the globe;—supplying examples from which may be formed the most interesting collection of geology that can be imagined."

To attain this national object, and to encourage contributions to the funds for the original establishment of the collection and assay office, it is proposed to give the subscribers similar privileges to those on which a large sum has been recently and rapidly collected for the library of reference,—with only this difference, which the difference of the object appears to warrant, that, in case of a patron's subscription to this collection, whether a proprietor, a life subscriber, or an annual subscriber to the Institution, it may be competent for him to exercise the rights of a patron;—and that a select committee shall, from time to time, be appointed by the managers, from among the subscribers, to form and arrange the collection, and direct the operations of the assay office.

For

For the provision to be made for the future expenses of the collection and office of assay, the managers look with confidence to the public for sufficient assistance, in case the measure shall appear, upon investigation, to be deserving of it.

With respect to the subscription for the collection, it is proposed to open it, not only to the proprietors and subscribers of the Institution, but to the members of the different mineral companies and others in this kingdom, and also to the members of those learned bodies which do so much honour, and render such essential service, to this country; and particularly to the fellows of the Royal Society, of the Society of Antiquaries, of the Society for the Encouragement of Arts, &c., and of the Linnean Society; to the trustees of the British Museum, to the members of the Board of Agriculture, and of the British Mineralogical and London Chemical Societies.

It is also proposed, that the patrons of the collection shall, with the sanction of the managers, have the power to form any arrangement with the trustees of the British Museum or others, whenever it shall appear that it may tend to the advantage of their respective collections of minerals.

Upon an attentive view of the subject, the managers and visitors discover great advantages which may result from the execution of this measure, on a scale worthy of the British empire; which has, from the most remote antiquity, been peculiarly distinguished for mineral productions. To the British Islands, and to the lesser territories which form their immediate appendages, the benefit of the proposed collection and office of assay will be highly important. But in the immense territory which now forms our East India possessions, are to be found the most valuable mineral treasures that are known in this globe; and from the wisdom and liberality of the East India Company, great and effectual assistance may be hoped for in aid of the execution of a plan, by the adoption of which the intrinsic value of those treasures may be ascertained and brought into use.

The proprietors and subscribers may be assured, that the managers and visitors will never consider their labours as finished, while there remains any effort to be made for the diffusion and useful application of practical science in this country. They would indeed have deemed themselves extremely culpable, if there had been any neglect or delay on their part, in submitting to the consideration of their members, and of the public, a plan which promises essentially to promote the prosperity of the Royal Institution, and at the

the same time to contribute to the extension of useful science and to the increase of our national resources.

SOMERSET, Chairman,

17th May, 1804.

Plan of the proposed Collection of Minerals and Office of Assay.

I. The collection of minerals and office of assay shall be and remain under the same direction and government as the other parts of the Institution; subject only to such privileges (to be enjoyed by those proprietors or subscribers who shall think fit to qualify themselves as patrons of the collection) as are hereinafter mentioned, or may be hereafter conceded by the by-laws of the institution.

II. Proprietors and subscribers contributing to the collection 100l. or upwards, shall be hereditary patrons of the collection.

III. Proprietors and subscribers contributing 50l. or upwards, not amounting to 100l., shall be patrons for life.

IV. Subscribers of lesser sums (when their united subscriptions amount to sixty guineas or upwards) may, by writing, appoint, of their own number, any one, being a proprietor or a subscriber, a patron for life.

V. The application of the subscriptions, in providing and arranging the collection and establishing the office of assay, shall be under the direction of the patrons.

VI. The collection shall be open at times to be fixed on the part of the Institution for the proprietors and subscribers; and also for scientific men, of this or any other country, to be introduced or recommended by the patrons; each patron having a power to introduce or recommend one such person, each day, to the collection.

VII. No person shall be capable of exercising his right as a patron, except during such time as he shall continue and be a proprietor or subscriber to the Institution.

VIII. In case of the death of any of the patrons for life, the surviving patrons may elect in his room a life patron, who shall have previously paid, or secured to be paid, the sum of 50l. or upwards to the funds for the support and increase of the collection; which money shall be forthwith applied accordingly, under the direction of the patrons.

IX. The patrons ahall make rules for the direction of their mode of proceeding, and shall elect a chairman, deputy chairman, treasurer, and secretary, and appoint committees

mittees and sub-committees for such part of their business as they shall think proper.

X. A select committee shall, from time to time, be appointed by the managers, from among the subscribers to the collection, to arrange the collection, and direct the operations of the office of assay.

Subscriptions to the collection and office of assay will be received by William Savage, at the Royal Institution, and by the following bankers; Messrs. Ransom, Morland, and Co., Pall Mall; Messrs. Hoare, Fleet-street; Messrs. Herries, Farquhar, and Co., St. James's-street; and Messrs. Pybus, Call, Grant, and Hale, Old Bond-street.

ACADEMY OF SCIENCES AT PETERSBURGH.

The following account of the transactions of the Academy in the course of the year 1803 has been published:

The papers read in the different sittings were, 1st, On siliquose plants, by T. Smelovsky. 2d, A brief account of the extraordinary cold which took place at Saratof on the 13th of January, by F. A. Meyer. 3d, A specimen of Phœnician literature in some inscriptions of Citium, described and decyphered from their analogy to the wedge-formed characters, by Lichtenstein. 4th, Doubts in regard to the system of Dr. Gall, by C. A. Rudolphi. 5th, A speech addressed to the Chamberlain Novosilzof on the day he took the President's chair, in the room of the President Fuss. 6th, Account of some general results from the tables of births, deaths, and marriages, at Petersburgh, by Kraft. 7th, On the integration of a differential equation, by Fuss. 8th, On the loxodromic curve described on any round body, by F. T. Schubert. 9th, History of the Imperial Academy of Sciences for the years 1797—1798, by Fuss. 10th, Observations on the stuffing and preserving of animals, by Dr. Langsdorff. 11th, New observations on stones formed by aggregation, by Severguine. 12th, An attempt towards explaining different phænomena connected with the crystallization of salts, by Lowitz. 13th, *Ob ognêmêre, ili orudii koim moshns oprédélât vsê stepeni shara rotschin*, Zacharova. 14th, A description of some rare plants. 15th, Memoir on the tables of the population of the imperial establishments for the mines of Catherinenbourg, transmitted by Mr. Hermann, by Kraft. 16th, On the viburnum opulus, by Oseretzkovsky. 17th, Some astronomical observations made at the Observatory of Petersburgh, by Inschodzof. 18th, 18th, Speech of the President Novosilzof, on the day when he announced to the academy the confirmation of its new regulations. 19th, Plantæ contortæ discovered at the Cape of Good Hope, by C. P. Thunberg. 20th, Researches respecting the first integrals of equations with partial differences, by Trembley. 21st, On the great use of continued fractions in the integral calculus, by F. Kausler. 22d, A specimen of the metamorphosis of amphibious zoöphytes, by Lichtenstein. 23d, Observation on the white variety of the *lepus timidus*, by A. Pansner. 24th, Detailed plan of a new Technological Journal, preceded by some general reflections, &c., by Fuss. 25th, Dissertation on the loxodromic curve, &c., continued by Schubert. 26th, New method of making platina malleable, by Count Moussin-Pouschkin. 27th, *Chimitscheskoie ispytanii e kammennych ugol' yev blir goroda Borovoitschii; sotch*, Volkova.

The following observations, experiments, and notices, were laid before the Academy.—Meteorological experiments were made at St. Petersburgh, by Inschodzof; at Mosco, by Professor Bause; at Nicolayef, at the school of navigation for the Black Sea; at Kasan, by M. Lachtin; at Katharinenburg, by M. Hermann; at Saratof, by M. Meyer. M. Kraft communicated observations respecting a galvanic experiment; an experiment on the preparation of jelly from bones; on the present declination of the magnetic needle. M. Lowitz transmitted notice of a fat substance extracted from Siberian cochineal, with a specimen, and observations on a remarkable crystallization of nitro-muriate of platina, effected by intense cold. By Mr. Hermann, account of a new gold mine discovered on the Tshussovaia; on the freezing of quicksilver at Katherinenburg, and on a remarkable fire-ball observed at the same place. By M. Kritschevskii, on some phænomena which occurred during the freezing of quicksilver; and, by M. Robertson, a notice in French, respecting observations made in the upper regions of the atmosphere, during an aërial excursion. The Academy has lately published the first number of a Technological Journal, of which a volume, consisting of two numbers, will appear annually. The object of this useful collection is to make the public acquainted, in a manner suited to the capacity of readers in general, with the newest technological discoveries, and their application to different purposes.

Petersburgh, July 11, 1804.

The aërial excursion undertaken by order of the Academy of Sciences for making scientific discoveries has had the wished-for result. On the 12th instant the Academician Sacharoff, who is an excellent chemist, and Professor Robertson, ascended from the gardens of the corps of cadets at twenty-five minutes past seven, the weather at that time being fine. The learned bodies, and all those interested for the progress of the sciences, were present at this ascent, which was the finest ever seen at this place. The three small balloons which were previously let off proceeded first southward, but soon after were driven towards the Baltic. This, however, did not prevent the two philosophers from undertaking their journey, for which a great many instruments had been provided in order to make experiments. The balloon hovered more than an hour above the sea. It was found that there were two currents of air. The spectators observed the travellers make a manœuvre, the object of which was to avoid the higher current and to cause the balloon to proceed more to the south. It was then observed to rise gradually higher till about ten o'clock, when it entirely disappeared from the persons who were stationed on the Observatory. In the evening of the following day an account was brought to the Academy of Sciences, by a courier, that the travellers had arrived safe at Sivaretz, sixty versts from this capital. They descended about forty-five minutes past ten at the English garden, opposite the seat of his excellency General P. G. Demidof, by whom they were received in the most hospitable manner. The result of this aërial excursion, undertaken merely for scientific purposes, will soon be published.

ACADEMY OF BERLIN.

Colonel von Knobelsdorf, ambassador at the Ottoman Porte, who was received on the 7th of June as a member of this learned body, presented to the Academy twelve volumes of Persian manuscripts which he had collected in the East. This valuable present consists of the following works: 1st, Rauzat al Safa, the Great History of the East by the celebrated historian Mirkond, in seven volumes, of which an account may be seen in Herbelot, and in the history of Gengis Khan, by La Croix. 2d, Zobde Tavari, Select Histories. 3d, A History of the Family of Sefi to Schah Abbas. 4th, History of Nadir Schah. 5th and

6th,

6th, The Works of the celebrated poet Grami, entitled Divan.

ACADEMY OF SCIENCES AT TURIN.

The class of the physical and mathematical sciences has proposed the following prize questions:—1st, The phænomena of electricity and galvanism present on the one hand so many analogous circumstances, and on the other such a great number of different effects, that many philosophers consider them as identic, while others suppose that there are two different fluids. The Society therefore requires new experiments, which may determine in a definitive manner whether the fluids are the same or different.

The prize is 600 franks; and the papers must be sent in before the 20th Dec. 1804.

2d, It appears by the *Connoissance des Tems*, an 12, p. 217, that the refraction assumed does not make the observations of the summer and winter solstice of the years 7, 8, and 9, to coincide so exactly, as to give to the ecliptic that obliquity which it ought to have; and it is evident that a difference of eight seconds, found in the result of the calculations, not of one or two, but of all the observations made on different days of different years, must arise from some cause or other: a satisfactory explanation of this subject is required. The prize and period the same as above.

The class of literature and the arts have proposed the following question:—To show whether the science known under the name of Statistics be new; and what advantage states derive from it. Prize and period as before.

The papers may be written in Latin, French, or Italian; and must be sent to the Academy post paid.

THE MARKISH ECONOMICAL SOCIETY.

This society has offered a premium of twenty-five rix-dollars for the surest and best means of extirpating caterpillars. The premium will be adjudged in the spring of the year 1806, but the papers must be transmitted to the society before May 1805.

ITALIAN NATIONAL INSTITUTE.

Paris, August 8th.

Equally desirous of conferring the blessings of order and the happiness derived from science, his Imperial Majesty has decreed a National Institute for the Italian republic. This body of scientific men opened their sittings at Bologna

Bologna on the 10th ult. All Italians eminent for learning, illustrious from talents, and respectable for virtues, are members of it. The constitution of the Italian Institute is the same as that of the French, and foreigners may be elected members of it, and received as such, if the Emperor approves of the choice. The report, that all learned Frenchmen, members of our Institute, are, *de jure*, members of the Italian Institute, is without foundation; though the Italians, by free-will, and without any foreign impulse, have chosen many French literati for their associates in the difficult task to enlighten the superstitious nations of Italy. His holiness the Pope has been elected deputy protector, the Emperor their sovereign being the natural protector; but Pius VII., by the advice of some fanatics, has declined the proffered honour; and the Vice-president Melzi has been chosen in his place. Among its most remarkable members is Signor Paulini from Ravenna, who, though blind, is one of the first Italian mathematicians, at the age of only eighteen. The Italian men of letters, subjects of the Emperor of Germany, and of the King of Naples, have returned the diplomas sent them as members of the Italian Institute; no doubt by the orders of their respective sovereigns.

BOARD OF AGRICULTURE.

Premiums offered by this Board.

[Continued from p. 204.]

Draining.—To the person who shall lay before the Board the most satisfactory account of one of Mr. Elkington's drainages——*the silver medal.*

The soil, and state of the land before draining, the method and expense of the improvement, with a plan, and the result of the operation, to be produced on or before the second Tuesday in December, 1805.

Draining.—To the person who shall execute, and report to the Board in the most satisfactory manner, the greatest drainage in any method the most applicable to the state of the soil——*the gold medal.*

The soil, and state of the land, before draining; the method and expense of the improvement, with a plan, and the result of the operation, verified by certificates, to be produced on or before the second Tuesday in December, 1805.

Folding Sheep.—To the person who shall, by a series of the most satisfactory experiments, ascertain the comparative

tive advantages and disadvantages, and best method of folding or cotting sheep——*the gold medal.*

Accounts, verified by certificates, to be produced on or before the first Tuesday in April 1805.

The same premium for 1806.

The same premium for 1807.

Irrigation.—To the person who shall, in a country where irrigation is not generally in practice, water the greatest number of acres, not less than ten, and in the completest manner——*the gold medal.*

To the person who shall, under similar circumstances, water the next greatest number of acres, and in the completest manner——*the silver medal.*

Accounts of the old and new state of the land, and its value, and of the method, expense, and produce, verified by certificates, to be laid before the Board, on or before the third Tuesday in January 1805.

The same premiums for 1806.

Horses and Oxen.—To the person who shall make, and report to the Board, the most satisfactory experiments on the comparison of horses and oxen, in the general business of a farm——*the gold medal.*

The account, verified by certificates, to be produced on or before the last Tuesday in April 1805.

The same premium for 1806.

The same premium for 1807.

Manures.—To the person who shall lay before the Board, the most satisfactory account, verified by chemical experiments, or other sufficient authorities, of the nature of manures, and their effect on the principles of vegetation——*the gold medal.*

To be produced on or before the first Tuesday in December 1804.

The same premium for 1805.

Manures.—To the person who shall lay before the Board, the most satisfactory account of the application and effect of manures, verified by practical experiments on not less than one acre for each sort of manure——*the gold medal.*

To be produced on before the first Tuesday in December 1804.

The same premium for 1805.

Marl and Chalk.—To the person who shall report to the Board, the result of the most satisfactory experiments, made by or under the inspection of the reporter, on marling, chalking, or claying, not less than 100 acres of land ——*the gold medal.*

 It

It is required that the nature and quality of the manure, and of the land on which it is spread be described.

Accounts, verified by certificates, to be produced on or before the first Tuesday in March 1805.

L. *Miscellaneous Correspondence.*

To Mr. Tilloch.

One essential service which is rendered by a Philosophical Journal, conducted on the plan which you pursue, is to unite, and bring into a more general point of view, many curious facts and remarks that are scattered up and down in literature, and often in works where you would least expect to find them. The learned Warburton, in his Divine Legation of Moses (vol. ii. 4to. ed. p. 241.), has the following note, referring to this preceding passage: "We are told that Pythagoras's popular account of earthquakes was, that they were occasioned by a synod of ghosts assembled under ground." But Jamblichus informs us, that he sometimes predicted earthquakes, by the taste of well-water.— One scarce meets with any thing in antiquity concerning Pythagoras's knowledge in physics, but what gives us fresh cause to admire the wonderful sagacity of that extraordinary man. This story of his predicting earthquakes has so much the air of a fable, that I believe it has generally been ranked (as it is by Stanley) with that heap of trash, which the enthusiastic Pythagoreans and Platonists of the lower ages have raked together concerning him. Yet we learn from the collections of Pliny the elder, which say, "*futuro terræ motu, est in puteis turbidior aqua,*" l. ii. c. 83. that the antients profited of this discovery, verified by a modern relation of Paul Dudley, Esq. in the Philosophical Transactions, No. 437. p. 72, who, speaking of an earthquake which lately happened, was surprised to find his water, that used to be always sweet and limpid, stink to that degree that they could make no use of it, nor scarce bear the house when it was brought in; and thinking some carrion was got into the well, he searched the bottom, but found it clear and good, though the colour of the water was turned wheyish, or pale. In about seven days after the earthquake, his water began to mend, and in three days more returned to its former sweetness and colour. Yours, &c.

R. Minorqueen.

Mr.

Mr. Tilloch.

On Tuesday the 14th instant (August), about ten at night, the atmosphere being rather cloudy, a most brilliant stream of light suddenly appeared at Petworth in Sussex, extending from the N. E. towards the South Downs. It lasted about a minute and a half, and then gradually disappeared, beginning from the N. E. Probably some of your correspondents may have also observed this curious meteor. I never witnessed any so singularly beautiful.

Yours, &c. J. S. S.

Mr. Tilloch.

Your excellent publication possesses, in my opinion, an additional value, from the extracts you have lately inserted from curious and scarce books, which now are not generally known. With this idea I send you the following excellent recipe for the speedy recovering of the use of the foot or hand that has been violently sprained: which appeared in the Annual Register for 1760, signed Theoph. Lobb, Bagnio-court, Newgate-street.

"1. Let it be fomented with vinegar, a little warm, for four or five minutes at a time, once every four hours: this will render the circulation of the fluids in the parts affected more easy; and either prevent a swelling, or promote its subsiding.

"2. Let the person stand three or four minutes at a time on both his feet, in their natural posture, and sometimes move the strained foot: and sometimes, when sitting with his foot on a low stool, let him move it this way and that, as he can bear it. This will contribute much to contract the over-stretched vessels, and to recover a due circulation of their fluids through them.

"3. Let a gentle dry friction with a warm hand be sometimes used to the parts affected, which will conduce much to the same ends.

"4. Two hours after every application of the vinegar, let the part affected be just wetted with the rectified spirits of wine, and then gently rubbed.

"By these means persons to whom I have advised them have recovered from the effects of very violent sprains in a few days, as some others have been weeks in recovering by different ways of management; such as a continual resting of the strained foot, and disuse of its motions."

F. M.

Mr. Tilloch.

DEAR SIR,

As it is the wish of philosophers to collect every thing that has occurred relative to the stones which, at different periods, have fallen on our globe, I send you the following extract from the third volume* of the poet Cowper's correspondence, as published by his learned friend Mr. Hayley, June 13, 1783.

"The fogs I mentioned in my last still continue; though, till yesterday, the earth was as dry as intense heat could make it. The sun continues to rise and set without his rays, and hardly shines at noon even in a cloudless sky. At eleven last night the moon was a dull red; she was nearly at her highest elevation, and had the colour of heated brick. She would naturally, I know, have such an appearance looking through a misty atmosphere; but that such an atmosphere should obtain for so long a time, and in a country where it has not happened in my remembrance, even in winter, is rather remarkable. We have had more thunder storms than have consisted well with the peace of the fearful maidens in Olney, though not so many as have happened in places at no great distance, nor so violent. Yesterday morning, however, at seven o'clock, two fire-balls burst either on the steeple or close to it. William Andrews saw them meet at that point, and immediately after saw such a smoke issue from the apertures in the steeple, as soon rendered it invisible: the noise of the explosion surpassed all the noises I ever heard: you would have thought that a thousand sledge hammers were battering great stones to powder, all in the same instant." Yours, &c. J. S. S.

LI. *Intelligence and Miscellaneous Articles.*

PARTICULARS OF THE SALE OF PART OF HIS MAJESTY'S FLOCK OF SPANISH SHEEP,

On the 15*th Day of August* 1804.

It is a singular circumstance, considering the great length of time that fine or broad woollen cloths have been in use in Europe, that the wool from a particular breed of sheep, kept only in Spain, where there are exceedingly large flocks

* Page 178. In a letter to the Rev. John Newton.

of

of them, should have been essential to its fabrication. These sheep are known by the name of the Merino breed, and were peculiar to Spain till about the year 1786, when the unfortunate Louis XVI. introduced a flock of them into France, the progeny of which are still subsisting, and their wool possessing all its original qualities, upon the national farm at Rambouillet, and in the neighbouring communes. His Britannic Majesty was not unmindful of this object, and within a year of the same period began, and continued from time to time, the importation of small flocks of Merino sheep, which were, with his majesty's known liberality, presented to different agriculturists and breeders; or sold, with a view of disseminating the breed, at the common prices of English sheep at the time. In the year 1792, through the medium of lord Auckland, who had been ambassador to Spain, his majesty procured from the marchioness Del Campo Dialange, forty of the best Spanish sheep, in exchange for eight fine English coach horses: this flock his majesty confided to the care of Sir Joseph Banks, bart. president of the royal society, who has paid more attention to the subject of wool (and is without doubt the most perfectly informed on all points relating to its production and uses) than any other man. His royal highness the duke of York's park, at Oatlands, was selected as the scene of these interesting and national experiments.

Sir Joseph Banks had assiduously employed himself upon his estate in Lincolnshire, since the first introduction of Spanish sheep, in trying the effect on wool and carcase, of all the crosses which could be made between them and the different breeds in England; but on receiving charge of the royal Merino flock, in 1792, he disposed of all his own sheep, in which there was any mixture of Spanish, and has confined his views in the management of the royal flock to the preservation of the original breed of 1792, having since admitted no crosses, not even of newly imported Spanish sheep, however superior their pretensions. These sheep are very far from handsome in their shape, and too generally look thin and poor; they are principally distinguished from other sheep, next to the superior fineness of the fibre of their wool, by the dirty appearance of their fleece outside, though beautifully white within, owing to the greasy matter, or yolk, as it is called, with which it abounds, causing the dirt of the land to adhere to the wool; they have also white faces, of a peculiar silky appearance; just above the nose are two or three singular wrinkles, and upon the head,

 behind

behind the horns, is a soft protuberance of flesh: they are also less in size than a great proportion of the English sheep. The Merino flock continued healthy, and increased very fast: but the buyers of wool were averse to the idea that any wool grown in England could answer the purpose of that imported from Spain, in the manufacture of fine cloth; and Sir Joseph Banks was unable to obtain more than 2s. per pound for the wool of these sheep in 1796, and only 2s. 6d. in 1797. In 1798, this wool was washed previous to the sale, and sorted into three different parcels, according to its fineness, as is done in Spain, viz. prime wool, or Raffinos (R), which sold for 5s.: choice locks, or Finos (F), at 3s. 6d.; and fribs or Terceros (T), which fetched 2s. 6d. The fleeces of 1799 from this increasing flock, treated in the same way, were sold; the prime wool, or R's, for 5s. 6d., the choice locks, or F's, for 3s. 6d., and the fribs, or (T's), for 2s.;—5s. 6d. being in these two last years the standing price of the very best imported wool. The royal Merino flock at Oatlands continuing to increase, in 1800 the R's produced 5s., the F's 3s., and the T's 1s. 6d. In 1801 the R's fetched 5s. 6d.; the F's 3s. 6d.; and the T's 1s. 9d. Eleven wether or castrated sheep were this year fatted, and at Christmas 1801 sold at good prices; the mutton also proving excellent in quality: and very unexpectedly the pelt wool, or that obtained from the skin by the fellmonger, produced 10s. for each sheep, after all expenses attending it were paid.

In 1802 Sir Joseph Banks obtained for the wool of his majesty's Spanish flock, the R's 5s. 9d.; the F's 3s. 6d.; and the T's 1s. 9d.; and in the year 1803, the prime, or R's, produced 6s. 9d.; the F's 4s. 6d., and the T's 2s. The quantity of the inferior sorts of wool, from each fleece, has evidently decreased since these sheep were in England, and at this time less of the fribs will be found in any number of fleeces of his majesty's wool, than in the same number and weight of fleeces produced in Spain; a proof that the wool is not disposed to degenerate in our climate. The wool of the present season was washed on the backs of the sheep in the English way, and sold all together without scouring or sorting, at 4s. 6d. per pound. The royal Merino flock in June last consisted of 100 ewes, 5 rams, and 78 lambs; these 78 lambs being the produce of 90 ewes, with which 4 rams were used; also of 23 shearling rams, 7 rams of greater ages, and 14 ewes, which were selected for the intended sale, in a paddock in Richmond park, by the side of Kew Foot-lane, not far from the Pagoda.

Among those who have most distinguished themselves in seconding the noble views of his majesty, in introducing and extending the breed of these sheep, are to be named, lord Somerville; Dr. Parry, of Bath; Mr. Bridge, of Winford Eagle; Mr. Ridgeway, of Upperton; Mr. Tollet, of Gloucestershire; and the Bath Agricultural Society; while Mr. John Maitland, of Basinghall-street; Mr. Laycock, of the Borough; and Mr. Edrige, of Chippenham, have done themselves great honour in their endeavours to promote the sale and manufacture of English Merino wool. Mr. Gibblet, of Bond-street, and Mr. King, of Newgate-market, are also deserving of great praise for their exertions in removing the prejudice which was generally entertained against Spanish mutton, on the first introduction of the Merinos into this country.

Mr. Tollet possesses a ram, bred from a ram and ewe sold to him from the royal flock in 1801, which in June last yielded 11¾lb. of wool of the very first quality. The same care and attention which have been for some years past paid to the improvement of other breeds of sheep in this kingdom, by breeding constantly from the most perfect animals in the flock in preference to others, have succeeded in the carcases of several of the royal Merino flock; and as Sir Joseph Banks, in a late address to the public, observes, —"give a justifiable hope, that by a due selection of rams, and a correct judgment in matching them, Merino sheep will in time be produced, with carcases perfectly fashionable, and wool as perfectly fine." The same address, after noticing that the demand for his majesty's Merino sheep increases prodigiously, particularly in Gloucestershire, thus introduces the notice of the present sale from his majesty's flock: "As speculation on the value of Spanish sheep is evidently on the increase, and a reasonable probability now appears that his majesty's patriotic exertions in introducing the breed, will at least be duly appreciated and properly understood; it would be palpably unjust, should the views of those who wish to derive fair advantage from the sale of the progeny of Spanish sheep, purchased by them from the royal stock, be in future impeded by a continuation of the sale of the king's sheep, at prices below their real value."

This circumstance having been stated to the king, his majesty was graciouly pleased to permit the rams and ewes that are to be parted with from the royal Merino flock this year, to be sold by auction, in the same manner as is done at Woburn by his grace the duke of Bedford, and at Holkham by Mr. Coke, on the presumption of this being the most likely manner of placing the best individuals of their improved breeds in the hands of persons most likely to preserve and further to improve them.

Notwithstanding the heavy and almost incessant rain on the morning of the day of sale, near 50 gentlemen and breeders of sheep assembled soon after eleven o'clock, at the pens of sheep intended for sale, and minutely examined them. Sir Joseph Banks, who has but just got abroad from a severe fit of the gout, ventured out, and staid in the field the whole time.

About two o'clock, Mr. Farnham, the auctioneer of Richmond, opened the business by a short but neat speech, on his majesty's gracious views in promoting the breed of excellent sheep before them, and read the printed conditions of the sale. After Sir Joseph Banks had stated that his friends Sir Richard Worsley, of the Isle of Wight, and Sir James Riddle, of Scotland, not being able to attend, had commissioned him to bid for six or more of the sheep, the sale commenced,—at which much keen bidding was seen among the amateurs and breeders present.

The first twenty-three lots consisted each of a single shearling ram.

Lot 1, was a ram, labouring under a temporary privation of sight, which Sir Joseph Banks and Richard Stanford, the king's shepherd, stated to be not very uncommon with these sheep at this season, but from which there was no doubt he will perfectly recover; the weight of his fleece was stated to be, at the last shearing, 3lb. 4oz.; he was knocked down to captain Macarthur, at 6l. 15s. after Sir Joseph had apprised him that an old act of parliament stood in the way of exporting sheep from this country—the captain's object being to take the sheep which he was purchasing to New South Wales, in about three weeks time, to add to the flock which he is rearing near to Botany Bay, with a degree of success which promises to be of the greatest national importance. The sheep intended for lot 2 was unwell, and not offered for sale. Lot 3, fleece 4lb. 3oz. was sold to George Home Summer, Esq. at 7l. 12s. Lot 4, fleece 3lb. of very fine wool, was sold to Mr. Knowles, at 9l. 10s. Lot 5, fleece 4lb. was bought by Mr. Andrews, for Mr. Beckingham, near Canterbury, at 10 guineas. Lot 6, a very lively sheep, was bought by captain Macarthur, at 11l. Lot 7, fleece 3lb. 12oz. with bad eyes at present, was knocked down to Sir Joseph Banks, for one of his friends, at 6l. 7s. Lot 8, fleece 5lb. 4oz. was sold to Mr. Knowles, at 10 guineas and a half. Lot 9, fleece 3lb.

 12oz.

12oz. was bought by J. W. Allen, Esq. near Bury, at 30 guineas. Lot 10, fleece 3lb. 6oz. was sold to Mr. Leith, at 10 guineas and a half. Lot 11, fleece 3lb. 12oz. of better wool than the last, sold to captain Macarthur, at 15 guineas. Lot 12, fleece 5lb. 4oz. was sold to George Home Summer, Esq. at 27 guineas. Lot 13, fleece 3lb. 4oz. was bought by captain Macarthur, at 16 guineas. Lot 14, was sold to Mr. Warren, at 15 guineas. Lot 15, a sheep at present blind, fleece 4lb. 15oz. sold to captain Macarthur, at 22 guineas. Lot 16, a very perfect sheep and fine fleece 4lb. 4oz. sold to Sir Joseph Banks, at 20 guineas. Lot 17, a sheep having the disorder called the foot rot, fleece 4lb. 12oz. was sold to Mr. Warren, at 12 pounds. Lot 18, fleece 4lb. 8oz. was bought by Sir Joseph Banks, at 14 guineas. Lot 19, fleece 4lb. 12oz. very fine wool, was sold to G. H. Summer, at 20 guineas. Lot 20, fleece 4lb. 6oz. was bought by Sir Joseph Banks, at 15 guineas. Lot 21, fleece 5lb. to Mr. Beckingham, at 25 guineas. Lot 22, fleece 4lb. 4oz. to captain Macarthur, at 21 guineas. Lot 23, fleece 4lb. 8oz. to Sir Joseph Banks, at 20 guineas. Lot 24, fleece 5lb. 12oz. to Mr. Freeman, near Henley, at 42 guineas, which finished the shearling rams. Lot 25, a full-mouthed ram, which had not been used, though so expressed by mistake in the bill, was sold to general Robinson, of Scotland, for 7 guineas and a half. Lot 26, a full-mouthed ram, called Young Snag, four years and a half old, whose sire was in as much repute among the king's sheep, as Eclipse among race-horses, and who had been used in the king's flock, fleece 5¾lb. was sold to G. H. Summer for 18 guineas. Lot 27, a four-tooth ram, which had not been used in the royal flock, fleece 7lb. 8oz. was sold to Mr. Jefferson, at 38 guineas. Lot 28, a ditto, fleece 8lb. was sold to Mr. Heaven, at 25 guineas. Lot 29, a four-tooth ram, which was used last year in the king's flock, was sold to John Proctor Anderson, Esq. at 24 guineas. Lot 30, a ditto, fleece 7lb. 2oz. was sold to captain Macarthur for 27 guineas. Lot 31, a good ditto, fleece 6lb. 8oz. was sold to Mr. Kidd at 24 guineas, which completed the lots of rams; the remaining fourteen lots being full-mouthed ewes, which had been bred from in the royal flock, and were warranted good bags. Lot 32 sold to Mr. Beckingham at 9 guineas. Lot 33, to Mr. Hallet, at 8 guineas. Lot 34, to Mr. Beckingham, at 7 guineas and a half. Lot 35, to Mr. Freeman, at 7 guineas. Lot 36, to Mr. Freeman, at 8 guineas. Lot 37, to Mr. Leith, at nine guineas and a half. Lot 38, to Mr.

Mr. Eyton, at 11 guineas. Lot 39, to Mr. Knowles, at 7 guineas. Lot 40, to Mr. Beckingham, at 8 guineas. Lot 41, to captain Macarthur, at 11 guineas. Lot 42, to Mr. Campbell, at 9 guineas. Lot 43, to colonel Greville, at nine guineas. Lot 44, to general Robinson, at 7 guineas; and lot 45, to Mr. Hallet, at 6 guineas.

The sale ended about a quarter past four o'clock, when Sir Joseph Banks stated, that the prices at which the sheep had been sold exceeded his majesty's and his own expectations and wishes on the subject; his majesty never having before sold a Spanish sheep for more than six guineas, (they were always before sold by private contract) while he had given away more than 170 sheep: but from the eagerness exhibited this day in bidding, he had no doubt but his majesty's intentions, of placing the sheep in those gentlemen's hands who would most value and attend to the increasing of the breed, would be fully answered. It was stated, that the sheep might stay three days in his majesty's pasture, or even a longer time, at the risk of the purchaser, if not convenient to remove them sooner; but such was the eagerness of the buyers to bear off their lots, that two or three carts appeared in the field in a few minutes, and were loaded with the sheep; and one gentleman took away a sheep he had bought in a post-chaise with him! Besides the gentlemen mentioned above, as present, we noticed Henry Hugh Hoare, Esq. Mr. Chute, Mr. Snart, superintendant of his majesty's farm at Richmond, Mr. Lawrence, Mr. Farey, &c. This show and sale of sheep is intended to be annual; and next year a larger number of ewes are intended for sale, his majesty's flock having now arrived at the number intended to be kept.

COPERNICUS.

The following letter of count Thadæus Czacki and colonel Molski, who have been employed in collecting information respecting this celebrated man, has lately been published in one of the foreign journals:

"During the tour which we undertook with a view to collect monuments of our country, now become extinct, we sought for the remaining traces of Copernicus. Our discoveries have not been great; but, agreeably to our own wish, and the desire of our society*, we have deposited them in the hands of a person who has resolved to make

* Of the Friends to the Sciences at Warsaw.

particular

particular researches respecting the life and writings of Copernicus*. N. Copernicus was a canon at Ermeland, and administrator of the possessions of the chapter of Allenstein. As he had therefore two places of residence, he had observatories at both. In the habitation possessed at present by an evangelical Lutheran pastor, there were some manuscript verses, written by Copernicus with his own hand, pasted to the chimney piece; but about fifteen years ago a pastor who left the place carried with him this memorial of that celebrated man. The name and arms of Copernicus were also painted in colours on a pane of a window; but this monument, which had remained three centuries and a half, disappeared likewise about a dozen years ago. Over the door is shown a place where there was an aperture, through which the solar rays entered at stated times and passed into another chamber; but six years ago the present possessor caused the hole to be filled up†. The tower in the neighbourhood, on which Copernicus made his observations, is kept in bad repair, and serves for the confinement of prisoners, the rattling of whose chains we could hear. When we arrived at Frauenburg we visited the church where the ashes of Copernicus are deposited, and several times repeated his name—a name never mentioned by the old or the young but with the greatest respect; they leave to the learned to pay honour to the extent of his scientific knowledge, and venerate the remains of a man who is their neighbour. Frauenburg has a high situation: where the church stands there is no water, nor is there a single mill in the surrounding district. Copernicus constructed half a mile higher up the river an oblique dam fifteen ells and a half in length, where he erected a mill, and the water was raised by a wheel to the summit of a tower, from which it was distributed by pipes, so that each of the canons had water conveyed into his house. This machine has been worn out. The chapter, whose finances in the year 1772 were in a bad state, are now about repairing this work. It is a common saying among the learned of this place, that a model of this machine was requested in the time of Louis XIV. We entered the church. Near the altar is a grave-stone covered in part by a marble balustrade

* I. Sniadecki.

† It is probable that this was an astronomical gnomon, which Copernicus had caused to be constructed in his habitation for the purpose of observing the equinoxes, solstices, and inclination of the ecliptic.—*Note by Sniadecki.*

which

which surrounds the altar. Spheres cut out on it in relief, and the letters *Nicol*, showed the place where the ashes of this man were deposited. The chapter were so kind as to permit us to remove every incumbrance. Having washed the stone, we found the following letters NICOL.... COP....CUS, and in another line AN.... M; the other letters were obliterated. We raised up the stone and came to the grave, where we found only the remains of mouldering bones, of which the chapter kept a part, and gave us five fragments with an attestation by the chief prelates: two of these fragments we have reserved for ourselves, another we sent to Pulavy, and two we shall bring to the society. We searched for the manuscripts of this great man, and found some of his signatures among the acts of the chapter. It gives us pleasure to remark, that the tour of Copernicus to Italy, where he seems to have formed his system, was defrayed by the chapter*. The inhabitants of Frauenburg relate, according to an old tradition, that there were there some mathematical instruments made by Copernicus himself. Tycho Brahe in the 16th century set great value on an instrument called a *parallacticum*, which, as he said, had been constructed by that incomparable man, and which was presented to him by Hannof canon of Ermeland. All these monuments are lost, and those who have seen them differ in their accounts. We endeavoured to find some work of Copernicus; but all his works, unfortunately, have been dispersed. His work on the establishment of the mint, to an office in which he was appointed like Newton, is lying somewhere in a town of West Prussia. We, however, found some of his letters on private affairs. One of them we transmit, in order to verify his writing, in case any of his manuscripts should be discovered. We were also in the place in which he resided. It is a small chamber in the upper story, from which there was a passage to his observatory; and of the steps some fragments are still remaining. On three sides he had a view of the strait; on the fourth was a plain, which at present is concealed by a tower built at a later period.

THADÆUS CZACKI,
MARTIN MOLKI."

* M. Sniadecki is of a different opinion.

HUMBOLDT

HUMBOLDT THE TRAVELLER.

It gives us much pleasure to be able to state that the rumours of his death, which have found their way into different journals and newspapers, are unfounded. A letter from Baltimore in America, dated the 16th of June last, states his arrival there from his tour through a great part of South America; and we learn by subsequent accounts that he reached Bourdeaux on the 6th instant (August), accompanied by M. Bonpland, after a favourable passage of twenty-nine days from Philadelphia. Besides the geological collections transmitted to Europe, they brought with them nearly thirty boxes of different articles, which are the more valuable as the countries traversed by these travellers have been little visited.

PROFESSOR PALLAS.

St. Petersburgh, 24th July.

"The celebrated professor Pallas, whose death has been announced in the public journals, is now residing in good health in the neighbourhood of Achmetshet, or Simpheropol, the capital of the Crimea, called at present the province of Taurida, on an estate given to him by the late empress Catherine II., and on which he has lived for several years."

LECTURES.

On the 1st Monday in October next will commence Lectures on Physic and Chemistry, by George Pearson, M.D. F.R.S. of the College of Physicians, London; and senior physician to St. George's hospital.

A lecture is given on Therapeutics, from a quarter before to a quarter past eight o'clock; on the Practice of Physic, from a quarter past eight to about nine; and on Chemistry, from a quarter after nine to ten every morning, excepting Saturdays; on which days a lecture is delivered on the Practice of Physic, from eight to nine, and on the Cases of Patients, from nine to ten.

A complete register is kept of the cases of Dr. Pearson's patients in St. George's hospital, and an account is given of their progress, treatment, and termination, every Saturday morning.

In the course of lectures on the Practice, as preliminary, theoretic Principles of Physic are delivered; the text or heads of which are contained in a printed work for the pupils only.

Here

Here are fully explained the laws of excitability; the leading characteristic symptoms of each disease are given; the evident causes of diseases in general are arranged and explained; and the means and substances for the prevention and cure of diseases in general are also explained, according to an arranged plan.

The articles of the *Materia Medica*, in the Therapeutics, are arranged in a printed work for the pupils only, according to the principal effects on account of which they are prescribed in diseases; specimens of them may be seen; the natural and other parts of their history are related; the forms of administration; the doses; the indications they can fulfil, or diseases in which experience has shown them to be efficacious, are fully explained.

During the summer courses, evening lectures are given on Pharmacy, in which the London Pharmacopœia for 1791 is used as a text book, which may be attended gratis by the perpetual pupils to all the other lectures; as well as lectures on the Cow-pock, at the Institution, 44, Broad-street.

The following courses of lectures will be delivered during the ensuing winter at the Medical Theatre, St. Bartholomew's Hospital:

On the Theory and Practice of Medicine, by Dr. Roberts and Dr. Powell: Clinical Lectures on select cases occurring in the hospital will be occasionally given by Dr. Roberts.

On Anatomy and Physiology, by Mr. Abernethy.

On the Theory and Practice of Surgery, by Mr. Abernethy.

On Chemistry and the *Materia Medica*, by Dr. Powell.

On Midwifery, and the Diseases of Women and Children, by Dr. Thynne.

The Anatomical Lectures will begin on Monday, October the 1st, 1804, at two o'clock; and the other lectures in the ensuing week.

Further particulars may be known by applying to Mr. Nicholson, at the apothecary's shop, St. Bartholomew's Hospital.

At the Theatre of Anatomy, Blenheim-street, Great Marlborough-street, Mr. Brookes will commence his autumnal course of lectures on Anatomy, Physiology, and Surgery, on Monday, the 1st of October, at two o'clock.

A suite of spacious apartments, thoroughly ventilated, and replete with every convenience for the purposes of dissecting and injecting, will be open every morning till two, where Mr. Brookes attends.

N. B. All the subjects are preserved by an antiseptic process.

Dr. Hooper will commence his autumnal course of lectures on the Practice of Physic, *Materia Medica*, and Pharmaceutical Chemistry, on Wednesday, the 3d of October, at a quarter before eight o'clock in the morning, at Mr. Brookes's Theatre of Anatomy.

Dr. Batty's lectures on Midwifery, and the Diseases of Women and Children, will begin on Monday, the 8th of October, at half past ten o'clock, at Mr. Brookes's Theatre.

For particulars, and a prospectus, apply to Mr. Brookes, Theatre of Anatomy; Dr. Hooper, St. Mary-la-bonne Infirmary; and Dr. Batty, Great Marlborough-street.

LIST OF PATENTS FOR INVENTIONS, FROM JULY 24 TO AUGUST 24, 1804,

That have passed the Signet-office.

His Majesty's grant,

To W. Warris, of Sheffield, in the county of York, optician, of the sole use, benefit, and advantage of his invention of an improvement in the mounting of glasses, commonly called opera-glasses. To hold to him, his executors, administrators, and assigns, within England, Wales, and the town of Berwick upon Tweed, for the term of 14 years, pursuant to the statute in that case made and provided.

To Edward Greaves, of Sheffield, in the county of York, razor manufacturer, for his invention on razors.

To Joseph Huddart, of Highbury Terrace, in the county of Middlesex, esquire, for his invention of a mode or art of manufacturing and spinning yarn, different from any such now in use.

To Barker Chifney of London, gentleman, for his invention of a composition to be used in washing, in order to render muslins and linens beautifully white, and for other purposes.

To John Gregory Hancock, of Birmingham, in the county of Warwick, die engraver, for his invention of a method of forcing or working the bolts of presses, or of engines, used for the purpose of cutting, pressing, and squeezing of metals, horn, tortoise-shell, leather, paper, and other substances.

METEORO-

METEOROLOGICAL TABLE*

For August 1804.

Days of the Month.	Thermometer. 8 o'Clock, Morning.	Noon.	11 o'Clock, Night.	Height of the Barom. Inches.	Degrees of Dryness by Leslie's Hygrometer.	Weather.
July 27	60°	65°	58°	29·50	40°	Cloudy
28	59	68	60	·51	35	Showery
29	63	69	59	·68	44	Showery
30	61	73	61	30·02	75	Fair
31	63	78	69	·20	93	Fair
August 1	70	80	62	·30	58	Cloudy
2	62	71	58	·16	32	Cloudy
3	61	79	64	29·85	36	Cloudy
4	63	72	58	·77	28	Cloudy, rain at night
5	64	72	61	·85	55	Fair
6	63	70	58	30·00	71	Fair
7	57	68	56	·08	60	Fair
8	60	69	56	29·62	31	Showery
9	59	60	57	·82	54	Fair
10	58	69	56	·60	50	Showery
11	58	68	57	30·03	53	Fair
12	60	66	54	29·68	42	Showery
13	55	60	49	·56	15	Rain
14	52	67	55	·50	47	Fair
15	58	68	57	·57	52	Showery
16	59	67	56	·72	41	Stormy
17	58	66	50	·87	45	Showery
18	52	64	54	·94	38	Showery
19	55	63	51	·80	40	Cloudy
20	54	64	52	·86	46	Fair
21	55	64	55	·92	47	Fair
22	56	63	49	·98	49	Fair
23	55	63	53	30·10	49	Fair
24	56	65	57	·15	49	Fair
25	55	63	57	·15	43	Cloudy
26	57	65	58	·30	43	Fair

* By Mr. Carey, of the Strand.

LII. *An Inquiry concerning the Velocity of the calorific Rays which proceed from the Sun, with a View of ascertaining the Rate of it experimentally, though it should not be far short of the Velocity of Light, &c. &c.*

The author of the following paper sends it with his most respectful compliments to Mr. Tilloch, and refers the publication of it, in his valuable Philosophical Magazine, entirely to his convenience. Though it has been but lately drawn up, yet the general view of the subject, and the theory of the experiment, were fully explained by the author to a few of his philosophical friends and correspondents more than a year ago.

Ramsgate, 9, Effingham Place,
25 August, 1804.

TILL of late times, whatever effects were observable in the case of different substances being, for a longer or shorter time, fully exposed to the influence of the sun, it was held as evident that all such had a necessary dependence upon his rays of light. The changes produced on vegetable colours, the aromatic oil of plants, their acquiring the property of being combustible, the irritable state of their leaves; and further, certain curious effects on the mineral acids, on manganese, on the oxides of silver, lead, bismuth, &c.; nay even the burning heat of the focus of a lens or speculum. All these changes and effects were considered as in some way or other produced by the action and properties of the sun's light. This conclusion seemed indisputable; as derived from the direct information of sense. In this however we meet with a remarkable instance of our being sometimes liable to error, from the limited nature of our faculties, even when pursuing philosophical researches according to the rules of a just and cautious induction.

It was not then suspected, that in the *solar beam* were blended other emanations, which, being unrelated to vision, had altogether eluded our notice; or that the marvellous body of the sun, by those recondite processes in his atmosphere which our telescopes show to be in perpetual activity, might be the great fountain not only of light, but of other radiant principles, subservient also to the œconomy of nature, as established in the planetary system.

That the sun's radiations are actually so compounded, and richer far than had been thought of, has lately begun to appear by two very interesting discoveries.

The numerous and important experiments of that excellent and most indefatigable philosopher Dr. Herschel, manifestly show, that rays of a nature different from light, on which depends the vivifying heat of the sun, are also emitted by him, and are subject to similar laws of reflection and refraction. By the experiments also of the admirable Scheele and Senebier, as further cultivated by Messrs. Ritter and Bockman in Germany, and by Dr. Wollaston in England, we have still more recently detected a third sort of rays, fairly separable by the prism from those of light and caloric, and which, beyond the visible boundary of the violet colour, are found to produce very peculiar effects, heretofore falsely imputed to the sun's light.

These two discoveries will probably be thought important by the philosophical chemist. At any rate, they will demand of him to review and new model certain received opinions, and may ultimately lead to no small improvement of his science, by discarding from it several imaginary effects of light, and tracing the same to their real sources by a more enlarged experience.

Ever since considering the sun's emanations as so compounded, and as consisting at least of three different principles, namely, light, caloric, and rays also of what has been called the *deoxidizing principle*,—it has appeared a curious question, how far these radiations may differ in respect to the velocity with which they are emitted or sent forth by the sun. This inquiry seems not only interesting on its own account, but because, were their velocities found unequal to any considerable degree, we should have an additional argument of much force in favour of such rays being of a nature entirely different.

In a valuable philosophical work lately published by a very respectable author, there is an observation relating to this subject expressed in the following terms: "That as the rays of light and of caloric, emitted by the sun, accompany each other, it cannot be doubted that they move with the same velocity*." But as to this, so far as the meaning is understood, there seems to be some mistake or oversight. If by the rays so accompanying one another be meant that all the constituent particles of each of the two kinds, at the same instant emitted, still keep contiguous, each to each, in their progress forward from the sun, then surely they must move with the same common velocity. This, however,

* See Mr. Thomson's System of Chemistry, 2d edit. Edinburgh, 1804, vol. i. page 306.

ever, seems to be merely an identical proposition, or a begging of the question. For where is the proof of their so keeping together? Perhaps it may be said it consists in this, that we always find a body is both illumined and warmed as soon as exposed to sunshine; which shows that, wherever the luminous particles are found, they are accompanied by those of caloric. But this may be very possible without supposing the particles in question have kept contiguous in their journey all the way from the sun, or indeed longer than a very small moment of time. Their velocities may differ exceedingly, and yet, as to sense, particles of each kind may every instant arrive simultaneously, and affect the body. For this, nothing more is required than that the interval of time between the arrival of one particle after another, belonging to either of the rays, be so very transitory as wholly to elude our perception: a position which it is presumed will not be disputed.

The same author, in the way of further proving the great velocity of the rays of caloric, refers to some experiments made by the ingenious M. Pictet, of Geneva, the result of which shows, that they pass over a space of sixty-nine feet in an interval of time too minute to be measured. If however the velocity in question, even supposed much slower than the astonishing speed of light, approximates to that high scale of rapidity, such experiments would be utterly incapable of assisting us when aiming at any measurements. For, though the motion were a hundred times slower than that of light, still the calorific rays would be propagated from the sun at the rate nearly of two thousand miles in a second of time; a transit far too rapid to be measured or ascertained by M. Pictet's method.

If, indeed, the sun had been so constituted as that, now and then, a total failure of his emanations took place for twelve or fifteen minutes, their relative velocities could have been determined, according to Mr. Pictet's method, by watching the order of their arrival after such an intermission. According to this, should his light, for example, move with double the velocity of his calorific rays, a lens or speculum might give a bright image of the sun deprived of all power of affecting the thermometer for near four minutes, till the arrival of the rays of caloric, which would then give a burning focus. In like manner we might wait shorter or longer, before the effects of the deoxidizing rays could be perceived beyond the violet colour of the prismatic spectrum, according to their velocity compared to that of light. Such means of trial are, however, utterly to be despaired of.

It shall next be attempted to explain the principles of an experiment applicable to the same purpose, and which does not seem to be altogether beyond our reach. Though great difficulties may stand in the way of an adequate apparatus, yet at any rate it may not be amiss to expound the theory of the method, so as to have it in reserve. The history of science affords not a few instances of great difficulties of a practical kind being at last surmounted.

It is well known to astronomers how, by Dr. Bradley's noble discovery of what has been called the *aberration* of the fixed stars, the velocity of their light has been determined. The observations of the same astronomer prove also the remarkable fact, that the velocity of all star-light is the same. From this circumstance it might have been concluded, upon the strongest grounds of analogy, that the light of our sun is emitted with equal rapidity. But previous to the discovery of aberration, the velocity of the sun's light, as reflected to us from Jupiter's satellites, was determined by Romer in a different way; and the near agreement between this and that of star-light makes it still more reasonable to believe that the velocity of the sun's emitted light makes no exception to the general law.

It must therefore be so astonishingly rapid, as to carry the rays over a space little short of two hundred thousand miles in a single second of time. Still, however, rapid as this is, the velocity of the earth in its orbit is found to bear some sensible proportion to it. In consequence of this, it is demonstrable that we can never behold the sun in his true place in the ecliptic, but always removed from it towards the west, or contrary to the order of the signs, by an angle of twenty seconds, corresponding to what has been called the aberration of his light.

Were the sun's light to be emitted with only one half or one third of its present velocity, the corresponding aberration or apparent change of place towards the west, as is well known, would be doubled or tripled; the centre of his disk all the while still keeping in the ecliptic.

In like manner, were the sun all at once to emit an additional set of rays equally refrangible, suppose of a deep violet colour, but with one tenth part only of the velocity belonging to his present white light, the centre of this violet disk would appear to us more westerly on the ecliptic than that of his usual white disk, by an angle of three minutes; that being the difference of aberration corresponding to the supposed difference of velocity of the two kinds of light. These two equal round disks, therefore, each of

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whose diameters would subtend an angle more than ten times greater than this separation of their centres, would appear in the heavens not entirely to coincide, but to overlap one another, as represented in fig. I. (Plate IX.) where the strong marked circle stands for the sun's usual white disk, and the faint one for the disk corresponding to the supposititious violet rays, and the line EC for the ecliptic passing through the centres of both.

The consequence of this overlapping would be remarkable. We should behold what now might be called a compound disk of the sun, a little drawn out or elongated in the direction of the ecliptic, and having the *lunula* or *crescent* W shining with white light, forming its eastern limit, and an equal and opposite crescent V shining with the supposititious violet light, while the intermediate portion of the disk bounded by the two crescents GGGG, would shine with both the white and violet light blended together.

The very same description would equally apply to an *image* of this kind of sun, formed by a large object-glass of long focal distance, on a white screen or plane placed at the focus, and perpendicular to the principal axis of the lens. The image formed on the screen would consist of the white and violet crescents, and the intermediate space of a mixed colour; only inverted as in fig. 2; just as it would be were there no aberration in the case, and as if such a party-coloured sun as in fig. 1, really shone in the heavens, the earth being supposed at rest.

To draw nearer to what is ultimately to be illustrated by this detail, let it next be supposed, that either the calorific or the deoxidizing rays were emitted by the sun, in place of the violet rays above mentioned, with the same slow velocity, but agreeing with the sun's white light in refrangibility. Then it is evident that the rays of caloric, for instance, would be collected in the very same circular space on the screen which was formerly occupied by the violet rays; that is, within the space defined by the *faint circle*, fig. 2. The consequence of this would be, that the portion of the bright image represented by the crescent W would be wholly deprived of the rays of caloric, whilst the rest of the image would be overspread by such rays. Further, it is manifest that another space V beyond the image, but bounding it, corresponding to the former violet crescent, would also be overspread by the rays of caloric.

Thus, therefore, would the sun's bright image on the screen be attended with extraordinary circumstances, which, though not in the least perceivable in the first instance by our sight, yet might be made evident by a careful application of very minute delicate thermometers, or by any other means suited to discover to us the presence of caloric. For thereby that whole portion of the bright image answering to the crescent W would be incapable of heating or affecting the thermometer, since by hypothesis no rays of caloric are there to be found; whilst all the rest of the image, as well as the dark space beyond it corresponding to the crescent V, would suddenly heat and affect the instruments.

It may be observed, in passing, that similar extraordinary circumstances would also attend the sun's bright image, in relation to the deoxidizing rays, upon the same assumption of the slowness of their motion and equal refrangibility. For a narrow slip of paper, prepared by the muriate or nitrate of silver, would not be discoloured when exposed any where within the bright crescent W, which by hypothesis is deprived of the deoxidizing rays; but would soon be so in any other part of the image, and even when exposed in the dark crescent V.

But to return to the instance of the calorific rays: it will easily now be understood that the greatest breadth AB, fig. 2, of either crescent W, V, will be more or less considerable, according as their velocity falls more or less short of that of the sun's light. For these crescents, so related to the sun's image on the screen, may be considered merely as creatures of aberration, so to speak, arising from the difference of velocity of the two sorts of rays. AB therefore, the greatest breadth of either crescent, must in all cases be equal to PO, the separation of the centres belonging to the bright image and circle comprehending the rays of caloric. But, from the principles of aberration, this space PO, or its equal AB, considered as lying in the plane of the sun's image on the screen, must subtend at the vertex of the object-glass, an angle equal to the difference of the aberration of the rays of light and of caloric. If, therefore, we could by any means ever measure this space AB, the greatest breadth of either crescent, we should immediately discover the difference of aberration sought. For, the focal distance of the image being always given, that would be to AB, suppose found, as radius to the tangent of the angle required; from which the velocity of the calorific rays is immediately deducible; as will more fully appear in the sequel.

Further, it is obvious that the space AB, so to be measured in the screen, would become more and more extended

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in proportion as the image itself and corresponding circle of calorific rays are enlarged by increasing the focal distance. Even though the velocity of the rays last mentioned fell but little short of the vast rapidity of light, still the crescents might be measurable on the screen, if we had it in our power to extend the focal distance at pleasure, with a suitable enlargement of aperture, so as to give an image of the sun a little hotter than common sunshine.

Part II.

To enter now, a little, upon a practical view of the subject, it comes to be considered how much slower the velocity of the sun's calorific rays ought to be, compared to that of his light, before we might expect to discover, by the most delicate thermometric trials, the presence of the two crescents susceptible of being measured. In order to this, it is apprehended that a focal distance of at least fifty feet could be so managed, by a proper apparatus, as to give sufficient steadiness to the image, whose diameter on the screen would be about five inches and a half, as in fig. 2.* Next suppose that, by thermometrical trials, we found out the two crescents, the bright one from B to A relatively cold, and the opposite dark one hot to the distance of A, and that AB, the greatest thickness of either, measured 2-10ths of an inch. From this last datum, the velocity of the calorific rays, corresponding to it, would be determined by the following analogy: As six thousand, the focal distance expressed in tenths of an inch, is to two-tenths the greatest breadth of either crescent, so is radius to a fourth proportional, the tangent of an angle of sixty-eight seconds, or 1′ 8″. This would be the difference between the angles of aberration of light and the rays in question, which when increased by twenty seconds, the known aberration of the former, would give an angle of eighty-eight seconds for the real aberration of the calorific rays. Lastly, as it is well known that the velocities of any two sets of rays must be inversely as the tangents of the angles of aberration corresponding to them, or to the angles themselves when very small, it follows that, in the present example, the velocity of the calorific rays would be to that of light in the ratio of 20 to 88; that is, only between four and five times slower.

It is of importance here particularly to remark, that

* In the original diagrams sent with this article the diameter of the circles was $5\frac{1}{2}$ inches, but in the engraving this has necessarily been reduced to 3 inches.—Edit.

though,

though, with this extent of focal distance, we discovered not any symptoms whatever of such crescents, yet still such an apparatus, if sufficiently manageable, would enable us to conclude, in the way of approximation, that the velocity of the calorific rays comes nearer to that of light than in the ratio above mentioned. For otherwise the crescents would be rendered very palpable by the power of such an apparatus.

It is almost needless to mention, that the foregoing example would equally apply in the case of inquiring about the velocity of the deoxidizing rays; since, by their property of quickly changing the colour of certain prepared substances, the crescents corresponding to them might, by careful trials, be either made evident, or, if that failed, a certain conclusion might be drawn in the way of approximation.

It will not probably have escaped notice, that hitherto it has been all along supposed, that crescents only of very small extent would be the consequence of the different aberrations arising from the different velocity of the sun's several radiations. This has arisen, in some measure, from having prejudged the question, by thinking it most probable that the difference of the velocities may be so inconsiderable. But, for what is at present known to the contrary, the crescents may be found somewhat more extended, and so much the more favourable for the experiment proposed.

Possibly it will not immediately occur to those who think that the velocity of the calorific rays may be comparatively exceedingly slow, why we have adhered to the supposition of crescents of any size. It may be said that, according to the principles laid down, and the possible sluggish motion of the rays, we ought, in place of two crescents, rather to look for a total separation of the sun's bright image from the circle comprehending the calorific rays, and to some distance, more or less considerable, on the screen. To this it can be answered, that though the aberration would certainly, in an extreme case, produce that effect, were the velocity so slow as is contended for, yet many facts already well known incontestably prove the contrary of that low degree of velocity. For, in the manifold experiments which have been occasionally made with lenses and mirrors exposed to the sun, some of which were of considerable focal lengths, it was never observed that the burning focus lay separated from the concentrated light, or distant laterally from the sun's bright image; which ought to be the case on the hypotheses alluded to. No lens or speculum has ever

ever been found to produce a bright and cold image of the sun in one place, and to burn at another. This fact is now referred to, for the first time so far as we know, as a complete demonstration that the motion of the calorific rays looks up to some high scale of rapidity; though as yet we know not whether it equals or exceeds, or how far it falls short of, the velocity of light. This view of the subject will fully account for our having confined the foregoing illustrations to the case of even small crescents.

Part III.

In order to take still a nearer practical view of the whole of this matter, it is full time now to mention, that though, for the sake of greater simplicity, all the illustrations have proceeded on the supposition of the sun's image being formed by refraction, yet the image made by reflection from a metallic speculum would exhibit the same phænomena of the crescents, &c. as have been treated of at so much length.

Indeed it is only in this way that trials on the principles advanced can be attempted: and for two reasons. 1st, Because we can easily command a competent aperture for the object speculum, in order to obtain, at a long focal distance, an image of the sun sufficiently hot for the intended experiments. Double or triple the force of common sunshine may probably be found the most commodious. 2dly, Because, by reflection, the foci of the calorific and deoxidizing rays, how much soever they differ from light in refrangibility, would lie in the same plane with the luminous image. This condition, it is evident, would be quite necessary for discovering the crescents, if such existed to any sensible extent, and especially for measuring AB, their greatest breadth. In order to this, it would not be requisite to have the sun's image projected on the under side of any screen placed at the focus of the speculum, where it could not be seen or examined without uneasy postures and much inconvenience. The place of the image, free from any screen, and when formed in the air, might in several ways be made visible so far as to know where to apply the thermometers or minute spherules of wax or jelly at the two opposite points, where the crescents, if existing, ought to be broadest, as at A and B, which may be called their *vertices*.

As the success of the experiments would much depend upon our knowing at any time the precise place of either vertex, the following short theory of them ought to be fully understood:—

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When the principal axis of the speculum, by means of a telescopic finder of sufficient magnifying power, is directed to the centre of the sun's disk, it may be considered as parallel to the plane of the ecliptic; the sun's parallax being so very small as not sensibly to alter the case. For the same reason the plane of the ecliptic may then be regarded as cutting the image at right angles and centrically. The diameter of the image, corresponding to this common section, must therefore lie in the direction of the earth's motion in the orbit at the time. The aberration, accordingly, of the sun's rays must lie in the direction of that diameter of the image which, if produced a little at one extremity, must consequently pass through or mark out the vertices of both crescents, should any such be formed by a difference of aberration of the rays of light and caloric.

To find out practically this diameter, or *directrix* as it may be called, some apparatus would be necessary near the focus of the speculum. It might consist of frame-work, so contrived that two harpsichord wires stretched across one another in the same plane, and revolvible on a fixed centre, might be made to intersect at any angle. Let the centre round which the wires turn be placed in the axis of the speculum, at the focus, and the plane of their revolution at right angles to it. Then, on any day at noon, when the centre of the sun's image is brought to the intersection of the wires, turn one of them into the plane of the meridian, and then the other till it cuts the first at the same angle which the ecliptic does the meridian, at the time, as found by calculation, or nearly so. Then this second wire will lie in the plane of the ecliptic, and in the direction of the earth's motion at the time, and consequently will be the directrix sought, passing through the vertex of each crescent, should any such be formed by a difference of aberration.

Should the experiment be reserved for the noon of the day of either solstice, selecting such as fall very near to noon at the place of trial, a horizontal line, conceived drawn through the centre of the image, would then be the directrix, and would continue so, without an equatorial motion, for such short time as might suffice for some trials of the crescents.

The same may be done at any time of the day and year, by first setting the two wires to the same angle which the ecliptic makes with the parallel of the place for the time, and then turning round both till the sun's upper or under limb

limb keeps on one of them as it passes through the field of view. Then will the other wire lie in the plane of the ecliptic, and so will become the directrix, marking out the vertex of each crescent when the axis of the speculum is again pointed to the centre of the disk.

Some have imagined that rays of any kind which are less refrangible than others must, on that account, move with a greater velocity before incidence. According to this opinion, those calorific rays, which Dr. Herschel's late admirable discovery has shown to be less refrangible than light, must move the swiftest of the two; and light, in like manner, swifter than the deoxidizing rays, which, by a more recent discovery, highly interesting also, have been found more refrangible. But such conclusions do not appear to be at all sufficiently supported. They depend on several assumptions; particularly on this, that the constituent particles of the three different kinds of rays, were they to begin their motion at equal distances from the refracting surface, would be equally accelerated in the perpendicular direction by the power of the medium. For what can be shown to the contrary, however, this may be wide of the truth. May not the refractive power of the same medium accelerate very differently the particles of which rays wholly different in their nature are constituted? May not those even be refracted the least whose velocity is the slowest, and in a ratio little depending on the velocities; according to what may be called elective attractions, or peculiar affinities, which may obtain between the medium and rays differing so much in kind? The phænomena of the different dispersions of the constituent parts of the same rays, namely light, evidently show some variable affinity of this sort, according to the nature of the refracting medium. Why, therefore, may not such an affinity be anomalous, according to the nature of the rays which differ from one another so much?

Though therefore the rays of caloric, as emitted by the sun, were all found the least refrangible, yet their velocity may be far inferior to that of light. For what we know, the fact really may be, that the refracting medium governs the motion of the latter much more powerfully than that of the calorific rays.

As in the present state of our knowledge we can entertain nothing but conjecture on a point so interesting, so the necessity of having recourse to some experimental mode of proof, to clear away doubts and lead us to the truth, appears in a strong point of view.

Before

Before concluding it may shortly be hinted, that the principles which have now been explained may possibly serve also for discovering whether the colour-making rays themselves which constitute the solar white light be all of them emitted with the same or with a different velocity.

If ever it shall be found practicable to procure a very sharp image of the sun by a speculum of such small aperture and feeble reflecting power as to admit of our viewing the image in the way of Dr. Herschel's *front view*, at a focal distance of about a hundred feet, and without the intervention of any medium put before the eye-glass, it would be well worth while to examine carefully whether the extreme verge of the limb of that image on the opposite sides, as pointed out by the directrix so often mentioned, assumed, in any degree, tints allied to the *red*- and *violet*-making rays. If so, this would manifestly be the effect of aberration arising from the different velocity of the extreme prismatic light. Though this were so small as to make the difference of aberration half a second only, still the space at the image corresponding to this angle would be three of those parts of which an inch contains a thousand. Such therefore might be considered as the greatest breadth of the *incipient crescents*, so to speak, in this instance. These, if at all perceivable, would be distinguished from one another by the outermost confines of the one being related, in point of tint or colour, to the least refrangible rays, and of the other to the most refrangible. In looking for such a criterion, our sight would enable us to discern very minute and delicate differences.

It is not at present asserted that a telescope such as has been described would have power enough to decide the merits of that theory which makes the different refrangibility of the prismatic rays of light to depend on their different velocity before incidence. But should the power be sufficient, and supposing the experiment practicable, if no symptoms of such incipient crescents were perceivable, the negative of the theory would thereby be demonstrated. In either case, therefore, such an experiment would be highly valuable also by settling a matter which has long been merely conjectural, and which, besides, is intimately connected with other elementary points of great importance to optical science, themselves doubtful, at this day, by resting on hypotheses.

LIII. *Ac-*

LIII. *Account of the Object and Destination of the first Voyage round the World undertaken by Russia.*

The great number of establishments which the Russian American company, encouraged by the favourable result of its fur trade, has formed in the course of a few years past, on the north-west coast of America, from Cook's River to Norfolk Sound, and the great increase of the seamen and other persons in their service, render it necessary to send thither a larger quantity of European manufactures, ammunition, and even provisions, for no corn is cultivated either in the Aleutian Islands or on the American coast. A dock for ships has, however, been constructed at Prince William's Sound, where vessels of 250 tons are built; but no materials for constructing and rigging vessels can be found, except timber. Hitherto the company's establishments have been supplied with necessaries and stores through Iakutsk and Ochotzk; but the great distance, and the difficulty attending the transportation of them, for which four thousand horses are annually employed*, raise the price of the articles even at Ochotzk 560 per cent. and more. A pood of rye meal, for example, costs five rubles, a pood of tobacco twenty-five, and a gallon of brandy twenty rubles, &c. These articles also, when they have got half way, are frequently plundered, and a remnant only, which has been saved, reaches Ochotzk. It appeared at first that to send thither anchors and cables would be almost impossible; and as those articles could not be dispensed with, it was necessary to have recourse to means which occasioned the loss of many ships: cables were cut into pieces of seven or eight fathoms, and afterwards joined when they reached Ochotzk; by which process they always lost some part of their strength. The anchors were also transported in pieces, and afterwards welded; but, in consequence of the want of good workmen, they were put together in a very imperfect manner. But however difficult and expensive the transportation might be to

* Those who have read Muller's, Lessep's, and Billing's Voyages, must know, that from Iakutzk to Ochotzk there is no road for carriages; and that all goods must be transported on horseback: each horse carries about five pood, and with such a load can travel twenty versts a day. The carriage is a copec for each verst; one driver is allowed to six horses, besides another on which he rides, and he carries with him two relay horses. Ochotzk is a thousand miles distant from Iakutzk.

Ochotzk,

Ochotzk, it was still more so to the islands and the coast of America. The ignorance of the greater part of the commanders, and the stormy nature of these seas, which renders it dangerous during the greater part of the year for such vessels to navigate in them, occasioned every year the loss of a great many ships and of the valuable cargoes with which they were laden; even at present no intelligence has been received these three years from Kodiak, and therefore it is not impossible that the vessels expected from that place have perished.

This trade, however, which, notwithstanding difficulties that might have discouraged a nation possessed of a less enterprising spirit than the Russians, produces great profit to those engaged in it, and would no doubt be attended with still greater advantages, were these obstacles only in part removed; and since the fur trade has been carried on not by individual merchants, but by a company, some measures have been adopted which cannot fail of having a very happy influence on the progress of their commerce. The company have taken into their service an Englishman, who constructed on the coast of America a very fine ship, which he commands himself, and who has entered into a contract to build more. They supply the captains of their ships with the best sea charts, the necessary mathematical and astronomical instruments, the latest voyages, and the best books which treat on the subject of navigation. But it was only since the accession of the present emperor, who interested himself in a particular manner for the success of the American company, took a share in it, and encouraged others to do the same, and on whose protection dependence can be placed, that the company has exerted itself with zeal and activity to give a new form to this trade, so long and so much neglected.

Nothing therefore was more natural than that their first object should be to supply with the necessary stores and provisions those colonies which were first established, and which, in an inhospitable country destitute of every thing, must soon have fallen to ruin; to place them in a proper state of defence against the attacks of the natives, to which they are so much exposed; to procure to their agents better means for building ships; to supply them with good tackle, anchors and cables; and to give them more skillful commanders and more expert seamen.

In the month of March last year, when the emperor granted permission to the officers and sailors of his navy to serve on board merchant ships, the company engaged a very expert navigator,

vigator, M. Chuvastof, whom they sent along with a midshipman, named Davidof, to Ochotzk, to assume at that place the command of one of their best ships. The company, however, would not have entirely accomplished the object in view, had they not, in order to supersede the necessity of the difficult and dangerous land carriage, resolved to dispatch ships direct from Cronstadt to the north-west coast of America, which, after delivering their lading, were to take on board a part of the furs which are collected in larger quantities in the islands and on the coast, than can be disposed of at Kiachta, and to convey them to Canton, to be exchanged for Chinese articles, which not only find a ready sale in Russia, but can be sold at a very great profit. Under the reign of the late emperor, captain-lieutenant Von Krusenstern, a meritorious officer, who served several years in the British navy, and had made a voyage to India and China, transmitted to count Kuschelef, then minister of the marine, a detailed plan for a voyage of this kind; but, in consequence of some causes which are not known, it was never carried into execution. Since the accession of the present emperor, this plan, and the representations made on the same subject from other quarters, were thought worthy of a more minute examination. Admiral Mordvinof, who succeeded count Kuschelef in the naval department, was desirous that the first voyage might be undertaken by government: and this would have been the case, had not the American company offered to fit out two ships at their own expenses; an offer which the government immediately accepted, and at the same time advanced to the company for this undertaking the sum of 250,000 rubles, at five per cent. interest, for eight years.

As there were no ships in Russia fit for the purpose, it was resolved that two should be purchased in England. Captain-lieutenant Lisianski, destined to command one of the vessels belonging to the expedition, was for this purpose sent with M. Rasumof, an eminent ship-builder, to this country, where they bought for 5000l. sterling the Leander of 470 tons, three years old; and for 17,000l. the Thames of 430 tons, built twenty months. The sheathing with copper and the repairing of these ships cost about 5000l. more. The name of the former was changed to the *Nadeshda* (the Hope), and the other to that of the *Neva*, and both were to proceed to Cronstadt as soon as the season would permit. The names of the officers appointed to the Nadeshda were as follows:

Krusenstern

Krusenstern, captain-lieutenant, commander.
Radmonof, Romberg, Solovaschef, Lovenstern, } lieutenants.
Bellingshausen, midshipman.
Kamenschikof, pilot.
Bistram, garde marine.
Dr. Espenberg, surgeon.

Those appointed to the Neva were:
Lisianski, captain-lieutenant, commander.
Arbusof, lieutenant.
Berg, Druskofskoi, } midshipmen.
Kalinin, pilot.
Dr. Labaud, surgeon.

While the ships were getting ready, and other preparations making for the voyage, the government resolved to embrace this opportunity of sending an ambassador extraordinary to Japan. The trade with these rich islands seems to promise the greatest advantages to the American company. The neighbourhood of Kamtschatka, which produces so many articles suited for the Japanese market, such as furs, the teeth of the walrus, whale's blubber, salt fish, &c. must be very favourable to this branch of the Russian commerce. The attempts made from time to time by individual navigators, to open a commercial intercourse with the Japanese are well known, and also the mission of lieutenant Laxman, who was dispatched by government, in the year 1792, for the purpose of carrying home some Japanese who had been wrecked on the Russian coast. The favourable answer given to the request of the Russian government, for leave to send a ship every year to Nangasaki, certainly affords reason to hope, that a solemn embassy attended with the necessary pomp and splendour, and accompanied with valuable presents, will make a still greater impression. The counsellor of state, Resanof, whom the emperor had nominated one of the lords of the bed-chamber, was appointed to this important and honourable mission. To receive a favourable reception to his propositions, he has not only carried with him a great many valuable presents, but also some Japanese who were wrecked in the year 1793 on the coast of the Andreanofskoi Islands, and who since 1797 resided at Iakutzk. As the ambassador took his passage on board the Nadeshda, the return of the vessels, in consequence of the embassy, may be delayed a year longer than it other-

wise

wise would have been; and on this account the emperor has engaged to defray the whole expense of this vessel; but he allowed the company to send out in her, without paying freight, as large a quantity of goods as she could conveniently take on board.

The lading of both ships consists of iron, sail-cloth, anchors, cables, ropes for rigging, gunpowder, cannon, muskets, pistols, sabres, flour, wine, rum, French brandy and other spirits, coffee, sugar, tea, and tobacco; all kinds of tools and instruments proper for mechanics; and various articles fit for carrying on trade by barter with the natives of these islands and of the coast of America. The company engaged two ship carpenters, together with locksmiths, common smiths, and carpenters, who will settle in America, and be conveyed thither by these vessels.

The following is the route of the voyage: Both vessels double Cape Horn, and proceed to the Sandwich Isles, where they will separate: the Nadeshda will then direct her course to Japan, to land the ambassadors, and go to winter at Kodiak. The Neva will sail straight from the Sandwich Isles to Kodiak, and at the proper season proceed to the coast of America: she will winter also at Kodiak. In the month of April the second year, both ships will steer for the coast of America, in order to visit the different Russian establishments, and to take in the lading destined for China. In the month of August they will direct their course to Canton, and, having exchanged their American for Chinese articles, will return the third year to Russia by the way of the Cape of Good Hope.

Both ships sailed from Cronstadt on the 26th of July, 1803. The presents carried out by the embassy, for the emperor of Japan, were selected from among the curiosities preserved in the hermitage of the imperial winter palace; and in the choice of them great attention was paid to the taste of the Asiatics. Among them is a beautiful piece of mechanism representing a peacock of the proper size, which spreads out and folds together its magnificent feathers with the most perfect imitation of nature; it is surrounded by a great many small birds, which all move in the easiest manner, and emit the notes peculiar to each: this beautiful automaton was purchased by Catharine II. for 15,000 rubles.

The number of the Japanese wrecked on the coast of Russia amounted to sixteen*, but four of them afterwards

* According to some accounts, they arrived at Irkutsk in the month of September 1794.

 died:

died: of the remaining twelve four embraced christianity; only three of them resolved to return to their own country, and even one of these will accompany the embassy back to Russia. They have made themselves pretty well acquainted with the Russian language, and may be of great use as interpreters*.

But besides the commercial and political objects of this expedition, it is destined to promote the cause of science. The emperor, desirous that so favourable an opportunity of enlarging human knowledge might not be lost, invited scientific men to take a share in it. M. Tilesius of Leipsic, and Dr. Horner of Hamburgh, were accordingly engaged to accompany the expedition, the former as naturalist, the latter as astronomer. The two surgeons, Dr. Espenberg and Dr. Labaud, are also men of talents, who will keep regular journals of every thing remarkable that occurs. The latter had left Petersburg on a literary tour to Paris, and had reached Riga, when he was overtaken by a courier, who brought him a commission as surgeon on board one of the vessels †.

The chief of the expedition, M. Von Krusenstern, is not only an expert navigator, but a man of excellent character, and inspired with great zeal for the success of the expedition, which he once proposed himself. He married not long ago a respectable lady whom he was obliged to leave behind him in Russia, because he had given up his cabin to the embassy; but the pain of this separation has been much alleviated by the munificence of his imperial majesty. This magnanimous prince, to render M. Von Krusenstern easy in regard to his family, whatever may be his fate, has

* The situation of the Japanese who have remained in Russia was determined in the following manner by an ukas of August 12, 1803: one of them who, at baptism, assumed the name of Kolotygin, and who had been before appointed teacher of the Japanese language at the school of Irkutsk, with a salary of 200 rubles, returns to his post, and besides his salary will receive a pension to the same amount during life. The other eight: Andrew Kondratyef, Ivan and Semen Kisselef, who have embraced christianity; and Min Sucha, Motsch Si Fey, Seen Sa Buro, Schee Sa O, and Sa Day, who have adhered to the religion of their country, are each to receive a pension of fifty rubles for life, with exemption from all taxes and services, and liberty to reside in any part of the empire, and to follow whatever occupation they think proper. Those who wish to return to Irkutsk are to receive money from government to defray their expenses.

† Besides these men of science, Dr. Langsdorf of Göttingen accompanies the expedition. His zeal for the progress of natural history induced him to repair to Copenhagen, and to offer his services without any view to pecuniary remuneration; but M. Von Resanof and captain Krusenstern immediately engaged to defray the expense of his maintenance on board ship, which will amount to 800 rubles per annum.

consigned

consigned to his lady an estate in Poland, worth 3000 rubles per annum.

A letter received by the Academy of Sciences from captain Krusenstern, dated Santa Cruz, in the island of Teneriffe, October 25, 1803, states that the vessels had arrived there in safety after a short passage from Falmouth; there was not a single person sick on board, and the Russian sailors were in high spirits, and performed their duty with alacrity, though no Russian ship had ever proceeded so far south. The Spanish governor received captain Krusenstern and his fellow-navigators in the most polite manner, fitted up as an observatory for them the house where the Inquisition holds its sittings, and transmitted their letters to Europe by the speediest conveyance.

On the 25th of October the vessels had taken on board water, with a supply of wine, and were to set sail next day in order to proceed to Rio Janeiro in Brazil, where they intended to remain a few weeks. In latitude 37° 40′ north, and longitude 3° 28′ east, the Russian navigators had an opportunity of observing a very remarkable meteor. At half past eight in the evening, October the 10th, they saw in the south-west a large fire-ball, which proceeded in a horizontal direction, at the elevation of fifteen degrees, to the north-west, where it disappeared. It had a very long tail, which was so bright that the whole ship was illuminated by it for a minute. What was most remarkable, however, and perhaps unexampled, is the great strength of the light; for after the meteor disappeared there remained a bright line in the same direction, which was visible for an hour. M. Krusenstern communicated also to the Academy some important observations on currents, which he had an opportunity of making in the course of his voyage.

The last letters received from the expedition are dated from Brazil, January 22: at that time M. Krusenstern had sent the crews of the vessels on shore to procure refreshments. He purposed putting to sea in the beginning of February, and expected to reach Japan by the middle of June.

LIV. *Account of the first Russian Embassy to Japan in the Years* 1792 *and* 1793.

THE Russians have been acquainted with Japan ever since their second voyage of discovery in the eastern ocean, or

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the second Kamtschatka expedition. In the year 1738 captain Spangenberg explored the whole Kurile Archipelago, which had been known to the Russians but imperfectly since 1711, and the islands of Matmai and Niphon, on which occasion both he and lieutenant Walton, who commanded the second vessel, landed in Japan.

This attempt, the immediate and principal object of which was to rectify the geographical knowledge of that part of the world, was attended with no beneficial consequences to commerce, and forty years elapsed before a Russian ship appeared again on the Japanese coasts; but during that period government established a school of navigation at Irkutsk, in which young persons who were bred up to the sea received instruction also in the Japanese language.

In the year 1777 some private Russian navigators made a second landing on the Japanese coast: a ship fitted out at Ochotsk, by Schelechoff and company, which had come to anchor at the 18th Kurile Isle*, in order to winter, dispatched thirty-three men in *baidars* † to Matmai, where they went on shore in the neighbourhood of a village named Atkis. The Russians were received with great friendship by the Japanese, and an interchange of presents, consisting of such articles as they had with them, took place between them.

The ship which performed this voyage, after remaining a fortnight at Ochotsk, proceeded a second time to Japan, under the direction of M. Schebalin, a merchant of Irkutsk. She wintered at the 18th Kurile Isle, and next year, that is in 1799, M. Schebalin sailed with forty-five men to Atkis. Here he met with an officer of the Japanese government, to whom, during a formal audience, he expressed a wish, that in future a trade by barter might be established between Russia and Japan; but this proposal the Japanese endeavoured in a civil manner to decline. M. Schebalin, without accomplishing the object of his voyage, then returned to the 18th Kurile Island, from which he proposed next year to proceed again to Matmai, but was prevented by an earthquake, which took place in the month of January 1780. No attempt of importance to cultivate an acquaintance with the Japanese was then made for thirteen years; but in 1792 a vessel was fitted out

* This island, in the language of the natives, is called *Urup*; but by the Russians, who in a bay at the eastern side of it have formed the settlement of *Kurilo Nossii*, it has been named Alexander's Island.

† A particular kind of boats.

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at Ochotsk by order of government, for the purpose of carrying back to his own country a Japanese merchant, named Kodoiu, who had been wrecked at Unalaschka, in a ship laden with rice. Some of the Japanese who accompanied him came to Petersburg, where they received presents from the empress; and all of them had experienced so much attention to their situation, and so much friendship, particularly in Siberia, that they quitted their benefactors with every mark of the liveliest gratitude. As M. Laxman of Irkutsk, in particular, had acquired their confidence in the highest degree, his eldest son, lieutenant Adam Laxman, was appointed commander of the expedition; and at the same time was charged to exert his influence to procure to the Russians, if possible, liberty of trading to Japan on definitive terms. That the embassy was not intrusted to a person of higher rank, and that the empress did not, on this occasion, herself write to the emperor of Japan, but gave orders to the governor-general of Irkutsk to write a letter to the Japanese government, arose in all probability from her being unwilling to expose her dignity in an affair the result of which might be uncertain; but there is great reason to think that in consequence of this neglect the mission was attended with so little success.

It is however probable, that the formal embassy accompanied by valuable presents, which the emperor Alexander lately dispatched to Japan, will make a greater impression, and meet with a more favourable reception. Of this embassy some account has been given in the preceding article; and we shall now, as a companion to it, lay before our readers an extract from the journal of lieutenant Laxman, which contains several curious particulars respecting the Japanese.

Extract from the Journal of Lieutenant Adam Laxman, kept during a Voyage to Japan, undertaken in the Years 1792 *and* 1793, *by the Command of Empress Catharine II.*

Lieutenant Laxman received orders by an imperial rescript, addressed to M. Piel, governor-general of Irkutsk and Kolyvan, to carry home in a vessel fitted out at the expense of government some Japanese, whose ships had been stranded on the Aleutian Islands. In consequence of this order, lieutenant Laxman sailed from Ochotsk on the 13th of September 1792.

On the 17th the vessel having proceeded west about 300 versts was found to be opposite to the island of St. Jonas, the

the circumference of which is estimated at six versts. It consists for the most part of granite rock, produces neither trees nor bushes, and seems to be inhabited only by sea-gulls and other aquatic birds.

On the 26th, after keeping some time on the same course, our navigators came in sight of the 19th of the Kurile Islands, named Itarop*, along the coast of which they proceeded towards the south-west.

On the 28th of September they saw a small peak like a sugar-loaf, the summit of which was covered with snow, and which formed the northern extremity of the 20th island, named Kunaschiri.

Till the 6th of October they stood off and on along the series of islands, and passing through the strait between the 19th and 20th island, keeping in the same direction as the eastern shore of the latter, came to anchor in a harbour at the south end of it. The ground however was so soft, that they were soon obliged to heave up again, and to continue their voyage till the next day, when they found good anchorage at about the distance of seven versts from the northern shore of the 22d island†. A boat was here dispatched with thirteen men, to search out a harbour proper for wintering in. The natives, as soon as they saw the ship, left their summer habitations on the coast, and retired to the interior parts of the island. The boat's crew, however, at length, found some of them; and by means of M. Schebalin, a merchant of Irkutsk, who understood their language, a friendly intercourse was opened, and some fresh fish were procured from them in exchange for tobacco, on which they seemed to set great value. Satisfied with this introduction, the crew towards night returned to their ship. On the day following, October 8th, a boat was dispatched to another settlement, pointed out by the natives the day before, and named Nischpaz, from the name of a rivulet, at the mouth of which it is situated, and where the crew were received by a great number of Kurilians and Japanese. The latter resided here only for the purpose of collecting the duties on the merchandise sold by the Kurilians to the subjects of Japan. They informed them that at the southern extremity of the island there was a spacious and secure harbour named Atkis‡; but as the approach to it was dangerous on account of numerous

* In the best Russian maps it is called *Atorpu* or *Atorku*.

† That is the Island of Marmai.

‡ Atkis lies on the north-east coast of the island.

shoals

shoals and two reefs of sunken rocks at the eastern end of the island, they recommended another bay named Nimuro; which being found convenient, they anchored in it on the 9th, and made the necessary preparations for passing the winter. At this landing-place they found a very neat house belonging to a Japanese custom-house officer, together with a magazine. The Japanese not only offered to build a habitation for the Russians, but promised for their greater security to reside there with his people during the winter; a circumstance which never before took place, as he was accustomed to return about that time to Matmai. Matmai, which is the residence of a Japanese governor, is situated, according to the Japanese mode of reckoning, at the distance of 300 *rih* from Nimuro.

On the 12th of October M. Laxman dispatched a letter by a Japanese messenger to the governor of Matmai, to announce his arrival, the object of his voyage, with his intention of wintering there; and to request that he would communicate this information to his government, and obtain from it permission for him, in case he should be prevented by contrary winds in spring from reaching the principal landing-place, to touch at any other part of the kingdom.

On the 13th of December an officer brought to M. Laxman a note from the governor, in which it was stated, that his letter had been sent to Jedo to be submitted to the decision of government. The officer, who was a man of great politeness, requested some of the charts which he saw in the ship, in order that he might copy them, which he did with wonderful precision, by means of transparent paper placed over them. He also showed two charts of Matmai, Jedo, and the island Karop, lying to the north-west, which were exceedingly well executed. The island of Karop is subject to the governor of Matmai. The tribute paid by the inhabitants consists of dried fish, train oil, dried mushrooms, and a small quantity of fox skins: they trade chiefly with the Coreans, from whom they are separated only by a strait of about fourteen versts in breadth. The articles they receive from these people are, coral and Chinese stuffs of every kind, for which they give in exchange the skins of sables, foxes, and wild goats.

On the 29th two civil officers arrived from Matmai, induced, as they pretended, by mere curiosity; but it was soon discovered that they were spies. The Japanese in general, and these two in particular, showed a great desire for acquiring knowledge: they not only took drawings of all

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the instruments and utensils which the Russians showed them, but made a great many models, in the construction of which they displayed much ingenuity: the objects, however, for which they seemed to have the greatest fondness were charts and plans.

The Japanese divide their common year into twelve, and every leap year into thirteen months*; the first and fifteenth days of each month are for the most part holidays †. On the evening before new-year's day they perform a great many ceremonies, and decorate their idols and houses with ribbons, lights, &c. The compliments of the new year are punctually observed, and in general the first month of every year is spent in idleness and salutations ‡. The age of a child is not reckoned from the day on which it comes into the world, but from the first day of the year in which it is born. To point out the lapse of time, they use, instead of clocks, matches made of twisted rope-yarn, divided by means of knots into a certain number of intervals accurately measured. These matches are kindled, and as the divisions burn they indicate the hours. In all the towns there are watchmen who announce the hours pointed out in this manner, by striking upon bells. They admit twelve celestial signs as we do; and these, as well as the whole of their kalendar, are as old as Nin-Oo, one of their first rulers, who lived about 660 years before the birth of Christ §: the same prince laid the foundation of the present political constitution of the country, and established the greater part of the laws by which it is governed.

The Japanese ships are ill calculated for enduring storms at sea, because the stern is entirely open, and for this reason they always keep close in with the shore; the under-part of the keel, the joinings, and all the seams of one of these ships which lay at Nimuro, along with the Russian vessel, were sheathed with copper. It had only one mast, and a very large sail of double cotton cloth; the breadths of which, instead of being sewed, were lashed together with a piece of twine. The advantage of this method of uniting the pieces is, that when storms take place, and the sail cannot be soon enough furled, the wind tears asunder the lacing, and, passing through the seams, does not exercise so much force on the sail.

When a Japanese of distinction dies at a distance from

* See the German edition of Kempfer, vol. i. p. 182.

† Kempfer, vol. i. p. 267. ‡ Kempfer, vol. i. p. 269.

§ Kempfer, vol. i. p. 180.

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his home, which was the case while the Russians lay at Nimuro, he is buried on the spot with great ceremony; but the hair of his head, his beard, and his favourite pipe are sent to his relations, who inter them with the same ceremonies as they would do the body.

The neighbourhood of Nimuro produces a great number of trees and plants, which belong to a variety of climates. Along with the pine and larch are seen the vines of the south, the chestnut tree, plum tree, and other tender vegetables, such as wild asparagus, which requires warmth. There are also three volcanoes on the island; one of them has in the middle of its declivity several warm springs, the medicinal quality of which in various diseases is much extolled by the Japanese.

Respecting the Kurilians, the proper natives of the island, M. Laxman, notwithstanding all the trouble he took, was not able to procure any certain information, because they were narrowly watched by the Japanese, who endeavour to prevent them from having any intercourse with strangers. They are entirely slaves to the Japanese, who employ them for all laborious and mean occupations; they even would not venture to accept the small presents offered them for the service they had rendered to the Russians by order of the Japanese. Besides the maize and the rice which they receive from Japan, their food consists of fish, mushrooms, wild roots, and the flesh of a kind of antelope found in the island. They feed also dogs, the flesh of which they eat, and consider it as delicious nourishment.

The Kurilians supply the Japanese with dried fish of every kind, seal's blubber, walrus and fish oil, beaver, otter, sable, fox and bear skins, but particularly bears' tails, for which the Japanese pay a very dear price. The principal trading places are the 16th, 17th, 18th, and 19th islands, to which a flotilla, consisting of more than 500 *baidars* or Kurilian boats, proceeds every year about the middle of March, and after they have transacted their business return again about the end of May.

The rest of the Japanese trade, as is well known, is exclusively in the hands of the Dutch, who, as one of the principal men among the Japanese told the Russian interpreter in confidence, use every possible means to blacken the character of all other nations, and particularly of the Russians. The government, however, notwithstanding the continual machinations of the Dutch, begin already to see, that a trade to Russia would be much more advantageous than that with the Dutch, who bring them from a great distance those articles

ticles which they could obtain much nearer and much better from the Russians.

On the 29th of April 1793 a numerous embassy arrived at Nimuro, from Jedo and Matmai. The whole suite consisted of sixty Japanese and a hundred and fifty Kurilians; the latter of whom were employed as an escort and porters. Next day the Russians were invited to an audience, and received in a large hall, which was formed of all the apartments of the house by removing the paper screens or partitions usual in Japan; and where they were entertained with tea, cakes, and a kind of wine called sakki, which the Japanese extract from rice. The senior then read the imperial answer to the letter sent to Jedo, by which, instead of the requested permission, the Russians were allowed only to proceed by land under an escort to Matmai, in order to deliver the Japanese whom they had brought with them. As this declaration, however, did not correspond with the object of the voyage, M. Laxman declined the proposal; and till the end of May the Japanese officers used every means in their power to prevent the Russians from proceeding further with their vessel. But M. Laxman, tired of the long delay, having at length declared that he would continue his voyage to Chakodasche, as being the nearest harbour of Matmai, they resolved to accompany him; and on the fourth of June he sailed from the harbour attended by two Japanese vessels.

On the 17th they passed the small island of Yururi, in the neighbourhood of Nimuro, at which the two Japanese ships, which had found a much shorter but a very dangerous route through two exceedingly narrow and crooked channels, had already landed in order to wait for their arrival.

On the 23d they sailed along another small island, Kidab, which had a small bay exceedingly convenient for anchoring.

On the 24th they anchored opposite to Atkis, in ten fathoms water. This harbour is deep, and sufficiently convenient and capacious for large vessels; it is entirely surrounded by hills covered with bushes, and sheltered from every wind. Besides the native Kurilians settled in the neighbourhood, there resides here a Japanese custom-house officer.

On the 4th of July the vessel arrived in the harbour of Chakodasche, and came to anchor. The *daigvan* or commander of the town immediately made his appearance, and with great politeness offered to assist the Russians in whatever

ever they might want. Besides a guard, which was requested to restrain the curiosity of the populace, who thronged around them, he dispatched thirty boats manned chiefly with Kurilians, by whose assistance, as it was then calm, the vessel was towed into the harbour.

In consequence of an invitation, the officers went on shore in the afternoon to refresh themselves, after the fatigues of their voyage, in the baths of the daigvan. M. Laxman and his suite were received on the shore with great ceremony by the daigvan and principal persons of the town, and conducted to a building, over the entrance to which was affixed a board with the inscription "Russian House." The house was neatly furnished, and lay contiguous to a garden, in which the wildness of nature was imitated with great art, by means of moss, shells, and other things. After enjoying the refreshment of the bath, the Russians were entertained with a collation, and then conveyed back to their vessel with the same ceremonies.

On the 9th M. Laxman paid a visit to the north side of the harbour opposite to the town. On both sides of the road he observed fields in a high state of cultivation, which were sown with wheat, beans, flax, hemp, and tobacco. In the gardens he remarked in particular, turnips, carrots, radishes, beet-root, common and Turkish beans. Of cattle he saw no trace, which arose, as he conceived, from the Japanese not being accustomed to eat the flesh of quadrupeds. Of fowls, they keep only hens *. M. Laxman requested leave to walk through the town, but this was absolutely refused.

The 13th of July was at length fixed for their journey to the town of Matmai, two days before which M. Laxman was again conducted on shore with great ceremony, and spent the night in the house already mentioned. Next morning he received notice that every thing was ready for his departure; two covered chairs, which in their form had a great resemblance to those of Europe, were provided for him and the second officer. They were carried by four men, who every half-hour were relieved by others, and who showed a considerable dexterity in changing places, even on full speed, without occasioning the least stoppage. Besides these bearers, each chair was accompanied by four domestics; the rest of the suite rode on horses, each of which was conducted by two men; so that the whole train consisted of 450 persons †. The road passed through the fol-

* Kempfer, vol. i. p. 141, 145.

† Kempfer, vol. ii. p. 144 to 152.

lowing

lowing towns and villages: Moïatschi, Nikona, Schirkudschi, Fuguschima, Yuschaga, Refige, and Ossamarussa, which was the last station before they arrived at Matmai. In each of these places a house was prepared for the Russians, and was furnished with the before-mentioned inscription.

At Ossamarussa the cavalcade was joined by a guard of 600 men, in the midst of whom the Russians were conducted into the town. The houses were all thrown open, and hung with carpets; they seemed to be full of people, but not a single person was to be seen in the streets, except the police officers, who were armed with spears, and posted at all the corners and crossings. Before the house destined for the residence of the Russians stood a guard of 120 men, one half of whom were armed with bows and arrows; the other with muskets without locks, and lighted matches. The house was completely fitted up in the European manner, with tables, chairs, and other furniture; and behind it lay a garden, on the wall of which, though of considerable height, a kind of railing was erected, hung with blue and white striped cotton cloth, to prevent the Russians from having any view of the town. Towards evening two masters of the ceremonies appeared, in order to make known to M. Laxman the manner in which he was to have his first audience, and the regulations to be observed on that occasion. They proposed that, agreeably to their manners, he should present himself barefooted, creeping on his belly, and that he should then speak, lying on his right side, or in a kneeling posture; but as M. Laxman absolutely refused to comply with this ceremonial, and proposed the European mode as much more convenient, they at length consented.

In consequence of this agreement the Russians next day were conducted to the house destined for the audience, which was situated on the summit of an eminence, so steep that it was necessary to ascend to it by a flight of steps. The emperor's deputies were sitting in a large hall, in a semicircle, and had over their dresses of ceremony mantles of white satin; their heads also were covered with large black lackered caps. As soon as the Russians were seated the senior deputy pulled out a letter, and read in substance as follows:—"We have received the letter of governor Piel, together with a Japanese translation, which informs us of your mission, the delivery of our people, and other matters, but the translation is so bad that we cannot make sense of it; and as it is impossible for us, on this account,

to

to come to any decision, we return your letter." A domestic then crawled forwards, half kneeling and half prostrate, and, having received the letter in that position, handed it to M. Laxman. To make up in some measure for this disappointment, the senior ordered the screen towards the garden to be drawn aside, and showed him a hundred bags of rice lying in a heap, which were destined for him as a present; a paper was then delivered to him, for the receipt and safe delivery of which to the Russian government he was obliged to give one in return. After this he was conducted into an adjoining apartment, where various refreshments were served up; and on the collation being ended he returned to a second conference in the hall of audience. M. Laxman was now permitted to make known verbally the object of his mission, which he accordingly did; and in a very long speech stated to the deputies, that by an order from his court he had been commissioned not only to carry home some Japanese subjects who had been wrecked on the Russian coast, but to convey them to Jedo-Koda the capital, that he might thus have an opportunity of expressing to his Japanese majesty the friendly sentiments of the empress of Russia, and her desire of entering into a closer and more intimate intercourse with the Japanese government. He concluded with proposing a journey to Jedo, and requested the advice and assistance of the deputies to enable him to carry his design into execution. The answer to this proposal was exceedingly short; the substance of it was: That according to the fundamental laws of the empire no strangers could be permitted to visit Jedo; and that M. Laxman had enjoyed the same advantage as if he had seen the emperor, as he had spoken to his deputies. They also desired that M. Laxman would make preparations for quitting as soon as possible with his ship the harbour of Chakodasche; and that he would either return to Russia, or proceed to Yedomo, which was the place originally destined for his landing. The deputies then retired, and the Russians were conducted with the same ceremonies back to their habitation, where they found a great number of presents provided for them by order of the emperor, and of the governor of Matmai. M. Laxman, desirous of testifying his gratitude to the latter, by giving some presents in return, requested that he might have the honour of waiting upon him; but this was refused. He was at the same time informed that the governor was a child, an expression by which the Japanese denote a man of simplicity; and that he was not worth seeing: they however added, that

that the presents might be sent by Japanese messengers; which was accordingly done.

Next day they were waited upon by two Japanese, who offered to assist the Russian interpreters in translating the Russian letter which had been returned, and the paper delivered to M. Laxman by the deputies. But when the translation of the Russian letter was ready the deputies refused to receive it, because it was not addressed to them by name; M. Laxman represented, that it was impossible their names could be known in Russia, but his remonstrances produced no effect; and after much trouble he obtained permission to have the letter read by an interpreter. The answer he received was, that strangers could be received only at Nangasaki. That the Russians, however, might in future have free access to that harbour and town, they wrote a permission on an imperial blank order, which they had by them, and transmitted it to M. Laxman. M. Laxman then endeavoured to obtain leave to exchange some articles of merchandise, which two Russian merchants on board the vessel had brought with them; but this was refused.

On the 23d of July M. Laxman had an audience of leave, during which he delivered the Japanese he had brought with him, and received a receipt.

On the 25th he was conducted back with the same ceremony to Chakodasche, and on the road the domestics who accompanied the suite, requested the Russian interpreters to give them privately, and without the knowledge of M. Laxman, a copy of the letter which the deputies at Matmai had refused to receive: this request was readily complied with.

On the 11th of August the Russians hove up their anchor, and sailed from the road of Chakodasche as far as the 21st Kurile Isle; being accompanied at some distance by two Japanese vessels, who were, no doubt, ordered to observe whether they attempted to land at any place in the neighbourhood.

On the 19th they discovered the summit of the 19th Kurile Island, and entered the strait between the 18th and 19th, in which, however, they made little progress, in consequence of the weakness of the wind.

On the 3d of September they were opposite to Morikon, a ridge of rocks half covered by water, which extend about fifteen versts from Ochotzk, in a north-east direction.

On the 8th they arrived in the road of Ochotzk, and on the 9th entered the harbour, after a voyage of 28 days from Matmai.

4 M. Lax-

M. Laxman concludes his journal with the following translation of the paper transmitted to him by the Japanese government:

"We permit one Russian ship to enter the harbour of Nangasaki; but we at the same time renew the prohibition that no foreign ships can be admitted into any other part of our kingdom, and that neither the Christian religion, nor any signs of it, can be allowed. We desire also, that in all transactions nothing may be done contrary to the laws of our empire, and that the regulations which we have established shall be strictly observed. For this purpose the present writing has been delivered to M. Adam Laxman.

Done in the town of Matmai."

LV. *Experiments to ascertain whether there exists any Affinity betwixt Carbon and Clay, Lime and Silex, separately or as Compounds united with the Oxide of Iron forming Iron Ores and Iron Stones. By* David Mushet, *Esq. of the Calder Iron-Works.*

[Continued from p. 282.]

Having rigidly ascertained the metallic properties of the oxide of iron which was to enter into the composition of several artificial mixtures, I next proceeded to reduce it to a very fine powder and mix it with different earths.

First Class

Consisted of 6 parts of well dried Sturbridge clay,
4 —— of oxide.

Exp. I. 500 grains of this mixture,
$12\frac{1}{2}$, or 1-40th of carbon, were fused together.

A minute spherule of malleable iron was obtained which weighed 14 grains, equal to $2\frac{8}{10}$ths per cent. from the mixture.

The glass was dark and rough, excepting where it approached the neighbourhood of the metallic mass.

II. 500 grains of mixture,
25 —— of carbon, or 1-20th.

These were intimately mixed and fused. A neat button of metal was obtained which weighed 46 grains, and equal to $9\frac{2}{10}$ths per cent. The glass in this experiment was materially altered: the additional dose of carbon and the revival of a greater portion of metal left the glass of a fine black shining colour, possessed of a beautiful lustre where it surrounded

rounded the iron. Its surface, however, was covered with a deep crocus-coloured film striated with milky blue lines.

In the former experiment a fraction more than a grain of metal was obtained for each grain of charcoal; in the present nearly 2 grains of soft malleable iron were obtained.

III. 500 grains of mixture,

$33\frac{1}{3}$ —— of carbon, or 1-15th.

There resulted from the fusion of this mixture a very perfect button of malleable iron, which was found to weigh 63 grains: produce in metal equal to $12\frac{6}{10}$ths per cent. The glass in this experiment was less black and shining than in former, inclining to clear brown somewhat transparent. A few globules of metal had evidently deflagrated upon the surface of the glass.

IV. 500 grains of mixture,

42 ——, or nearly 1-12th carbon.

This mixture was exposed to a very high heat. The crucible was shapeless when taken from the furnace, but the contents were safe. The fusion was imperfect. The clay and charcoal evidently form with the oxide a mixture very infusible, of a rough spongy nature, full of bright globules of metal.

A mass of malleable iron was found which weighed 77 grains, equal to $15\frac{4}{10}$ths per cent.

V. 500 grains of mixture,

50 —— of charcoal, or 1-10th.

This proportion was exposed to a similar heat with former, but was found to possess less evident marks of fusion. One small globule of iron only was found separated.

VI. 500 grains of mixture,

70 ——, or nearly 1-7th of charcoal.

This mixture, after a similar exposure, was also found unfused. A number of minute silver-coloured globules had exuded from the surface of the agglutinated mixture, and a few were found carburated upon the surface.

It would appear therefore to result from these experiments, that clay alone, as a mixture, is unfavourable to the operation of iron, seeing that the largest collected produce did not exceed $15\frac{4}{10}$ths per cent. (see Exp. IV.); whereas the proportion of iron contained in the oxide, had it been entirely revived, would have amounted to at least 28 per cent.

To prove that the oxide contained no matter capable of reviving iron, nor the clay which was mixed along with it, I took

VII. 300 grains of Sturbridge clay,
200 —— of oxide.

This mixture was fused into a rough mass without any appearance of glass or vitrification. It was carefully examined, but not one particle of metal could be found revived.

VIII. This was Exp. IV, repeated with the addition of 80 grains of raw chalk. The result was a very perfect fusion. The glass was of a dark olive green colour, and covered a very neat metallic button, which was found to weigh 114 grains, equal to $22\frac{8}{10}$ths per cent. This additional produce of $8\frac{4}{10}$ths per cent. above what was obtained in Exp. IV, and the perfect fusion of the mixture, may be solely attributed to the addition of 80 grains of chalk. From which it may be justly inferred, that although calcareous earth does not appear to absorb carbon itself, yet it acts a part not less important or interesting, by facilitating the union of the metallic particles with the carbonaceous matter in the mixture, and thus enlarging under the same circumstance the metallic produce.

IX. This experiment was performed with the same proportion and quantity of mixture as Exp. I; only vitrified Sturbridge clay was put in place of the same clay in a raw state. The result was a very neat metallic spherule of iron which weighed 12 grains; equal to $2\frac{4}{10}$ths per cent. The experiment which more immediately corresponds with this is Exp. I; the result of which gave $2\frac{8}{10}$ths per cent. The difference of $\frac{4}{10}$ths per cent. is so small, that nothing certain can be inferred from the use of clay in two states so opposite to each other.

A very different result, however, takes place when Wedgewood's pyrometric clay is used in the mixture.

X.	Wedgewood's clay - - -	300 grains.
	Oxide - - -	200
	Charcoal - - -	$12\frac{1}{2}$

The result was a neat spherule of malleable iron which weighed 11 grains; equal to $2\frac{2}{10}$ths per cent. This experiment was repeated, and a similar shaped spherule of iron obtained which weighed 14 grains; equal to $2\frac{8}{10}$ths per cent. These results are nearly the same with Experiments I and IX, where Sturbridge clay was used.

XI.	Wedgewood's clay, vitrified in a heat of 170°, - -	300 grains.
	Oxide - - -	200
	Charcoal - - -	$12\frac{1}{2}$

The fusion of this mixture afforded a fine metallic button of malleable iron which weighed 30 grains; equal to 6 per cent. from the artificial compound. The same experiment repeated yielded a button of iron which weighed 28 grains; equal to $5\frac{6}{10}$ths per cent.

The extra quantity of iron revived in this experiment in consequence of vitrified Cornwall clay, beyond what took place in Experiments I, IX, and X, with the same proportions of mixture, cannot be satisfactorily accounted for. It is an important lesson, however, in so far as it manifests the peculiar action which even the same earth, differently prepared, has upon the separation of iron from its ore.

Recapitulation of the foregoing Experiments with Oxide and Clay in the Proportion of six of the latter to four of the former.

Exp. I. 1-40th of carbon yielded $2\frac{8}{10}$ths per cent.
II. 1-25th of ditto —— $9\frac{2}{10}$ths
III. 1-15th of ditto —— $12\frac{6}{10}$ths
IV. 1-12th of ditto —— $15\frac{4}{10}$ths
V. Mixture not fusible.
VI. Ditto ditto.
VIII. No. IV, fused by means of 80 grains, chalk: iron separated equal to $22\frac{8}{10}$ths per cent.

Second Class

Consisted of 6 parts of very pure sand,
4 parts of the same oxide formerly used.

I. 500 grains of this mixture were exposed to fusion. The mass of glass was carefully examined afterwards to ascertain whether it contained any revived metal. The glass was dense and uniform in the fracture throughout, without any trace or vestige of metallic iron.

II. 500 grains of mixture,
$12\frac{1}{2}$ —— of charcoal, or nearly 1-40th.

This mixture was reduced to fusion, and a perfect glass obtained faintly marked with dull yellow, but possessing metallic lustre. A minute irregular mass of malleable iron was found separated which weighed 7 grains: equal to $1\frac{4}{10}$ths per cent.

III. Mixture - - - - - 500 grains.
Charcoal 1-25th, or - - 20

The fusion of this was productive of five very perfect spherules of malleable iron which weighed 37 grains. Produce

duce with this small proportion of carbon $7\frac{4}{10}$ths per cent. The glass obtained was of a rusty yellow colour mixed with black veins: the surface covered with brown vitrified oxide.

IV. 500 grains of mixture,
25 —— of charcoal, or 1-20th.

This mixture had fused in a very perfect manner, and a beautiful metallic spherule obtained which weighed 45 grains; equal to 9 per cent. The quality was malleable iron as soft as copper. The glass was a curious heterogeneous mixture of yellow and vitrified sand. In cooling, a complete separation of the parts had taken place. The iron was found beneath the yellow glass, but a mixture of siliceous particles and oxide had formed a handsome cone over all about one inch in height.

V. 500 grains of mixture,
33 —— of charcoal, or 1-15th nearly.

The fusion of this mixture yielded a button of smooth-skinned malleable iron which weighed 65 grains; equal in point of produce to 13 per cent. The mass of glass was light shining yellow, surmounted by a thin stratum of oxide of a purple brownish colour.

This experiment was repeated, and a metallic button obtained which weighed 63 grains, or $12\frac{6}{10}$ths per cent. The result otherwise was the same.

VI. 500 grains of mixture,
50 —— of charcoal, or 1-10th.

This mixture was found unfused in a heat of 160° of Wedgewood. The particles of quartz remained pure as when first introduced, but considerably rounded by the action of the oxide. The latter had resolved itself into a dark yellow glass, which had penetrated in small veins the mass of some vitrified sand.

Three detached masses of iron were found which weighed 45 grains; or 9 per cent. This experiment was repeated at a higher heat, and apparently a greater quantity of iron was revived; but this was dispersed over the surface of the unfused matter in thousands of minute silvery globules. What could be collected weighed 62 grains; equal to $12\frac{4}{10}$ths per cent.

VII. 500 grains of mixture,
80 —— of chalk,
50 —— of charcoal, or 1-10th the mixture.

The result of the exposure of this mixture in a temperature similar to the former was a complete fusion, a very perfect mass of greenish glass, and a neat metallic button which weighed 101 grains; equal to $20\frac{2}{10}$ths per cent.

By comparing the effects produced by chalk under the first class, Experiment VIII, with this it appears evident that calcareous earth produces the same facility to fusion when mixed with siliceous matter as with argillaceous, and the tendency of the iron to revive is nearly the same in both.

LETTER IV.

LVI. *On the Catoptrical and Dioptrical Instruments of the Antients; with Hints respecting their Revival, Re-invention, or Improvement, in modern Times.*

DEAR SIR,

1. AGREEABLY to what I promised in my last, I proceed to give a brief account of two memoirs of father *Abat*, which, though not so interesting perhaps as that of which I gave a translation in my last, tend, in a considerable degree, to elucidate the present inquiry. I shall endeavour to corroborate my author's statements with such proofs as happen to be within my reach; and shall conclude with a concise recapitulation of what has been advanced.

2. *Abat's* eighth Recreation is "*On a Mirror of Emerald, in which the Emperor Nero viewed the Combats of the Gladiators.*" Having proved, from respectable antient authorities, that *Nero,* the most detestable monster who had *then* disgraced the name of emperor, was a myope, or short-sighted, my author, whom the reader, no doubt, has by this time discovered to be both learned and ingenious, observes, that in many myopes the organ of vision is so delicately sensible to the impression of light, as to require it to be moderated before they can see distinctly; that for this purpose, some myopes view distant objects through small holes, in thin plates of metal; and that Nero, in order to moderate the light, used a mirror, which my author argues, I think with great appearance of truth, was nothing more than an emerald reduced to a plane polished surface.

3. I fear a detail of his arguments and authorities would be thought tedious. But I cannot omit a curious fact which he has taken from our countryman *Ellis's* Voyage to Hudson's Bay; a work which, it would seem, is more respected by the French than by ourselves; for I find my late excellent friend, *Dr. Beattie,* in his Dissertations, Moral and Critical, regretting that so good a book should have been suffered to go out of print. Speaking of the Esquimaux, (I translate

translate the French of *Abat*, having never seen his English original,) *Mr. Ellis* says: "Their snow eyes, as they very properly call them, are a proof of their sagacity. They are little pieces of wood or ivory *, properly formed to cover the organs of vision, and tied on behind the head. They have two slits of the exact length of the eyes, but very narrow; and they see through them very distinctly, and without the least inconvenience. This invention preserves them from snow-blindness, a very dangerous and painful malady, caused by the action of the light strongly reflected from the snow; especially in the spring, when the sun is considerably elevated above the horizon. The use of these eyes considerably strengthens the sight; and the Esquimaux are so accustomed to them, that when they have a mind to view distant objects, they commonly use them instead of spy-glasses."—Surely a more ingenious device never originated among any untutored tribe. Yet I could mention a modern system-wright, who is pleased to rank these Esquimaux among the *naturally* inferior races of men, which owe their existence to his own *imitative* imagination. But this is not the proper place.

4. My author's ninth *Amusement*, or Memoir, appears to be more interesting than the eighth; or at least it is more analogous to that which I translated in my last communication. It is "On the Antiquity of Glass Mirrors, such as we use at present; and on the Perfection of the metallic Mirrors, which were in Use among the Antients." In this memoir, *Abat* endeavours to prove that several antient nations possessed abundance of plane metallic mirrors, some of them of a large size; and he contends (against *Muratori*, in his *Antiq. Italicæ Medii Ævi*; *M. Carry*, in a MS. paper which he sent to the Academy of Cortona in 1753; and *Mr. Nixon*, in the London Phil. Trans. for 1758), that the antients had the art not only of casting and polishing glass plates, but of coating them on the back with metal. It would be tedious to follow him through his reasonings on this subject; but as his authorities must have cost him very considerable research, and some of the books are scarce, I shall here insert them.

5. "I. Metallic Mirrors.—In Exodus, ch. xxxviii. v. 8, we read that *Bezaleel* "made the laver of brass and the foot of it of brass, of the looking-glasses, or brazen glasses, of the women." (Mirrors are among the furniture

* No doubt the author means by ivory, any kind of solid bone.—*Translator.*

of a Jewish lady's toilet, as described in the third chapter of *Isaiah*.)—2. *Pliny*, lib. xxxiii. cap. 9. says: "*Optima* (specula) *apud majores fiebant Brundusina, stanno et ære mixtis.* In the time of our forefathers, excellent mirrors were made at Brundusium, of a mixture of tin and copper." The same writer has these words: "*Specula quoque ex eo* (stanno) *laudatissima, Brundusii temperabantur, donec argenteis uti cœpere et ancillæ.* Highly praised mirrors were manufactured at Brundusium, till the very maid-servants began to use silver ones."—3. *Seneca*, in his Natural Questions, book i. ch. 17, and also in his 88th epistle, says, that there were mirrors as large as the human body *, and that they were not thought suitable furniture for apartments unless they were adorned with silver, and gold, and precious stones; so that one such mirror would cost a lady more than the national dowries formerly given to the daughters of great officers who had fallen in battle.—4. *Muratori*, in his *Thesaur. Inscript. class* 7. p. 520, has preserved this inscription, which proves, that the mirror-makers were so numerous as to form a corporate society: "M. OGVLINO FEROCI .... ÆDITVO ÆDIS CONCORDIÆ ... COLLEGIVM .... SPECULARIORVM .... PATRONO OPTIMO. DD. .... Dedicated, by the Company of Mirror-makers, to their excellent Patron, Marcus Ogulinus Ferox, Warden of the Temple of Concord."—5. There are not many mirrors remaining, either of the antient Romans, or of other nations. Yet *M. Cailus*, in his *Recueil d'Antiq.* t. iii. p. 331, says, that "there were sent him from Arles several antient Roman mirrors, one of them four inches in diameter, which still fits a case of the same metal, with the greatest exactness." (The kind of metal is not mentioned.)

II. "GLASS MIRRORS.—1. The following words are cited by *Oleaster*, from *Rabbi Abraham*:—"*Mos erat omnium mulierum suam decorare faciem, et aptare tiaram, singulo mane, in speculis æneis, aut vitreis.* It was the custom of all the women, to adorn their face and to adjust their head-dress, every morning, in brazen or glass mirrors." Here *Abat* adds, that he might cite many similar passages from *Andreas Placus*, in his *Lexicon Biblicon*, and from other authors.—2. *Anthony* of *Padua*, who died in the year 1231, in a sermon, on the fifth Sunday after Easter, cites *St. James*, ch. i. v. 23:—"If any man be a hearer of the word, and not a doer, he is like unto a man beholding his natural face in a glass," or mirror; and he adds, "*Speculum*

* See § 83 of the last letter.

nihil

nihil aliud est quam subtilissimum vitrum. A mirror is nothing else than a very thin, or fine, glass."—3. *Vincent de Bauvais*, who flourished under the emperor Frederic II. A.D. 1240, in his *Speculum Naturale*, lib. ii. cap. 78, says, that "*Inter omnia melius est speculum ex vitro et plumbo:* The best mirror of all is of glass and lead." For, says he, in the same chapter, "*Quando superfunditur plumbum vitro calido, efficitur altera parte terminatum valde radiosum:* When lead is poured on hot glass, a very brilliant surface is produced on the other side."—4. The celebrated *John Peckam**, archbishop of Canterbury, in his *Perspectiva communis*, pars 2. prop. 7, says: "*Reflexio est a denso, quia densum; propter quod specula consueta vitrea sunt plumbo obducta:* Reflection is made from a dense body because of its density; on which account common glass mirrors are coated with lead." He afterwards adds: "*Si ut quidam fabulantur, diaphaneitas esset essentialis speculo, non fierent specula de ferro et chalybe a diaphaneitate remotissimis, nec etiam de marmore polito; cujus tamen contrarium videmus:* If, as some feign, transparency were essential to mirrors, they would not be made of iron and steel, which are most remote from transparency, nor even of polished marble; of which, however, we see the contrary."—5. My author next quotes from the *Ars Magna* of *Raymond Lully*, who lived from the year 1225 to 1315, the whole chapter *De Speculo*, which is too long and perplexed with school metaphysics to be here inserted. It may suffice to observe, that the subject of it is mirrors coated with lead.—6. *S. Isidore*, of Seville, who died A.D. 636, in his *Etymol. lib.* xvi. *cap.* 15, speaking of glass, says, "*Neque est alia speculis aptior materia;*

* I cannot but observe that, as far as I can find, *Abat* takes no notice of *Roger Bacon*, the countryman and cotemporary of *Peckam*, or *Peccam*; though in several parts of his book he had fair opportunities of doing so. Can this neglect be any way owing to the critique of Dr. S.? Certain it is, that in *Mr. Bonnycastle's* excellent translation of *Bossut's Hist. Gener. des Mathem.* p. 189, we find this passage:—"*Roger Bacon's* Treatise on Optics is particularly remarkable for the ingenious, just, and at the same time new, ideas it offers on the subjects of astronomical refraction, the apparent magnitudes of objects, the extraordinary size of the sun and moon near the horizon, the place of spherical foci, &c. Some English writers, a little too much prejudiced in favour of their countryman, have fancied that they discovered in this treatise that the author knew the use of spectacles, and even of the telescope: but Mr. S., an Englishman of more impartiality, and an irrefragable judge, has controverted this opinion by an accurate and critical discussion of the passages that gave rise to it." Does not *Roger Bacon's* fame gain more by the just commendation of the learned Frenchman, than it loses by the hypercriticism of the learned Englishman?—*Translator.*

Nor is any other material fitter for mirrors."—*Henry Stephens*, in his *Thesaurus Linguæ Græcæ*, article Ὑάλινος, (of or belonging to glass) cites a passage from *Alexander* of *Aphrodisium*, the celebrated commentator on *Aristotle*, who lived towards the end of the second century. *Abat*, not having seen the original, does not give the passage, but says that *Stephens* adds, "*Unde* Ὑαλινα Κάτοπτρα, *apud Alexandrum Aphrodisium, vitrea specula* : Hence the *Hyalina Katoptra* of Alexander Aphrodisius, signifies glass mirrors."

6. *Abat* goes on to state, that, in consulting authors whose only subject was the art of making glass, such as *Antonio Neri*, *Kunckel*, *Merret*, *Haudicquer de Blancour*, and *Brumoy* in his Latin poem *De Arte Vitraria*, he has not found a single hint of the time of the invention of glass mirrors; although all these writers inquire into the antiquity of glass, and the purposes to which it has been applied, not forgetting mirrors. He says that all the books of travels, geography, and history, he has met with, which notice the glass manufactories of Venice, Germany, &c. are silent as to the time and place of the first establishment of such works. *Abat* further observes, that *Scarabelli*, in his Description of the Cabinet of *Settala* or *Septala*, in Italian, positively says that no author has mentioned who was the inventor of glass mirrors. In short, my author declares, that, as far as he knows, no writer has given the least intimation of the time when glass mirrors were invented; except *Pliny*, who (in the words cited above, § 85,) says that they were contrived at Sidon.

7. My learned author observes, that, from all antiquity, the practice of coating copper with lead or tin has been used *; and he intimates that the following method of coating glass globes, which is common in Germany, is so antient, that no author who describes it makes mention of the inventor :—" Take equal parts of lead and antimony (the *stibium* † of the antients) and melt them together. Blow a glass

* *Ainsworth*, under the word *Stannum*, gives this quotation from *Pliny*, xxxiv. 17. "*Stannum illitum æneis vasis compescit æruginis virus* : Tin overlaid on copper yessels allays the poison of the verdigrise." In one of the volumes of *Dr. Anderson's* excellent miscellany, THE BEE, there is a very simple recipe observed by the Turks in tinning metallic vessels; but I cannot get the volume at present.—*Translator.*

† I have somewhere met with the following whimsical, but not impossible, account of the origin of the name Antimony:—Some monks having thrown out an antimonial preparation, with which they had been making experiments, it happened to be swallowed by some hogs, along with the kitchen offals, and almost worked them to death. But the animals

a glass globe of the size you want; and, while it is red hot, pour into it the melted mixture, along with a bit of colophony, or black rosin. Turn it gently, in all directions, till its whole interior surface be coated over. Take it immediately off the fire, and pour off what is left, and keep it for another occasion. Then with a diamond or an agate cut the globe into as many mirrors as you think proper. The same thing may be done with a mixture of tin and antimony."

8. I suppose my readers will agree with my author, that the total silence of history respecting the time and place of the introduction of glass mirrors, to which we may add the inventor's name, is one of the strongest possible presumptions that they had their origin in very remote antiquity; like the use of iron and the other common metals, alphabetical writing, the arithmetical digits, and other admirable and highly useful inventions. *Abat* appears to me to prove satisfactorily, that *leaded* glass was early used for mirrors; but he has not been able to discover any direct evidence that *silvered* glass mirrors are equally antient. He only quotes *Isidore* of Seville, *Etymol. lib.* xvi. *cap.* 18, where that father says, " *Sine hoc* (argento vivo) *neque argentum neque æs inaurari potest:—Servatur autem melius in vasis vitreis; nam cæteras materias perforat.* Without mercury neither silver nor copper can be overlaid with gold.—But it is kept best in glass vessels, for it perforates other materials." *Abat* observes, that such an opinion would induce people to keep their mercury in glass vessels; that when mercury contains lead or tin it adheres, though not very strongly, to glass, and thus presents to the eye the exact appearance of a silvered glass mirror; that *Pliny's* word *excogitaverat* implies, that the Sidonians had bestowed thought and pains on their glass mirrors; and that so simple a process as silvering them, could not long escape such ingenious artists. For, when they had once observed that mercury, mixed with tin or lead, adheres to glass, it would not be difficult for them to conceive, that foils of these metals, well imbued with mercury, would have the same property. In short, says *Abat*, an ingenious man, after some attempts, would easily succeed in doing the rest; or, in other words, would discover the process of silvering glass mirrors, which we now practise.

[To be continued.]

animals growing afterwards uncommonly fat and sleek, the monks tried its operation upon themselves, and suffered severely by the experiment. Hence, says my forgotten author, the name Antimony, which signifies An enemy to monks.—*Translator.*

LVII. *On*

LVII. *Osteological Description of the one-horned Rhinoceros, by* Cuvier*.

As I propose to publish a part of the researches I have made to discover to what species the fossil bones have belonged, I must first give the osteology of some quadrupeds, which, under this point of view have never yet been described.

When Pallas first published, in the 13th vol. of the *Novi Commentarii* of Petersburgh, an account of the fossil bones of the rhinoceros found in different parts of Siberia, he regretted that he did not find in the work of any naturalist an osteological description of the living rhinoceros, and particularly of the cranium.

Some time after Camper had an opportunity of procuring a part of what he wanted; he transmitted to the Academy of Petersburgh a description and figures of the head and cranium of the two-horned rhinoceros of the Cape of Good Hope. His memoir was inserted in the first volume of the Transactions for the year 1777, part ii. which was not printed till 1780.

This great anatomist had then no knowledge of the difference of the teeth, by which the two species of rhinoceros are characterized; and as he did not find incisors in his two-horned species, he accused Parsons, Linnæus, and Buffon of error, for having ascribed any to the one-horned species.

But before his memoir was printed he paid a visit to Paris, and, having observed the one-horned rhinoceros then in the menagerie at Versailles, he found its incisors. He even procured the head of a young individual of this species, and had a drawing made of the alveoli. He immediately sent an account of all these facts to Pallas, that they might be printed along with his memoir.

He related the same facts in his Dutch dissertation on the one-horned rhinoceros, printed in 1782, the figures of which were the same as those transmitted to the Academy of Petersburgh.

These he confirmed in 1785, when he procured a drawing of the head of a one-horned rhinoceros preserved in the British Museum; and having obtained an older than that which he had first in his possession, he caused it to be engraved by Vinkeles in 1787, with the old figure of the one-horned rhinoceros, in a superb folio plate, dedicated to

* From *Annales du Muséum National d'Histoire Naturelle*, No. 13.

I. Van-

I. Vandersteege; this plate, however, was never published, but distributed among his friends. For one of them I was indebted to the kindness of his son.

This figure of the head of the unicorn is imperfect, as the real figure of the bones is still covered by some ligaments: there is one in particular behind the orbit, which might deceive those little acquainted with the subject, and be considered as an osseous partition separating this fossa from that of the temples.

M. Blumenbach, however, has copied this plate on a small scale, in his collection of objects relating to natural history, No. 7.

M. Faujas also caused to be delineated on a small scale, by Mareschal, the bones of the head of an adult one-horned rhinoceros, which is preserved in the Museum, and had it engraved in the 10th plate of his *Essais de Geologie*, but this figure is not accompanied by any description. Besides, though very exact on the whole, it is confused by the rugosities being too strongly marked by the engraver, and the sutures not being seen.

If to these be added the excellent figures of the lower face of the cranium and of the lower jaw of the one-horned rhinoceros given by M. Merck, in his third letter on fossil bones, printed at Darmstadt in 1786, we shall have, I believe, a complete catalogue of the materials hitherto published in regard to the osteology of this remarkable species of quadrupeds; and it will be seen that I am not precluded from resuming the subject, and treating it with an extent suited to its importance.

The pieces which will serve as a basis to my description are the beautiful skeleton prepared by M. Mertrud, of the rhinoceros which lived twenty-one years in the menagerie at Versailles, the same which was examined alive by M. Mickel and Peter Camper; and the head of a younger rhinoceros, for which our Museum is indebted to the generosity of Adrian Camper, and which served as an original for the plate given by his illustrious father.

1st, *The Head.*

What strikes most in the form of the head of the rhinoceros, (see Plate VII.) is the pyramidal projection of the cranium: the occipital bone forms the posterior face of it, and the temporal fossæ are the faces of the sides: the obliquely ascending continuation of the front is the anterior face; and instead of a point the summit is a transverse line.

The occipital ascends obliquely from behind forwards, which is peculiar to the rhinoceros, and renders its pyramid almost straight. In the hog even, which has a pyramid almost similar, it is inclined backwards.

The contour of the occipital is a semi-ellipse, which becomes broader towards its base, to produce a projecting plate behind the foramen of the ear and the posterior base of the zygomatic arch.

The line of the base exhibits at its middle the condyles, and at the sides the mastoid apophyses pointed and hooked: in the hog they are exactly under the condyles. Before each of these apophyses is another very large one, which belongs to the temporal bone, and which contributes to form the articulation of the jaw; it prevents it from moving much from right to left, and it corresponds with an indentation situated at the interior extremity of the condyle.

Between these two apophyses, but a little more inwards, is another short apophysis, the end of which is hollow, and receives the os styloides.

The impressions of the muscles divide the occipital face of the four fossæ: the anterior face of the pyramid descends, always becoming broader between the eyes, where the post-orbitar apophyses of the frontal are the most distant limits. The point of the nose completes the formation of the rhomboid, which characterizes the upper face of the whole cranium. The region between the eyes is concave in the longitudinal direction, and plane in the transverse; that of the bones of the nose becomes convex in every direction.

The parietals begin a little before the summit of the pyramid; they terminate towards the middle of the space between that ridge and the orbitar apophyses; the sutures analogous to the coronal, and the lamdoid are perfectly transverse.

The scaly suture, or the limit of the parietal and temporal in the temporal fossa, is parallel to the direction of the anterior face of the pyramid.

The large ala of the sphenoid ascends only very little into the temporal fossa, and this bone is not articulated with the parietal.

The posterior half of the zygomatic arch belongs to the temporal; all the rest belongs to the os jugale or the cheek bone.

The direction of the arch is like an Italic *S*, descending obliquely from behind forwards: its inferior edge is very thick in my adult individual, and projects considerably; it is much less in the young subject given by M. Camper.

The

The maxillary bone advances under the orbit, and forms there a plate: there is no apophysis either of the frontal or the jugal to join the zygomatic arch to the frons, and to close the orbit behind.

The sub-orbitar foramen is small, longer than broad, and near to the bottom of the nasal indentation.

The maxillary bones form before a projecting apophysis parallel to the bones of the nose, and situated under them, which articulates with the incisors. The alveoli of the incisors form together an angle of more than eighty degrees in the adult, but which is not sixty in the young individual. The incisor foramen is very large, elliptic, and not divided into two parts.

The incisor bones have at their upper edge a small apophysis, and a square plate which rises towards the roof, formed by the bones of the nose.

The latter are of a size and thickness of which there is no example in other quadrupeds: they form an arch which inclines to the incisor bones, and which supports the horn. In my adult individual their upper face is granulated like the head of a cauliflower.

Between them and the incisor bones and that part of the maxillary bones which supports them, is that large nasal indentation, which on the first view characterises the cranium of the rhinoceros. It results from the depth of this indentation that in this animal three pairs of bones, the nasal, the incisors, and the maxillary, contribute to form the contour of the external apertures of the nostrils; while in other quadrupeds, the tapir excepted, there are only the two latter. The lacrymal bone is small, and advances a little on the cheek. It has a very broad lacrymal canal, before which is a small pointed apophysis.

The vomer is ossified only in its most remote part, and there remains nothing in four-fifths of its length even in my rhinoceros full grown, and in which all the sutures were effaced. This remark is of great importance for a comparison of the living with the fossil rhinoceros.

The posterior groove of the palate is very deep, for it advances opposite to the fifth molar tooth; the suture which separates the palatine from the maxillary bones corresponds to the interval between the fourth and fifth molar tooth.

The pterygoid apophyses are short in the longitudinal direction, but very high in the vertical; single, and only a little forked towards the end.

The middle part of the sphenoid is straight, and proceeds much further back than its pterygoid ala; its articulation with

with the os basiliare of the occipital forms a very sensible projection; along the middle of this basiliary part is a projecting ridge, which becomes broader and is flattened towards the inferior edge of the occipital foramen.

The rupes is small and very irregular: the foramen lacerum is large, and extends along the interior edge of the rupes.

Length of the head from the edges of the occipital foramen to the edges of the incisor bones -	0·6
Distance between the most projecting part of the zygomatic apophysis - - - -	0·43
Height of the occiput counting from the lower edge of the occipital foramen - - - - -	0·26
Breadth between the apophyses placed behind the holes of the ears - - - - -	0·31
Breadth between the orbitar apophyses of the frontal	0·23
Depth of the nasal notch - - - -	0·15
Its height - - - - - -	0·095

[To be continued.]

LVIII. *On the Antiquity of the Gealic Language.* By CUTHBERT GORDON, *M.D.*

Mr. Tilloch,

IF you deem the following observations on the antiquity of the Gealic language not entirely foreign to the nature of your publication, and worthy of a place in it, you will oblige me by inserting them.

I am, &c.

CUTHBERT GORDON.

THE Gealic presents numbers with their names, which no other language, the antient Hebrew only excepted, can do. To know why those names are fixed to numbers we must take them in their order, beginning at one. Doing so will naturally show why they contain such excellent names, as it were, within themselves; and why those names, in preference to all others, are given to be our numbers. Their order runs thus:

THE

THE GEALIC PRECEPT.

Numeral Characters	Pronunciations.	Roots and Explanations.	English Translation.
1.	Aon. Enn. ..	Ah—Ann.	He is—The Presence—I Am.
2.	Dao. Duo. ..	Du—O.	O—Out of. Du—The Black; out of the Thick Darkness.
3.	Dree. Drui. .	Dru—I.	Dru—Penetration or Incubation; I—The Spirit; *i. e.* The Incubation or Operation of the Spirit.
4.	Cheaher.	Che—Ah—Er. .	Che—The Cream: Ah—He is: Er—of Man; *i. e.* the phlogiston of man's intellectual powers; the taper of the mind; the light. As Cheair, *i. e.* the fat, wax, or phlogiston of the earth, is the symbol of the Sun and culinary fire; so Cheaer is the symbol of intellectual Light.
5.	Coighd.	Co—Ighd.	God alike—Deified alike—Almighty.
6.	Shiah.	Shi—Ah.	Shi—The Peace: Ah—He is; *i. e.* He is The Peace.
7.	Shiachd:	Shi—Achd. ...	Shi—The Peace, Achd, to Mankind; The Comforter.
8.	Euchd. Iuchd.	I—Uchd.	I—The God; Uchd—of the Breast—Charity—Universal Love.
9.	Naomgh.	Na—Omgh. ...	Na—As the; Omgh—Lamb; The Innocent; The Pure; The Holy.
10.	Dec.	Dec.	Depart.

"The Presence out of the Thick Darkness by the operation of the Spirit is the Light; He is The Almighty; He is The Peace; He is The Comforter; He is Charity or Universal Love; He is the Lamb—Innocent, Pure, and Holy. Now comes the O, or Cypher, the Symbol of our Globe the Earth, which of itself is nothing, or of no power; but supported by Unity, the Symbol of The Presence, makes 10, or Dec, commanding us to depart."

The

By this order of our numerals we discover one of the most excellent and interesting precepts that ever was delivered to man; containing, first, an excitement to wonder with amazement at the procedure of the Presence and the operation of the Spirit in the production of Light, calling forth our gratitude to the Great Author for that portion of this Light or Ray of himself he is pleased to endue us severally with: and, secondly, the prevention of hurt towards our neighbours; whether by defamation, murder, false witnessing, false weights and measures, unjust accounts, or otherwise. We are commanded to depart to replenish the earth, and not to prostitute in their own symbols those great and awful attributes; he must be most hardened, indeed, who, knowing the significations they bear, can dare to do it. Therefore those excellent names, preferable to all others, are given to be our numbers; and they are comprised in those numbers, that in all our transactions they may be as a lamp before us.

The commanding number Dec, the others being attributes of the Almighty, evinces that those characters, though commonly called Arabic, are truly the Gealic's; and in fact, neither the Arabians nor any other nation until now did ever claim them; nor could they, indeed, having no title to show. Whatever the Jews may have had, they dropped it long since in Ægypt.

The Gealic alphabet, if not providentially preserved as its numeral characters have been, is long since lost; and the following facts, handed down by tradition, may account for their being so.

The Magi (from the nominative plural Maghi, Maghim, or Maghin; singular, Mai; *i. e.* Ma-I, the goodness of God), or expositors of the goodness of God, became in process of time, from being esteemed the best and wisest of men, to be dreaded as dangerous innovators; and were accordingly suppressed. The more ignorant vulgar believed that, by their great knowledge in the secret operations of natural powers, they could at pleasure transmute their own bodies into those of other animals, and in particular into that of the hare; and from this opinion conceived so deep a prejudice at the flesh of that animal as to be scarcely worn out even at this day. Many of the more common Highlanders will say that they prefer eating of any other flesh to that of the ghare; *i. e.* the cut-lip or hare. If asked why? they immediately retort, "Ne Vaghi" (the oblique case of Maghi), Is it the Magi, or would I eat the Magi? and with a serious countenance will add, that ten hares to one are witches

witches or warlocks. No doubt the goodness of the Magi made them too communicative to the people, who could not well comprehend the principles of things taught them: and hence magicians, witches, and warlocks.

The Druids (from the nom. plu. Druidghi), or explorers of the wisdom of God, succeeded the Magi, and were in most instances the very contrasts of their predecessors. They nearly kept a total silence, suppressing all kinds of literature except what they themselves were pleased to teach orally; and even that was but to the flower of the people. There was neither book nor writing of any kind but what they eagerly sought after; and, if found, as eagerly destroyed. In short, the polity of the Gealic Druids was unhappily such as to destroy all letters and characters, of whatever denomination, within their power. Thus the Gealic alphabet is irrecoverably lost, if not somehow found in the antient Hebrew or in its primary dialects; but it is feared that those too are gone. The Jews were long captives in Ægypt; and their language as well as their precept gave naturally way to that of their masters; nor was Moses, while he led them in the wilderness, inspired to restore them the former though he was the latter, made suitable to man's declining powers; for now they must be commanded to do their duty, whereas formerly they had the Precept to guide them, with one only command—To withdraw, to replenish the earth. The Gealic numeral characters must have shared the fate of its alphabet, had it not been for the extensive communication that, some time or other prior to the administration of the Druids, its people must have had with other countries out of their influence; and their own transactions at home have kept their names almost pure.

Notwithstanding the great change that the Hebrew must have suffered during the long captivity of the Jews in Ægypt, yet the following names seem to retain their antient purity. If we view them along with the Gealic, comparison will show the affinity or relation they bear one to another.

Hebrew.	Gealic.	Mutual Roots.	English Translation.
I.	I.	I.	God; the Spirit.
Iah.	Iah.	I—ah.	The God or Spirit who am; I Am.
Iod.	Iod.	I—od.	The God that Am; I Am that I Am.
Iehovah.	Iahavah.	I—a—ha—vah.	I—The God; A—I Am; Ha--That is; Vah—That was; The God I Am; that is, and was.
Shiloh. . .	Shiloh. . .	Shi—lo.	Peace or good will to mankind.

If we may form our judgment by the above comparison, we will readily pronounce the antient Hebrew and the present Gealic the same language: let us therefore prosecute the affinity a little further, by taking a comparative view of the Gealic Precept and the Hebrew Decalogue; the comparison may still throw more light upon this high and interesting subject.

The Gealic Precept.	*The Hebrew Decalogue.*
The first four numbers of the Precept excite our wonder and amazement at the august Presence and the operation of the Spirit, demanding our utmost adoration and gratitude for the production of Light.	The first four commandments are much to the same purpose, requiring the like adoration and gratitude for the production of the creation.
The fifth number shows that the Light brought forth by the Presence and the Spirit, is God alike, or to be alike deified; but, proceeding from the Father and the Spirit, is ever obedient to their will.	The fifth commandment requires to honour your father and your mother.
The sixth number is Peace.	The sixth commandment requires not to kill.
The seventh number shows that the Light is the Peace and Happiness of mankind.	The seventh commandment requires not to commit adultery.

The

The Gealic Precept.	*The Hebrew Decalogue.*
The eighth number shows that the Light is Charity or universal Love.	The eighth commandment requires, not to steal.
The ninth number shows that the Light is Innocent as the Lamb, Pure and without guile.	The ninth commandment requires not to bear false witness against our neighbour.
The tenth number commands to withdraw or depart; but not to prostitute those attributes of our Great Author in their own symbols to the hurt of our neighbour by coveting his goods or estate, &c.	The tenth commandment requires not to covet thy neighbour's wife, nor his servant, nor his maid, nor his house, nor his ox, nor his ass, nor any thing that is his.
The production of the Light was out of the Thick Darkness, through the operation of the Spirit, by God.	The Law was given to Moses out of the midst of the Fire, of the Cloud, and of the Thick Darkness, by God.
The Precept is comprised in Gealic numbers, that we should be initiated in both the one and the other at one and the same time, and thus in all our transactions be as a lamp before us.	Moses inculcates the Jews diligently to instruct their children in the words of the Law; to bind them as a sign upon the hands, and that they be as frontlets between the eyes.
Our numbers are ten.	Our commandments are ten.

The above plain and cursory view puts the affinity of the Gealic Precept and the Hebrew Decalogue in so clear a light, that we can discover no material difference, or rather, indeed, none at all; and therefore must conclude them to be one and the same: which is the greatest proof that possibly can be given for the authenticity of the Precept, or for the antiquity of the Gealic language. The word Gealic, derived from Geal or Gial—Reason, Light, or Understanding; and Ec or Ic—He has; *i. e.* Rationality, is presumed to be the proper name of the primitive language, and not the word Hebrew, from Eber, a man's name. Eber, indeed, and his successors for a long time after him, may have preserved the language in its antient purity; and, to distinguish it from the corrupted dialects of their cotemporaries, may have also given it the name of their predecessor, Eber, who

 first

first had observed, perhaps, the falling off of the language, and endeavoured to provide against it; and hence called Heberew: but surely the word is of too selfish or confined a nature to be the proper name of the primitive or universal language, the distinguishing mark between the rational and brute creation. Gealic is therefore the antient and real name, carrying in its basom the idea of Rationality.

LIX. *Fourth Letter from Dr.* THORNTON, *Lecturer on Botany at Guy's Hospital, to Mr.* ARTHUR AIKIN, *Editor of the Annual Review.*

September 15, 1804.
No. 1, Hind-street, Manchester-square.

SIR,

HAVING skirmished at the out-posts, we come now to the body of the work itself, and the same want of solidity of criticism will, I trust, be shown here, as in the other parts.

The reviewer begins by declaring his total unacquaintance with the author, and very properly hopes, "that *our** minds are free from every improper bias, and as *we* shall *nothing extenuate*, so *we* shall set down *nought* in *malice*." "The first section, of twelve pages," he observes, "contains only the plan of the work."

"The second is devoted to an explanation of the three kingdoms of nature; and a *fanciful* comparison of the great families of plants, with the different ranks of civilized society, translated with little variation from the Systema Naturæ of Linnæus. The whole would scarcely have filled *two* pages; but to *swell* it to the *bulk* of *four*, it is *stuffed*† with two quotations from *Milton*, with a long note from *Aristotle* and *Cicero*, and a pious address to the Deity from *Fenelon*; which having, like Bayes's prologues, an *universal fitness*, would do equally for *any part* of *any system* of *natural history*, that ever *has been*, or ever *will be published*."

* There is no *egotism* in the writer. When reviewing Dr. Shaw's work, he there says, "Such *we* have reason to believe to be the case. In the summer of 1801, *we ourselves* happened to be at Inverary in the height of the herring fishery." Page 844.

† Applying the word *stuffed* to any insertion from the prince of poets, recalls to mind the story of a poor author, who, on a Saturday night, took, as his last resource, his Milton's Paradise Lost to a *pawnbroker*, who looking at the work said, "Pray, sir, where does this Mr. Milton live? I don't know nor never heard talk of such a man. If you had brought me some *Milton oysters*, I should have then known *what value* to have put on them."

To

To those unacquainted with my work it may be necessary to declare the whole truth. I open as follows:—My Title, "The Philosophy of Botany," is the finest penmanship of Tomkins, engraved by Vincent. Her most gracious *Majesty* having condescended to suffer me, with permission, to dedicate to her my work; facing the dedication is the portrait of her majesty, by Sir William Beechy, R. A., engraved, and surrounded by angels; the masterly execution of Bartolozzi, R. A. Then follows the bust of Linnæus, from a painting in the possession of Sir Joseph Banks, Bart. K. B. honoured by Æsculapius, Flora, and Ceres, with Cupid; by Opie, R. A. and Russsel, R. A., engraved by Ridley; with a description of the emblematic design of this picture. Then follows a secondary kind of dedication to the most eminent living botanists, or but lately deceased; and there now open on the "astonished view" the portraits of the *patrons of botany:* the late Earl of Bute, first lord of the treasury; the right honourable Sir Joseph Banks, Bart. K. B. president of the Royal Society; next the *president and institutor of the Linnean Society, professor of the Royal Institution,* James Edward Smith, M. D.; *the vice-president of the Linnean Society*, Aylmer Bourke Lambert, Esq.; *professors of botany and lecturers in the three principal British Universities,* the Rev. Thomas Martyn, George Williams, M.D., and Daniel Rutherford, M. D. president of the Royal Edinburgh College of Physicians; *professors of botany and lecturers of the National Institute at Paris,* Jean Baptiste Lamarck, Antoine de Jussieu, and Des Fontaines; *amateur and promoter of the science of botany,* Jean Jacques Rousseau; *poetic writers on the subject of botany,* Erasmus Darwin, M. D., George Shaw, M.D.; *botanic physiologists,* Sir John Hill, M. D., Rev. Stephen Hales, Jean Ingenhousz, Charles de Bonnet, Joseph Priestley, LL. D., Robert Hooper, M.D.; *writer on medical botany,* William Woodville, M.D.; *historian,* Richard Pulteney, M. D.; *agriculturist,* Arthur Young, Esq.; *voyager,* Rev. Joseph Townsend*; with appropriate vignettes by the most eminent

* Among *these* portraits might have been expected the head of Dr. Aikin; for throughout his excellent work, EVENINGS AT HOME, are interspersed many very excellent *lessons on botany.* "To make a book on the subject of natural history for young people," says the reviewer, "an union of *genius* and *science* is required, which is rarely employed in providing the first rudiments of knowledge for the young. We know of ONLY ONE LIVING WRITER, who has *all the qualifications* necessary for the *task,* and is at the same time accustomed to the consideration of entering into the imperfect views, and supplying the wants of the uninstructed

nent masters. Besides these original and fine portraits, we are promised by the author those of Grew, Malpighi, Ray, Tournefort, Vaillant, two of Linnæus: one of these from an original picture in his own possession; and next succeeds his own portrait by Russel, R. A. engraved by Bartolozzi; the vignette by Loutherbourg, with a plan of the work. And in the second section is, Man at his first creation: a subject which has called forth the utmost stretch of genius of a Howard, R. A., who at first doubted how far he had abilities to represent this figure of Adam: and the back ground is by Reinagle, sen. R. A., to be engraved by Sharp, and Landseer, sen. engraver to his majesty.—I appeal to every generous heart, whether, after an expense of *three thousand pounds* for an *opening* to a work, which Dr. Darwin was "delighted with," and "in which," he said, "he felt it an honour to have his portrait introduced;" whether, after such exertions on my part, and such a risk of fortune, I deserve to be accused of "*stuffing* my work with unadapted matter to swell its bulk from *two* to *four* pages." I appeal to the Barbaulds and the Aikins, themselves poets, whether the low vulgar expression "*stuffed*" be applicable to the grand description of man, by Milton, at his first creation, alone capable of exalting our conceptions to that most astonishing act of the omnipotent Creator. I appeal to the philosophic world respecting my quotation from Cicero, who has from Aristotle also endeavoured to raise our minds to the conception of that act. And lastly, shall the pious prayer

instructed mind. No one who has read, and *who has not read?* the sketches of natural history scattered throughout the little volumes, entitled EVENINGS AT HOME; or, The JUVENILE BUDGET OPENED, can be at a loss to guess *whom* we mean. That writer's *plain* and *elegant style*, and *happy talent* for familiar illustration, would be most beneficially employed in conducting the unpractised naturalist through the *three* kingdoms of nature, in explaining the principles on which the classification of their various parts has been conducted; and in selecting such details as would render the whole equally interesting and instructive." P. 864 of Annual Review, Arthur Aikin editor! As this perhaps intended work has not *yet* appeared, Dr. Aikin will forgive me for not placing him among those great botanists whose portraits I have presented to the public. I again, as I have often done, repeat that, in truth, I have an high sentiment of respect for Dr. Aikin; and as supposing the name of *Aikin* to stamp a considerable degree of weight on any Review passed under that name, from that cause alone I have entered the lists with *an opponent*, whom otherwise I should have considered as *beneath my notice*. As Dr. Aikin is grouped next but one to me in the print of some of the *principal* members of the Bolt-court Medical Society, of which his son Mr. Aikin is register, (but his portrait Dr. Sims has *somehow* omitted), I could have wished we had been next to each other, and I am sure *we* should not have troubled the world by *our* jarrings.

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of Fenelon, the author of Telemachus, who thus concludes his Survey of the Wonders of Creation, to rouse the senseless spirits of a giddy world to the contemplation of HIS glory who formed it, be also included in the mass of dull, stupid, and unappropriate matter? To its *fitness*, not as books *commonly* run, I appeal to every judge of composition. Adam is supposed, after the wonder excited by the objects of creation, to begin to class these in his mind, and he separates the three kingdoms of nature: he then discriminates the seven vegetable tribes, as represented to us by Linnæus. This appeared to me a proper, grand, and suitable opening to a botanic work; and, if wrong, might even from its "magnificence" have disarmed the severity of criticism. But your reviewer is devoid of all "*grandeur of conception*" and of "*taste*;" and, had he been placed as Adam was, would have only said, "All this is very pretty, but I want something good to *stuff* my guts with;" and brute-like, after filling his belly, would have fallen into a profound sleep, and snored like a hog, not caring about waking *.

I have the honour to be, sir,
Your obedient and much injured servant,
ROBERT JOHN THORNTON.

P.S. I would here wish to apologize to the philosophic reader for making him a party in this contest: but being openly challenged in this magazine to vindicate myself from what are called "*serious charges*," brought against me by Mr. Arthur Aikin's reviewer; as a public lecturer, successor to the Linnean Smith, I have esteemed it as a duty not to shrink, when the gauntlet is thus publicly thrown down; or I had contented myself with the single letter "on the satellite of Venus," not willing to obtrude more on the time and patience of the philosophic world.

* How delicately does Milton handle this subject! When he represents our first father as falling into *a sweet slumber*, he nevertheless makes him *dream*.

> "On a green shady bank, profuse of flowers,
> *Pensive* I sat me down: there *gentle* sleep
> First found me, and with *soft* oppression seiz'd
> My drowsed sense - - - - - - - -
> Then suddenly stood at my head a *dream*,
> Whose inward apparition *gently* mov'd
> My fancy to believe I *yet had being*."

LX. *Account of a Journey to the Summit of Mont Perdu: read in the French National Institute by* C. Ramond*.

I several times attempted to ascend Mont Perdu, but was always stopped at a little distance from its summit by precipices and an accumulation of ice, which it was impossible for me to pass. I was, however, anxious to reach it, either to verify, by the help of my barometer, the elevation of this mountain, which appears to be the highest of the Pyrenees; or to ascertain the nature and disposition of the banks of which the summits are formed: and thus to place beyond all doubt one of the most singular geological phænomena ever observed.

Of all the faces of Mont Perdu there was only the eastern declivity which afforded me any chance of success. On that side there is a very high defile, which the intrepid mountaineers sometimes pass in order to proceed directly from the valley of Beousse to that of Fanlo: this is what is called the *Col deNiscle*. I was persuaded that by proceeding from this defile it would not be difficult to ascend the peak itself, if the interval by which I was separated from it did not conceal from me some obstacle which it was impossible to surmount. I therefore sent two of my best guides to explore the way, and followed them myself four days after. I now found that I was not deceived in my opinion, and that I had conjectured the real route to Mont Perdu.

I took my first station at the *Port de Pinede*. In the Pyrenees the name of *port* or gate is given to those defiles which serve as passages of communication between one valley and another. The latter is in the Spanish boundaries, and is at a considerable elevation. According to a barometrical observation, it is 2516 metres, or 1291 toises; being 98 metres higher than that of the Col du Grand Saint Bernard. The Port de Pinede, however, is far from being the most elevated passage of this part of the Pyrenees.

Here the Col de Niscle is seen opposite; but the spectator is separated from it by the valley of Beousse. We therefore descended, proceeding in an oblique direction towards those enormous walls which sustain the lake of Mont Perdu and its terrace; and we arrived at the point where the torrent, issuing from this lake, falls down in a most awful

* From *Annales du Museum Nationale d'Histoire Naturelle, No.* 13.

cataract

cataract to the bottom of the valley. Here we passed the night in the open air, surrounded by the vapour of the cascades above us; Mont Perdu suspended over our heads, an abyss below our feet, and the storm growling every where around us.

Our first labour in the morning was to ford the torrent which discharges itself from the lake: its depth, its great rapidity, and in particular the coldness of the water, rendered this operation exceedingly troublesome. The water made the thermometer rise to only two degrees above congelation.

From this place to the top of the Col de Niscle we experienced no other difficulty than that which arose from the great inclination of the declivities. I ascertained the height of this defile, and found it to be on a level with the Port de Pinede, and a little more than that of the lake.

The last stages of Mont Perdu appear to the west of this defile, and rise suddenly with an awfulness which announces the avenues to the summit. Four or five terraces piled one upon the other form so many stories, the steps of which are in part covered with eternal snow, and ruins, which in some measure facilitate the approach to these walls, otherwise inaccessible. The first of these ruins are very large blocks of gres containing testacea; among which I found fragments of calcareous schist, strongly stained with argil, and interspersed with small polypiers to which I never saw any analogous, and which seem to constitute a new genus. Higher up, the ruins become smaller; and the greater part of them belong to a calcareous kind of stone, compact, blackish, and singularly fætid. By being crushed under our feet it infected the air with a nauseous odour, which had no similarity to any of those called forth by percussion from any of the common hepatic and sulphureous stones.

We employed more than an hour in traversing these immense ruins; and this part of the journey fatigued us very much, by the efforts we were obliged to make in climbing up the steep declivities, and in consequence of the mobility of the soil, which had a tendency to throw us towards the precipice.

At length we arrived at the upper terrace, and found ourselves on a band of solid rocks. This band was at first a narrow ridge cut out like the roof of a house; but it gradually became broader, and conducted us to a kind of valley or commencement of the glaciers, with which the peak is surrounded. Here I found the last rocks which I was able

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to observe, as all the rest were covered by the ice and the snow. I here discovered a repetition of those calcareous banks interlarded with silex, which I saw at the Port de Pinede. They affect in the like manner a situation nearly vertical, and a direction parallel to that of the chain; they are accompanied with laminæ of another calcareous stone, very much charged with sand, and which contain so great a quantity of *lenticular numismals,* that they often seem to be almost entirely formed of them.

When we arrived at this terrace we were obliged to ascend the glaciers, by the lower precipices of which I had been hitherto stopped; but this time I approached them at their origin, and consequently at the place where they have the least inclination. The passage, however, was disagreeable and very dangerous: sometimes the surface was slippery, hard, and resisted our cramp irons; sometimes we sunk into the fresh snow, which had fallen on the summits towards the middle of July. Beneath this snow we felt fissures, where we were every moment in danger of being lost. Other fissures were open, and opposed our passage; and we had very nearly been stopped by the last, at the distance of two hundred yards below the summit. This fissure extended transversally from the commencement of the glacier as far as the precipices of the valley of Beousse. We had no other resource than to clear this interval by leaping down: we did so, and succeeded: this was the last obstacle we had to encounter. I measured the visible depth of this fissure, and found it to be 50 feet; and as the point where we passed corresponded to the convexity of the mountain, it was evident that it was the place where the glacier had the least thickness.

From this place I beheld the summit, which before had been concealed from me by the disposition of the declivities which I had traversed. It appeared under the form of an obtuse cone, covered with the purest snow. The sun shone at the time in full splendour, and the sky appeared of a dark blue colour, so strongly tinged with green that my guides were struck with its strange appearance. The former shade has been observed on all high mountains, but there is no instance of the second; and I do not know to what cause this singular optical illusion is to be ascribed.

At a quarter past eleven I reached the summit, and had at length the pleasure of seeing the Pyrenees at my feet. I immediately prepared my instruments for making experiments. A violent wind prevailed at east-south-east, which rendered this operation very difficult, and which occa-

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sioned some confusion in the results. At noon I noted down the heights of the barometer and thermometer. The corresponding operations were made at Tarbes: at that place, the barometer, when every correction was made, stood at 27 inches 1·47 line; and the thermometer, at 20·50° of Reaumur. At the summit of the peak the barometer was 18 inches 11·14 lines; and the thermometer at 5·50° above the freezing point. The height given by calculating these observations is about 72 metres, or 37 toises below what is given by trigonometrical observations; but this difference seems to have arisen from the stormy state of the atmosphere: at least I think myself authorised to infer so, from more than 600 operations of the same kind, at different heights, with a view to ascertain the nature, extent, and influence which the different modifications of the atmosphere have on measures obtained by means of the barometer.

The peak is covered with snow to its summit: this snow is continued towards the north, and transformed into an immense glacier, which descends by stories to the margin of the lake; its vertical height being about 800 metres.

On the south, however, the face of the peak is uncovered; but this is occasioned not so much by the action of heat as by its steepness: as the snow cannot adhere, it continually falls down from the top of the mountain on a slope six or seven hundred metres below, where it forms a glacier of such extent as to resist the direct and reverberated heat to which it is exposed by its situation.

The uncovered part of the mountain did not exhibit to me any strata in their natural place: it is an accumulation of ruins divided by time, macerated by the snow, buffeted by the winds, and beaten by the thunder, of which the greater part bears impressions. All these ruins belong to the calcareous kind of stones, compact and fœtid, which are here in alternation with shell stones. I examined them with an attention suited to the importance given them by their situation. They contain a small quantity of fine sand, coals, a little iron, and a fœtid cadaverous principle, which seems to arise from a bitumen of an animal origin.

This last conjecture is certainly well justified by the dreadful destruction of the marine animals which accompanied the formation of these mountains. This fœtidity, therefore, is not exclusively annexed to the strata of marble found here. It is observed on breaking gres, of which carbonate of lime constitutes the smallest part, in the same manner as sand is found in marble, in which one might

scarcely

scarcely suspect its existence. All these masses form different mixtures of similar matters: sand, lime, fœtid carbonate, argil, shells, united in all possible proportions, according to accidents which modified in every point the influence of general causes. Such are the elements of all these strata and veins arranged here in so capricious a manner, and which succeed each other with so much irregularity.

From the top of Mont Perdu the eye beholds, at one time, all this system of similar mountains: it is a long series of summits with upright strata arranged in the same line, and which divide the immense horizon of the spectator into two parts, as different in level as distinct by the form of the mountains with which they are filled.

On the north, primitive mountains arise, the sharp and torn summits of which are closely enchained, and form a large band, the elevation of which totally intercepts a view of the plains of France.

On the south the spectacle is very different; every thing is suddenly depressed. It is a precipice of from a thousand to eleven hundred metres, the bottom of which is the summit of the highest mountains of that part of Spain. None of the summits have 2500 metres of absolute elevation, and they soon degenerate into low round hills, beyond which opens an immense prospect of the plains of Arragon.

But what attracted my attention was the aspect of that southern band of the Pyrenees, on which I looked down as if from the clouds. It seemed to me to be divided into two distinct parts. The nearest to the plains exhibited to my view those long ridges and those hollow valleys which in general form the calcareous hills on the borders of the large chains. On the other hand, the band which adheres to Mont Perdu, and which serves it as a base, retained that strange appearance which distinguishes every thing that belongs to this singular mountain. It is an immense and long plateau, the whole surface of which, seen from this height, appears to be nearly on a level. Some paps only, and a few small hills, separated by broad but shallow valleys, appear on it. But in the midst of these superficial inequalities, traced out by antient currents, there are four enormous crevices with sides exactly vertical. They proceed diverging from the bases of the peak, and are continued to the limits of the plateau, the protuberances and valleys of which they divide, and they even intersect it itself to its foundations. They absorb also the waters of it, and conceal them by thick forests observed in their hollows. These fissures, which

which might be supposed recently formed, have preserved so well their salient and re-entering angles, that every thing perfectly corresponds on both sides—their sinuosities and undulations—so that one might think their edges, in order to unite, waited only for a new effort of the power which disjoined them.

One might traverse these crevices without any advantage, were they not seen from above. Their extent, their depth, and the gigantic size of all their proportions, would not allow one to conjecture their origin and nature. To approach them, one must seek for the opening in the Val de Broto or of Fanlo. They are vast and majestic valleys covered with forests as old as the world, and which are known only to some shepherds who conduct thither their migratory flocks.

I spent two days in that called Val d'Ordera. I never saw any thing more striking or extraordinary. The soil is a series of terraces, perfectly horizontal, formed by banks of gres, between which is observed red gres, considered by geologists as one of the oldest on the globe. The torrent falls in cascades so regular, that the long ramp down which it pours seems to have been formed by the art of man. On the other hand rise, as far as the eye can reach, the sides of this vast fissure disposed in stories of a prodigious height, and of which the steepness, the matter, the colour and joinings excite so much the idea of human structures, that the spectator thinks he sees an immense edifice in ruins. From the bottom of this fissure I ascended to the plateau. Its elevation is 2430 metres or 1200 toises above the level of the sea, and the depth of the fissure is 900 metres or 460 toises towards its middle, and 1257 metres or 645 toises towards its mouth.

Every thing is secondary in these enormous masses. Pudding stones, gres, calcareous and fœtid shell-stones, are the materials; and among the marine bodies inclosed in them the most predominant genus is that of the *numismals*, which are found every where in such prodigious abundance, that it strikes with awe the mind the best accustomed to the idea of the grand devastations of nature.

In regard to the plateau itself, it is a frightful desert. Being too high to produce trees, it stifles the small vegetation which exists by the mobility of the ruins with which it is covered, and scarcely are there seen here and there a few meagre grass-plats. The heights even of Mont Perdu are not so naked: as far as the last stories I found rare and superb plants; and I collected, at the distance of some metres below the summit, the *cerastium alpinum* and the

aretia

aretia alpina in full bloom. I never saw the latter so vigorous and so beautiful as I did at an elevation which is the greatest, perhaps, at which parasitic plants have been observed in the same latitude.

These organic beings were the last I met with on the summit of Mont Perdu. I remained on it two hours; and to whatever distance I turned my eyes I observed no living creature but an eagle which passed over us, flying directly against the wind with inconceivable rapidity: in less than a minute we lost sight of it.

We struggled against this impetuous wind, over which an eagle triumphed so easily, and which made us experience a considerable degree of cold. No wind diminishes so speedily the sensible heat as the south wind, when one is exposed to its action in the superior regions of the atmosphere: it derives this property from its dryness and rapidity, which promote and hasten the evaporation of which bodies are susceptible. We were penetrated by it, though the thermometer indicated a very low temperature. This is the only inconvenience I experienced. We could breathe without difficulty this air so light, and which is not sufficient for the respiration of many others. I have more than once seen vigorous persons obliged to stop at a less height. On the Col du Geant, where the air was not so highly rarefied, Saussure experienced a shortness of breath and uneasiness as soon as he made the least exertion. Here nothing similar occurred; the state of the pulse only indicated a change independent of the agitation of the journey: it was not calmed by rest. During the whole time that we continued on the summit it remained small, tense, and accelerated in the ratio of 5 to 4. This fever, which is nervous, announced the uneasiness we should have experienced at a greater height; but, according to what we experienced, it was attended with an effect contrary to what a degree more would have produced. Far from occasioning dejection, it seemed to support my strength and to rouse my spirits. I am persuaded that we were often indebted to it for that agility of the limbs, delicacy of sensation, and flights of fancy, which instantly dissipated our fatigue and apprehension of danger; and we ought not, perhaps, to seek any where else for the secret cause of that enthusiasm found in the accounts of all those who have ascended to extraordinary heights.

LXI. *Account of an Aërostatic Voyage performed by Messrs.* Guy-Lussac *and* Biot. *Read in the Mathematical and Physical Class of the French National Institute, August* 27, 1804.

Since the use of aërostatic machines has become easy and simple, philosophers have been desirous that they might be employed for making observations which require a great elevation at a distance from terrestrial objects. The minister M. Chaptal afforded a favourable opportunity for realizing these projects so useful to the sciences; and Messrs. Berthollet and Laplace having been pleased to interest themselves in this affair, the minister complied with their request, and M. Guy-Lussac and myself * offered to undertake the expedition. We have performed our first voyage, and we now give an account of it to the class.

Our principal object was to examine whether the magnetic property experiences any appreciable diminution on removing from the earth. Saussure, according to experiments made on the Col du Geant, at the height of 3435 metres, thought he could perceive a very sensible decrease, which he estimated at one-fifth. Some philosophers even have announced that this property vanishes entirely on ascending from the earth in an aërostatic machine. As this fact is naturally connected with the causes of magnetism, it was of importance to clear up and ascertain the truth of it. At least, such was the opinion of several members of the class, and of the illustrious Saussure himself, who strongly recommends this observation, to which he several times paid attention in his excursions to the Alps.

To determine this question a very simple apparatus is sufficient. Nothing is necessary but a magnetic needle, suspended by a very fine silk thread. The needle is turned a little from its magnetic meridian, and suffered to oscillate. The more rapid the oscillations, the greater the magnetic force. This excellent method was invented by M. Borda, and Coulomb gave the means of estimating the force according to the number of oscillations. Saussure employed this apparatus during his excursion to the top of the Col du Geant. We carried one of the same kind with us in our balloon. The needle we employed had been carefully constructed by that excellent artist Fortin; and Coulomb was so kind as to magnetize it himself by the method of Æpi-

* M. Biot.

nus. We tried its magnetic force several times before we quitted the earth. It made twenty oscillations in 141 seconds of the sexagesimal division; and, as we obtained the same result a great number of times without the deviation of half a second, it may be considered as very exact. We used for our observations two excellent watches that beat seconds, lent to us by an ingenious watchmaker, M. Lepine.

Besides this apparatus we carried with us a common variation compass and a dipping needle; the former to observe the direction of the magnetic meridian, and the other to determine the variation in the inclination. These instruments, much less sensible than the preceding, were destined only to point out to us the differences in case any very considerable should take place. That we might obtain only comparative results, we placed all these instruments in our car when we observed on the earth the oscillations of the first needle. No iron was employed in the construction of the car or of the machine. The only articles of iron we carried with us, a knife, a pair of scissars, and two penknives, were suspended in a basket below the car at the distance of from 25 to 30 feet; so that they could have no sensible influence on the magnetic virtue.

Besides the principal object of this voyage, we proposed also to observe the electricity of the air, or rather the difference in the electricity of the different strata of the atmosphere. For this purpose we carried with us metallic wires of different lengths, from 60 to 300 feet. By suspending these wires close to the side of our car from the extremity of a glass rod, we were brought into communication with the lower strata of the atmosphere, and enabled to call forth their electricity. To determine the nature of this electricity we had a small electrophorus weakly charged, the resin of which had been rubbed with earth before we ascended.

We proposed also to bring back air collected at a great height. To accomplish this part of our plan, we had an exhausted glass balloon closely shut, so that to fill it with air nothing was necessary but to open it. We were provided also, as may be readily conceived, with barometers, thermometers, electrometers, and hygrometers. We had likewise metallic disks to repeat the experiments of Volta in regard to electricity excited by simple contact; and we carried with us different animals, such as frogs, birds, and insects.

We ascended from the garden of the *Conservatoire des Arts* on the 24th of August, at ten in the morning, in the presence of a few friends. The barometer stood at 28 in. 3 lines;

3 lines; Reaumur's thermometer at 13·2°, and the hygrometer at 80·8°; consequently very near to the greatest degree of humidity. M. Conté, whom the minister of the interior entrusted with the preparations, had taken every possible care to render our excursion successful; which was in reality the case.

The first moments after our ascent were not employed, we confess, in making experiments. We could not help admiring the beauty of the surrounding spectacle. Our slow and gradual ascent produced on us that impression of confidence which one always experiences when abandoned to one's self with secure means. We could still hear the encouraging shouts of the spectators: but we had no need of them; we were perfectly collected, and without the least uneasiness. We enter into these details only to show that some reliance may be placed on our observations.

We soon reached the clouds. They were like light fogs, which occasioned only a weak sensation of humidity. Our balloon being entirely distended, we opened the valve to let out the gas, and at the same time threw out ballast that we might ascend higher. We now found ourselves above the clouds, and we did not enter them again but in descending.

These clouds, when seen from above, appeared to us blueish, as when viewed from the surface of the earth. They were all exactly at the same elevation; and their upper surface, full of small eminences, and undulating, presented to us the aspect of a plain covered with snow.

We were then at the height of about two thousand metres *. We tried to make our needle oscillate; but we soon found that the balloon had a very slow rotary motion, which made the position of the car, in regard to the direction of the needle, continually vary, and prevented us from observing the point where the oscillations ended. The magnetic property, however, was not destroyed; for, on pre-

* We calculated these heights from observations of the barometer and thermometer made in the balloon, and compared with those made by M. Bouvard at the observatory. We employed the formula of Laplace with the corrected co-efficients which he adopted, and which M. Ramond deduced from a great number of trigonometrical measurements made with great care. Our thermometer was filled with spirit of wine; the scale was divided into 100 parts, and it was secured from the action of the sun by a white handkerchief folded double, which was wrapped round it, but in such a manner as not to be in contact with it. We took every necessary precaution in the calculation, that we might not give to our heights too great values; and they were rather too small than too great.

senting a bit of iron to the needle, attraction took place. This rotary motion became sensible when the ropes of the car were brought into a straight line with any terrestrial object, or with the sides of the clouds, the contours of which exhibited differences very sensible. In this manner we soon perceived that we did not always correspond with the same point. We, however, hoped that this rotary motion, already very slow, would cease in the course of some time, and permit us to resume our oscillations.

In the mean time we made other experiments. We tried to excite electricity by the contact of insulated metals: it succeeded as on the earth. We then prepared an electric pile with twenty disks of copper, and as many of zinc. We obtained, as usual, the pungent taste, a shock, and the decomposition of water. All this could be easily foreseen from the theory of Volta, and since it is besides known that the action of the pile does not cease even *in vacuo*; but as there was no difficulty to ascertain these facts, we thought it our duty to examine them. Besides, the apparatus could serve us as ballast in case of need. We were then, according to our estimation, at the height of 2724 metres.

When about this elevation we observed the animals we had carried with us. They did not appear to suffer any inconvenience from the rarity of the air. The barometer, however, stood at the height of 20 inches 8 lines. A bee (*apis violacea*) which we set at liberty flew off quickly, and quitted us with a humming noise. The thermometer indicated thirteen degrees of the centigrade division, or 10·4° of Reaumur. We were much surprised that we experienced no cold: on the contrary, we were very much heated by the sun; and we took off our gloves which we at first put on, as they were now of no use to us. Our pulse was accelerated: that of Guy-Lussac, which in general gives 62 beats per minute, gave 80; and mine, which in general gives 79, gave 111. This acceleration, therefore, in both, took place in nearly the same proportion. Our respiration, however, was in no manner confined: we experienced no uneasiness, and our situation seemed exceedingly agreeable.

We, however, still turned round: which thwarted us greatly; because, while that effect continued, we could not observe the magnetic oscillations. But by bringing ourselves in a line, as already mentioned, with terrestrial objects, and the sides of the clouds, which were at a great distance below us, we perceived that we did not always turn round in the same direction; the rotary motion gradually decreased, and took place in a contrary direction. We then

found

found that it would be necessary to watch the transition from the one motion to the other, because in the interval we remained stationary. We took advantage of this remark to make our experiments; but, as this stationary state continued only some moments, it was not possible to observe twenty concentric oscillations, as on the earth: we were obliged to be satisfied with five, or at most ten; taking care not to agitate the car; for the slightest motion, that even produced when we let the gas escape, or of our hand when we wrote, was sufficient to turn us aside. With all these precautions, which required a great deal of time, we found means to make ten experiments in the course of the voyage, and at different altitudes. The results in the order in which we obtained them were as follow:

Calculated Heights in Metres.	Number of the Oscillations.	Time. Seconds.
2897	5	35
3038	5	35
The same	5	35
The same	5	35
2862	10	70
3145	5	35
3665	5	35·5
3589	10	68
3742	5	35
3977 or 2040 toises	10	70

All these observations, made in a column of more than a thousand metres in height, agree in giving 35 seconds for the duration of five oscillations: but experiments made on the earth give $35\frac{1}{4}$ for this duration. The small difference of a quarter of a second is of little importance, and at any rate does not tend to indicate a diminution.

The same may be said of the experiment which gave at one time 68 seconds for 10 oscillations, which makes 34 for five: it indicates as little a diminution. It appears to us, therefore, that we may with certainty establish the following proposition:

The magnetic property experiences no appreciable diminution from the surface of the earth to the height of 4000 metres. Its action in these limits is constantly manifested by the same effects and according to the same laws.

It remains for us to explain the difference between these results and those of the philosophers before mentioned. And

* Voyage dans les Alpes, tome iv. p. 312, 313.

first,

first, in regard to the experiments of Saussure, it appears to us, if we dare say so, that some fault must have been committed. This is clearly seen by the numbers he has mentioned. When he attempted to determine the magnetic force of his needle at Geneva, he found for the time of 20 oscillations 302, 290, 300, 280 seconds,—results which cannot well be compared, as their difference amounts to 12. On the other hand, in the preliminary experiments which we made before we set out, we never found a difference of half a second in the time of 20 oscillations. There is an error also in the calculation made by Saussure to compare the magnetic force on the mountain and in the plain; and therefore it needs excite no astonishment that his results should be different from those obtained by us. But it appears to us that ours are preferable because they seem to agree better, and because we ascended to a greater height.

In regard to the other observation, made by some philosophers, on the irregularities of the compass when one rises in the atmosphere, it appears to us that it may be easily explained from the continual rotation of the machine already mentioned. These observers, indeed, must have turned round as we did, since the impulse of the gas alone, as it escapes on opening the valve, is sufficient to produce that effect. If they did not observe this circumstance, the needle which turned along with them must have appeared to them uncertain and without any determinate direction. This irregularity was therefore only an illusion produced by their own motion.

We have still to remove one doubt which may be excited in regard to our experiments. It may be apprehended that our watches were deranged during the journey, so that some variation might take place in the magnetic force without our observing it; but since we perceived no difference, the magnetic force in this supposition and the going of our watches must have varied in a contrary direction, precisely in the same ratio, and in such a manner as to compensate exactly: an hypothesis exceedingly improbable and altogether inadmissible.

We were not able to observe with so much accuracy the inclination of the magnetic needle, and we therefore cannot positively assert that it experiences no variation. It is however very probable it does not, since the horizontal force is not altered: but we assured ourselves, at least, that its variations, if they exist, are very inconsiderable; for our magnetic bars, brought into equilibrium before our departure, constantly retained during the whole journey their horizontal

horizontal position; which would not have been the case had the force which tends to incline them experienced any sensible change.

The declination also was an object of our researches; but the weather and the disposition of our apparatus did not permit us to determine it exactly. It is, however, equally probable, that it does not vary in a sensible manner; but be this as it may, we have now the means of measuring it exactly during another voyage; we can also ascertain correctly the inclination. That we might not interrupt this narrative, we passed over in silence some other experiments of less importance, to which it is necessary now to recur.

We observed our animals at various heights, but they did not seem to be in the least incommoded. In regard to ourselves, we experienced no other effect than an acceleration of our pulse, which I have already mentioned. At the height of 3400 metres we set at liberty a small bird called a greenfinch: it immediately flew away, but in an instant returned, and perched on the cordage of the balloon; it then took a new flight, darting towards the earth, and describing a serpentine line very little different from the vertical. We followed it with our eyes to the clouds, where we lost sight of it; but a pigeon which we let go in the same manner, and at the same height, exhibited a spectacle much more curious. When set at liberty on the edge of the car, it remained there a few moments, as if to measure the extent it had to traverse; it then darted off, hovering about in an irregular manner, as if it were trying its wings; but after a few strokes it confined itself to extending them, and, abandoning itself to them entirely, began to descend towards the clouds, describing large circles like the birds of prey. Its descent was rapid, but regular; it soon entered the clouds, and we could still see it below them.

We had not yet tried the electricity of the air, because our attention had been engrossed almost entirely by observing the compass, which was the most important object, and which made it necessary for us to embrace the moments favourable for that purpose. Besides, we had always had clouds below us, and it is well known that the clouds are differently charged with electricity; we had not then the means necessary for calculating their distance, according to the height of the barometer, and we did not know what influence they might have upon us. However, to try our apparatus, we extended a wire of 240 feet in length; and having insulated it from us, as already said, we extracted electricity from its upper extremity, and applied it to the elec-

 trometer;

trometer: it was found to be resinous. We performed this experiment twice at the same moment: first, by destroying the atmospheric electricity by the influence of the vitreous electricity of the electrophorus; and secondly, by destroying the vitreous electricity extricated from the electrophorus by means of the atmospheric electricity. In this manner we were able to ascertain that the latter is resinous.

This experiment indicates that electricity increases with the height; a result agreeable to what had been concluded from theory, according to the experiments of Volta and Saussure. But since we are now acquainted with the goodness of our apparatus, we hope to be able to verify this fact by a greater number of trials during another journey.

Our observations of the thermometer indicated on the other hand a temperature decreasing from the earth upwards, which is agreeable to the results already known. But the difference was much less than we should have expected. For, on rising to the height of 2000 toises, that is to say, far above the lower limit of permanent snow, in that latitude we did not experience a temperature lower than 10·5° of the centigrade thermometer (8·4° of Reaumur); and at the same moment the temperature of the observatory of Paris was 17·5° of the centigrade scale, or 14° of Reaumur.

Another very remarkable fact given by our observations is, that the hygrometer always advanced towards dryness as we rose in the atmosphere; and that in descending it gradually returned to humidity. When we set out it indicated 80·8° at 16·5° of the centigrade thermometer; and at the elevation of 4000 metres, though the temperature was only 10·5°, it indicated no more than 30°. The air then was much drier in the high regions than it is near the surface of the earth.

To rise to this height we had thrown out almost the whole of our ballast: we had scarcely four or five pounds left. We had therefore attained to that height to which it was possible for the balloon to rise with two persons at once. As we were, however, exceedingly anxious to terminate the observation of the compass, M. Guy-Lussac proposed to me to ascend alone to the height of 6000 metres (3000 toises), in order to verify our first results. We were to deposit our instruments when we reached the earth, and to carry up in the car only the barometer and compass. When we had formed this resolution we suffered the balloon to descend, losing as little gas as possible. We observed the barometer when we entered the clouds, and it gave us 1223 metres, or 600 toises of elevation.

tion. We had already remarked that they seemed all to be on a level; so that this observation indicates their common altitude at that moment. When we reached the earth there was no person near us to hold the balloon, and we were obliged to suffer all the gas to escape in order to stop it. Had we been able to foresee this disappointment, we should not have been anxious to descend so soon. About half after one we found ourselves in the department of Loiret, near the village of Meriville, at the distance of about eighteen leagues from Paris.

We have not abandoned the design of rising to the height of 6000 metres, and even higher if possible, that we may continue our experiments on the compass at that elevation. We shall immediately prepare for this expedition, which will take place in the course of a few days, since the balloon has not sustained the smallest damage. M. Guy-Lussac will ascend first; and if he thinks it necessary, I will ascend alone in my turn to verify his observations. When we have terminated our experiments on the compass, we purpose undertaking several voyages together, to make exact researches, if possible, in regard to the nature and quantity of the electricity of the air at different heights, on the variations of the hygrometer, and on the diminution of heat as one removes from the earth,—all objects which must be useful in the theory of refraction.

We do not despair of being able also to observe angles, in order to determine trigonometrically our position in the heavens, which would give us some interesting ideas in regard to the movement of the barometer as one ascends. The motion of the balloon is so gentle that the nicest observations can be made in it; and the experience of our first journey, and in the use of our apparatus, will enable us in the course of a short time to collect a great number of facts. Such are our present intentions, should we be so fortunate as to find that the class consider our researches as of any utility.

LXII. *On the fascinating Power of Snakes.* By John Toplis, *A. M.**

Mr. Tilloch,

As the fascination attributed to many kinds of animals, particularly rattlesnakes, is a subject which has excited much inquiry and speculation, I hope the following attempt

* Communicated by the Author.

to elucidate what has caused so much astonishment and vague conjecture, may not prove unacceptable to the readers of your Magazine.

That various animals do possess the power of rendering others motionless and afterwards devouring them, is so well attested by individuals of different ages and countries, that it is an unreasonable piece of scepticism to deny it. It appears to have been the belief of mankind at a very early period, as it is mentioned by Homer, one of the oldest writers extant.

> *Μητηρ δ' αμφεποτατο, οδυρομενη φιλα τεκνα.*
> *Την δ' ελελιξαμενος πτερυγος λαβεν αμφιαχυιαν.*
>
> Il. B. 315.

> While hovering round with miserable moan,
> The drooping mother wail'd her children gone:
> The mother last, as round the nest she flew,
> Seiz'd by the beating wing, the monster slew. Pope.

Toads, hawks, cats, owls, and various other animals, have been observed at times to possess the faculty of drawing towards them such small animals as serve them for food, by intently looking at them. That tigers have this power, is attested in the very entertaining account of the manner of hunting and sporting in Bengal, written by colonel Ironside, and inserted in the Philosophical Magazine, vol. xiv. p. 319.

"It is somewhat extraordinary, but nevertheless a fact," says that writer, "the influence of fascination possessed by the tiger and all of his (the feline) species over many other creatures. Spied by deer particularly, they stop at once, as if struck by a spell; while the tiger lies still, his eyes fixed on them, and quietly awaiting their approach, which they seldom fail to make gradually within his spring; for the large royal tiger cannot run speedily or far.

"Wherever tigers roam or couch, a number of birds continually hover or couch round about them, screaming or crying, as if to create an alarm. But the peacock seems to be particularly allured by him; for the instant a flock of peafowl perceive him they advance toward him directly, and begin strutting round him with wings fluttering, quivering feathers, and bristling and expanded tails.

"Of this enticement the fowlers also make their advantage; for, by painting a brown cloth screen, about six feet square, with black spots or streaks, and advancing under its cover fronting the sun, the birds either approach towards them, or suffer them to steal near enough to be sure of their mark by a hole left in the canvass for them to fire through.

"Beyond all other animals, however, serpents possess most eminently this occult power: frequently are they seen revolving on the branches of trees or on the ground meditating their prey,—either birds, squirrels, rats, mice, bats, frogs, hares, or other animals."

Birds of prey, and particularly hawks, are frequently seen flying followed by numbers of those sorts of small birds upon which they are accustomed to feed. And I have been several times assured by different persons, whose veracity I have no reason to doubt, that if a man sees a hare sitting, and instantly fixes his eyes on its eyes, it will remain motionless until it be taken up by the hand.

M. Vaillant, in his New Travels into the Interior Parts of Africa, says, that the fascinating power of serpents is believed by the Hottentots as well as Negroes and Moors. That serpents have this fascinating property is attested by great numbers of travellers into various parts of the world; and as it is asserted by the natives of very distant countries which have no communication with each other, there is the greatest reason to believe that it takes place. I shall not therefore trouble your readers with a long list of citations from various authors in confirmation of the fact, but content myself with relating the following instances for the information of those who may not be acquainted with its effects. They are all, but the last, extracted from the Gentleman's Magazine for the year 1765, page 511; and were communicated by Mr. Peter Collison from a correspondent in Philadelphia.

"A person of good credit was travelling by the side of a creek or small river, where he saw a ground-squirrel moving to and fro between the creek and a great tree a few yards distant: the squirrel's hair looked very rough, which showed he was scared; and his returns being shorter and shorter, the man stood to observe the cause, and soon spied the head and neck of a rattlesnake pointing at the squirrel through a hole of the great tree, it being hollow: the squirrel at length gave over running, and laid himself quietly down with his head close to the snake's: the snake then opened his mouth wide and took in the squirrel's head; upon which the man gave the snake a whip across the back, and so the squirrel being released he ran into the creek.

"When I was about thirteen years old, I lived with William Atkinson, an honest man, in Bucks county, who returning from a ride in warm weather, told us, that while his horse was drinking at a run, he heard the cry of a blackbird, which he espied on the top of a sapling, fluttering and straining

straining the way he seemed unwilling to fly, and holding so fast the sprigs he was perched upon, that the sapling top bent. After he had viewed the bird a few minutes, it quitted the place, and made a circle or two higher in the air, and then resumed its former standing, fluttering and crying. Thereupon William rode the way the bird strained, and soon spied a large black snake in coil, steadily eyeing the bird. He gave the snake a lash with his whip; and this taking off the snake's eye from his prey, the charm was broken, and away fled the bird, changing his note to a song of joy.

"Mr. Nicholas Scull, a surveyor, told me, that when he was a young man he happened once to be leaning upon a fence, and looking over it, he saw a large rattlesnake in coil looking stedfastly at him. He found himself surprised and listless immediately, and had no power for about a minute (as he thinks) but to look at the snake, and then he had the resolution to push himself from the fence and turn away; feeling such horror and confusion as he would not undergo again for any consideration.

"Dr. Chew tells me, a man in Maryland was found fault with by his companion that he did not come along: the companion stepping toward him, observed that his eyes were fixed upon a rattlesnake, which was gliding slowly towards him, with his head raised as if he was reaching up at him. The man was leaning towards the snake, and saying to himself, 'He will bite me! he will bite me!' Upon which his companion caught him by the shoulder, pulled him about, and cried out, 'What the devil ails you? He will bite you sure enough!' This man found himself very sick after his enchantment."

In addition to the above instances, I shall relate the following, which was told me by Mr. Thomson, a gentleman who resided fourteen years at Burlinton, near Philadelphia, and in whose house I now lodge. He says, that one day as he was fishing in a brook near Burlinton, he turned his head aside, and saw a very large black snake steadily eyeing him: from that moment all power of moving was taken from him; he stood motionless and filled with horror, unable to avoid the snake, which he saw approaching towards him. From this unpleasant situation he was removed by a dog which was with him, who coming up from a short distance, immediately saw the snake and flew at it. As soon as the snake turned from him to avoid the dog, he felt his powers return; notwithstanding which he felt himself ill for some time after.

A variety of hypotheses have been formed to account for this remarkable power; some supposing the animals to have been previously bitten, and from that cause unable to avoid their enemy; others, that the serpent emits from its body a stupefying vapour: it has been likewise asserted, that those birds that flutter round the mouth of the animal are in general those which nestle on the ground, in bushes, or on low trees, and which, having eggs or young in their nests, expose their lives through love for their brood at the approach of their enemy. The most common opinion is that which is given in the Encyclopædia Britannica, article *Serpent*, viz. That the serpent is endued with an occult property of attracting small animals to it by its look, somewhat analogous to the attraction of iron by the magnet. The generality of philosophers, unable to account satisfactorily for this circumstance, and their minds revolting at the idea of admitting any occult or fascinating property in the animal, have peremptorily denied the fact. In opposition to the above opinions it has been observed, that the effect of the bite of a serpent is entirely different to that which attends fascination; and likewise, that if the serpent be disturbed the animal runs away uninjured. That it cannot arise from a stupefying vapour, is evident from birds living and enjoying themselves when put in a box with a rattlesnake. Fascination has likewise been observed to take place where no nest could be in the neighbourhood, and the bird at first at a considerable distance from the snake: besides, the same effect takes place with small quadrupeds.

It appears to me that this wonderful effect, which has been a matter of such astonishment, may be accounted for by attributing it to extreme fear. That this passion is sufficient to account for it, I shall attempt to prove; and if it appears to be so, where will be the necessity of admitting any occult or fascinating property in the snake? That extreme fear has the effect of rendering a person motionless is undoubted; there are few people who do not know instances of it: I could relate several, were it necessary. To what other cause can we attribute the fluttering of small birds in circles round hawks until they are seized and devoured, or the sudden fixed posture of a deer on the sight of a tiger? The fluttering of pea-fowls around it must arise from the same cause: nor can it be attributed to any peculiar property in the tiger, as one painted upon canvas is found to produce the same effect.

It is asserted by many (see Philosophical Magazine, vol. ii. page 253.) that the rattlesnake fascinates small birds and

and animals by means of its rattle; and they attribute the whole charm to the terror produced by the sound of that organ. It is said moreover that the young Indians place a reed in their mouths, and imitate the noise made by the rattlesnake; by which means they are enabled to catch squirrels and small birds. By attributing the whole enchantment to fear, the above account will not seem improbable, as it is as easy to conceive that small birds and squirrels may be stupefied by the terror arising from the known sound of the rattle, as from the sight of the serpent.

Could any doubt remain in the minds of my readers that fear is sufficient to account for the effect, I think the following extract from Drinkwater's Siege of Gibraltar will remove it. Speaking of the destruction occasioned by the falling of bomb-shells, he mentions the following remarkable circumstances; "In other cases in which the persons themselves have observed the shot or shells coming towards them, they have been fascinated by its appearance, and unable to move from the spot, as small birds are said to be by the rattlesnake. This sudden arrest of the faculties was nothing uncommon: several instances occurred to my observation, where men totally free have had their senses so engaged by a shell in its descent, that though sensible of their danger, even so far as to cry for assistance, they have been immoveably fixed to their place. But what is more remarkable, these men have so instantaneously recovered themselves on its fall to the ground, as to remove to a place of safety before the shell burst. In this manner lieutenant Lowe of the 12th regiment was fascinated by a shot which he saw coming, but had not power to remove from the place before it fell upon him and took off his leg."

As the sight of a ball or shell coming towards a man produces the same effect as the sight of a rattlesnake, why not attribute it to the same cause? In the case of a ball or shell the cause must be undoubtedly fear; therefore we may conclude that the rattlesnake does not fascinate by any peculiar property inherent in it, but from the terror which it occasions by its approach.

Yours, &c.

JOHN TOPLIS.

Arnold, Notts,
September 11, 1804.

LXIII. *Pro-*

LXIII. *Proceedings of Learned Societies.*

BOARD OF AGRICULTURE.

Premiums offered by this Board.

[Continued from p. 294.]

Substitute for litter.—To the person who shall make, and report to the board, the most satisfactory experiments to ascertain the best substitutes for straw, stubble, rushes, or fern, so as to answer the purpose for littering horses and cattle, and raising manure—*a piece of plate, or ten guineas.*

Accounts, verified by certificates, to be produced on or before the first Tuesday in March, 1806.

Manuring grass and arable lands.—To the person who shall draw up and produce to the board, the most satisfactory account, founded on his own experience, or on specified facts, of the comparative advantages of manuring grass and arable lands—*the gold medal.*

Accounts to be produced on or before the first Tuesday in March, 1808.

Manuring with peat.—To the person who shall report to the board, the best account, verified by satisfactory experiments, either on grass or on arable land, of applying peat moss, mixed or unmixed, as a manure—*the gold medal.*

Accounts to be produced on or before the first Tuesday in April, 1806.

Salt.—To the person who shall report to the board, the most satisfactory experiments to ascertain the advantages or disadvantages which have attended the use of salt as a manure, either simple, or mixed with other substances, and also for assisting in the food of animals—*the gold medal.*

It is required that the accounts of it, as a manure, shall contain a description of the soils on which the experiments are made; the other manures which may previously have been used on the land; the quantities of salt, mixed or unmixed, applied, and the effect carefully ascertained; and the quantity given, and in what manner, to any sort of live stock.

To be produced to the board on or before the first Tuesday in December, 1805.—The same premium for 1806.

Plough.—To the person who shall produce to the board, the plough which shall, with the least force, turn a furrow not less than six inches deep, and nine broad, in the best and

and neatest manner—*from five to fifty guineas, according to merit.*

To be produced on or before the first Tuesday in February, 1805.

The plough which gains the premium to remain the property of the board, the price of it being paid.

IMPERIAL ACADEMY OF SCIENCES AT PETERSBURGH.

The following observations on the remarkable cold which took place on the 13th of January last year, were communicated to the Academy of Sciences by their correspondent Dr. Meyer, in a letter dated Saratof, January 11, 1804. They were collected partly at Saratof, and partly obtained from the southern districts.

At Pensa, which is 200 versts north from Saratof, M. Europeus made the following remarks during the cold period.

From the 3d to the 5th of January the cold increased from 26 to 30 degrees. It then decreased till the 10th, on which day it was only 16. On the 11th, the weather being serene, with a boisterous north wind, it was in the morning 23, at noon 22, and in the evening 28 degrees. On the 12th in the morning 29, at noon 30, and in the evening 31 degrees, the weather serene and windy: the wind north-west. On the 13th the mercury sunk entirely into the bulb of the thermometer, the scale of which reached only to 44 degrees. In the morning and evening the atmosphere was thick; at noon clear, with the wind north. On the 14th the cold was 40 degrees, the weather clear, and the wind north. On the 15th the cold decreased from 26 to 18 degrees, and then to 21 and to 3 degrees.

From general Savelief, who has an estate on the Caucasian lines, the following information was obtained: The Terek had ice above half an arschin* in thickness: in common years this rapid river has ice only 2 verschocks in thickness, and very often no thicker than a straw. The greatest cold, which took place in the beginning of January, prevailed only in certain places: in some it was milder; in others all the pear, plum, apricot, and peach trees were completely frozen; the apple trees, however, were not affected. On the 26th and 27th of April a strong frost again took place, and did great injury to the vines.

The ice on the Volga, which in common years is from 12 to 14 verschocks† in thickness, was in February, when

* The arschin is 28 inches English.

† A verschock is the 16th part of an arschin.

broken

broken up for the wine-cellars, 19 inches in thickness. Hempseed-oil froze in the vessels containing it; and in taverns the common brandy formed a crust of ice on the sides of the casks; two things never before seen in that part of the country. Most of the fruit trees in these districts were frozen to the roots, and snow fell in an unusual quantity.

ACADEMY OF SCIENCES AT BERLIN.

On the 9th of August the academy, in honour of his majesty's birth day, held a public sitting, which M. Merian, the director, opened with an appropriate speech.

The director then announced that only two papers had been received on the question respecting the state of the arts, of oratory and design in the middle ages, one of which was written in German, and the other in Latin; but as neither of them fulfilled the expectation of the academy, this interesting question is continued, with the prize of 100 ducats, till the month of May 1806.

The mathematical class has repeated the question on the obliquity of the ecliptic, with a prize of 150 ducats. The answers to be transmitted to the academy before the above period.

The physical class has repeated the questions proposed for the year 1804.

1st, on Mariott's law.

2d, on the disease of the spleen among horned cattle.

3d, on the structure of the lungs.

And the philosophical class has repeated the question on the property of analysis, and the analytical method in philosophy.

A foreign literary man of rank has proposed a prize of fifty louis d'or on the following question, to be determined by the academy: "Whence comes it that the civilisation of the human race is found only in the East, and that in all the countries discovered in the West, and in the numerous groups of islands in the South Seas, scarcely any traces of civilisation have been observed?" Answers will be received till the month of May, 1805. They may be written either in French, Latin, or German.

Mr. Bode read a paper on the real and apparent revolutions of the two new planets Ceres and Pallas, and their connection with each other, which he illustrated by drawings and a model. M. Hufeland closed the sitting by reading a paper on the influence which the atmosphere and situation of a place have on the life, health, and physical character of the inhabitants.

LXIV. *Intel-*

LXIV. *Intelligence and Miscellaneous Articles.*

AERIAL NAVIGATION.

While some persons were making, or endeavouring to make, a great deal of noise in regard to the means they had discovered for directing air-balloons, M. Pauli, a native of Swisserland, and an excellent mechanic, was inventing and improving, in silence, a machine proper for raising or lowering a balloon, for carrying it to the right or left, causing it to turn round at pleasure, and to move several leagues an hour without the least wind. This discovery is now published. The first trial, if we can believe the account given of it, was crowned with the most complete success. It was made at Sceaux, in the small park of M. Lecompte. M. Pauli, on the 22d of August, ascended in the presence of a great number of spectators; and when he reached the height of 500 toises, he caused the machine to move round in a semi-circle, and seemed to return to the point from which he set out. He then turned several times from right to left, and from left to right; but being alone in the car, and having only the half of his calculated force, instead of going directly against the wind, he proceeded south-west, while the wind ought to have carried him south-east. By means of these manœuvres he advanced to the castle of Osinville, near Arpajon, five leagues distant from the place from which he set out, in less than an hour; and in that interval descended twice to the earth. (Gazette de France, 30th August.)

According to an account of the ascent of professors Sacharof and Robertson, read in the last public sitting of the Academy of Sciences at Petersburgh, it appears that the object of this aërial excursion was to ascertain with more precision the physical state of the atmosphere and its constituent parts at different elevations, as determined by the barometer. It is certain, that the experiments made by Deluc, Saussure, and Humboldt, on high mountains, must have exhibited modifications arising from the terrestrial attraction, or from the decomposition of organised bodies. The above two aërial travellers, therefore, carried with them twelve reservoirs, in which a barometric vacuum had been formed. These were destined to collect the atmospheric air at every elevation, indicated by the descent of each inch of mercury in the barometer. The Academy,

Academy, desirous of rendering these experiments useful, had made a trial of the different processes for ascertaining the direction of an aërostatic machine, when its elevation does not admit of its being seen from the earth, and when there remains no object with which it can be compared. The process which these philosophers employed is both ingenious and simple. It consists in attaching to the car, by a silk thread, a float, or very light log, which by its position always indicates the direction, the ascent or descent of the balloon, even before the barometer has made the least movement. By means of a powerful achromatic telescope, which traversed in a perpendicular direction the bottom of the car, the observers were enabled to distinguish the spot over which the balloon hovered; and in this manner they ascertained the moment when they entered the Gulph of Bothnia, and the time when they got out of it. They made experiments also on the echo of sound, the reflection of which is exceedingly sensible and calculable in the upper strata of the atmosphere. It is believed that during their next ascent they will endeavour to determine the difference of the ratios between the ascent of sound and its propagation in a horizontal direction. The observation made by Mr. Robertson, when he ascended at Hamburgh on the 18th of July 1803, is confirmed by M. Sacharof. The north pole of the dipping-needle was raised ten degrees, &c. The existence of a superior current, which twice drove the balloon towards the sea, prevented the travellers from rising so high as they intended. The mercury in the barometer fell eight inches and a half. The thermometer, which indicated thirty degrees at their departure, stood at three degrees at the highest elevation. They remained four hours in the air, and descended at the distance of twenty-five leagues from the place of departure.

Venice, Aug. 25.

Count Zambeccari, whose unfortunate aërial journey, from Bologna across the Adriatic sea to Pola in Istria, is still fresh in the memory of the public, undertook a new voyage last week, and from the same place. He was saluted at first with loud acclamations from the many thousand spectators, because he made the balloon rise and fall at pleasure. At the end of four hours, when hovering over the village of Cao, some flasks filled with spirit of wine caught fire. He immediately descended; and M. Andreoli his companion, jumped from the balloon, in order to secure it by fastening the anchor. Count Zambeccari was desirous of getting out also; but before he could accomplish it, the balloon suddenly rose in the air, and carried the unfortunate Count along with it. No accounts of him have since that time been heard.

Bologna, August 24.

The following is a more particular account of the new aërial excursion which was undertaken here on the 22d by Count Zambeccari and M. Andreoli, both known by their unfortunate expedition of the same kind last year. They ascended in the presence of an immense concourse of spectators; for besides the 70,000 inhabitants of this city, about 60,000 strangers were collected from the neighbouring places. The spectators took their station chiefly on the surrounding hills, and formed a beautiful spectacle. At six in the morning a signal was made by the firing of three cannon, and at ten the ascent took place. About one the balloon was entirely out of sight; and the inhabitants and strangers who had viewed the scene, were agitated between hope and fear for the fate of the intrepid aëronauts, when Dr. Andreoli arrived unexpectedly in a post-chaise, at four in the afternoon, with his arm bound up. The people immedistely flocked round him, all anxious to know what had become of Count Zambeccari. The account which Dr. Andreoli gave was as follows: In order to prevent their being carried too near to the Adriatic sea, they had suffered the balloon to descend at Capo d'Argine, the first post-station on the road to Ferrara, and had made their anchor fast to an elm. At the moment when it caught one of the branches, the car received a violent shock, by means of the rope, which threw down a few sparks from the Montgolfier fire-pan contained in the car, and kindled some spirit of wine in the vessel below. Alarmed at this apparent danger, Dr. Andreoli let himself down to the tree by the anchor-rope, and laid hold of a branch; but the branch breaking, he fell to the earth, and received a contusion on his arm. The balloon being rendered much lighter by the doctor's quitting it, and more inflated by the fire which took place in the car, could no longer be kept down, though two peasants, who had hold of the rope, exerted all their strength for that purpose. It rose again into the air with the velocity of lightning, and disappeared in the clouds. Not without reason, therefore, did people apprehend that Count Zambeccari would be exposed to the horrid fate of being burnt alive in the upper regions. But this intrepid aëronaut, though exposed to the greatest danger, did not lose his presence of mind. He found means to extinguish the fire in the car; and, as the rudder was in flames, to throw it down to the earth, where it was found: but it was not considered as a proof of the Count's safety. He now endeavoured to descend as speedily as possible, because he was already in sight of the Adriatic. The same good fortune which rescued him from death during his former voyage, attended him on the present occasion. Some fishermen, who were out at sea between Comachio and Rimini, hastened to his relief, and took him into their boat; but the balloon escaped, because they did not immediately make some incisions in it as the Count had desired. This day, at one in the afternoon, he made his entry into Bologna: above a hundred coaches accompanied the open chaise in which he rode, and which was drawn by a crowd of young men, amidst the thunder of cannon, while the French and Italian troops lying here marched along to the sound of military music. Count Zambeccari will soon publish a particular account of this new adventure. The car remains at Comachio; but the balloon, it is probable, has been carried to a considerable distance, perhaps to the Turks in Bosnia, who fired at the first as a strange monster, and then took it prisoner. Whether Count Zambeccari will undertake a third aërial journey is uncertain; but at any rate he will not employ a balloon filled according to Montgolfier's method, which is always attended with the danger of fire. The present French method of filling balloons is certainly far preferable. Before Count Zambeccari made his triumphal entry, 2000 people at least had gone to meet him. The day was considered as a festival, on which no one did any work. Dr. Andreoli was not seated in the triumphal car.

VACCINATION.

Vienna, Aug. 25.

According to the latest information received by Dr. de Carro from different physicians, and the governor of Bombay, it appears that vaccination has become general in all the British possessions in India; that the neighbouring Asiatic princes vie with each other in obtaining from them vaccine matter, in order to propagate it in their states; and that hopes are entertained of soon hearing that it has been introduced into Tartary and Japan.

A passage translated from an Indian manuscript, written by a native prince, and published in the Bombay Gazette, proves that some of the Bramins, many centuries ago, were not only acquainted with the cow-pock, but with vaccine inoculation; that the operation was performed by means of an impregnated thread; but that it was not common, as the Bramins inoculated only those children whose parents worshipped the Bhowany, a female deity, the protectress of those who have the small-pox. The goddess is generally represented riding on an ass; and the father of the child to be inoculated brings her an offering, consisting of corn, which he takes from his bosom, and gives to the ass to feed upon. The ceremony is repeated as soon as the cow-pock appears. Governor Duncan, of Bombay, has transmitted this information to Dr. de Carro, with a handsome letter, and a present of two valuable shawls and three pieces of most beautiful muslin for his lady.

ASTRONOMY.

Bremen, Sept. 8.

Mr. Harding, about 10 o'clock in the evening of the 1st, discovered from the observatory here, in the sign of Pisces, a new planet perfectly similar to Ceres in light and apparent magnitude, and moving retrograde towards the west with increasing southern declination. The following are the observations which have been made:

		R. A.		Declination.
Sept. 1.	-	2° 25′	-	0° 37′ N.
4.	-	2 1	-	0 1 S.
5.	-	1 52	-	0 11 S.
6.	-	1 44	-	0 24 S.
7.	-	1 37	-	0 36 S.

Nothing nebulous can be distinguished around this star by the best telescopes, and in all probability it is a sister of the new discovered planets Ceres and Pallas.

A correspondent has favoured us with the following particulars of this discovery:—" M. Harding, of the observatory at Lilienthal, near Bremen, who has been making an atlas of all the stars down to the eighth magnitude which lie within and near the orbits of the two new planets Ceres and Pallas, as announced in baron Von Zach's journal, has discovered a third new planet. While examining the stars in the constellation of Pisces on the 1st of September, he observed a small star, about the eighth magnitude, of which he could find no account in Lalande's *Histoire Celeste*; and therefore, not knowing its true place, he put it down in his charts as near as he could estimate by the eye: but two days after, looking for it again, he found it was gone, and observed another star exactly like it a little to the south-west of its place, which he had not seen in that place before. This raised his suspicion that the star he had observed was a planet; and, looking at it again on the fifth, he was satisfied it was so. Since then several observations have been taken of it. Its place, as settled by Dr. Olbers, on Sept. 8, was at M. T. $8^h\ 11^m\ 20^s$, A. R. 1° 29′ 39″,

 declin.

declin. south 0° 47′ 19″: its motion in A. R. is about 7′ 56″, or 31·7″ in time retrograde, and in declin. about 12′ 34″ south per diem."

LIST OF PATENTS FOR INVENTIONS,

Which have passed the Signet Office between August 24 and September 24, 1804.

To Robert Frith, of Broughton, in the county of Lancaster, dyer, for an improved method of dyeing cotton wool, cotton twist, cotton weft, and cotton cloth, of a nankeen colour, and of a buff colour.

To Michael Scarth, of Castle Eden, in the county of Durham, sail-cloth manufacturer, for a new method of manufacturing sail-cloth with double or single thread warp, without starch or any substitute for stiffening, and without the double threads being twisted together.

To John Bywater, of the town and county of the town of Nottingham, for a new and improved method of clothing and unclothing the sails of windmills while in motion, provided that they are made after the Dutch manner, as the generality of windmill sails are constructed, by which the mill may be clothed, either in whole or in part, in an easy and expeditious manner, by a few revolutions of the sails, whether they are going fast or slow, leaving the surface smooth, even, and regular in breadth, from top to bottom; and in like manner the cloth, or any part thereof, may be rolled or folded up to the whip at pleasure, by machinery simple and durable, that may be fixed up in a few days, at comparatively easy expense, requiring very little alteration of any part of the mill, and is equally applicable to any old sails on the common construction, however warped or bosomed, without the necessity of having new cloths.

To Charles Frederic Möllersten, of Hackney Wick, in the county of Middlesex, gentleman, for a chemical composition, and method of applying the same, in the preparation of hides, skins, and leather, silks, taffetas, and linen, and to all articles already made of skins and leather, thereby colouring and giving a beautiful gloss to the same, rendering them water-proof and impenetrable to hot or corroding liquids, and at the same time preserving them from decay, and keeping them soft and pliable.

To Thomas Porthouse, of Hall Garth, in the parish of Haughton le Skern, in the county of Durham, flax-spinner, for a machine for hackling flax and hemp, and at the same time carding the tow.

METEOROLOGICAL TABLE*

For September 1804.

Days of the Month.	Thermometer. 8 o'Clock, Morning.	Thermometer. Noon.	Thermometer. 11 o'Clock, Night.	Height of the Barom. Inches.	Degrees of Dryness by Leslie's Hygrometer.	Weather.
Aug. 27	58°	70°	61°	30·22	71°	Fair
28	63	70	62	·20	40	Fair
29	64	75	65	·13	53	Fair
30	65	78	64	29·90	36	Fair: a storm in the morning
31	65	72	58	30·10	37	Cloudy
Sept. 1	60	68	55	·04	75	Fair
2	57	66	54	·20	57	Fair
3	55	65	60	·34	24	Cloudy
4	61	71	62	·31	37	Fair
5	62	72	61	·30	45	Fair
6	63	70	54	·05	53	Fair
7	56	71	57	29·98	52	Fair
8	54	69	60	30·19	41	Fair
9	58	71	57	·20	35	Fair
10	57	72	66	·01	45	Fair
11	56	68	57	·15	57	Fair
12	57	76	66	·10	49	Fair
13	67	78	66	·01	65	Fair
14	64	76	68	·01	49	Fair
15	66	76	65	29·98	57	Fair
16	66	82	67	30·05	53	Fair
17	61	66	60	·18	21	Cloudy
18	59	62	60	·18	20	Cloudy
19	62	68	61	·08	40	Fair
20	63	71	55	·08	47	Fair
21	56	66	50	·06	59	Fair
22	51	62	60	·01	47	Cloudy
23	50	56	47	29·92	56	Fair
24	46	54	50	30·00	40	Cloudy
25	51	61	46	·26	42	Cloudy

* By Mr. Carey, of the Strand.

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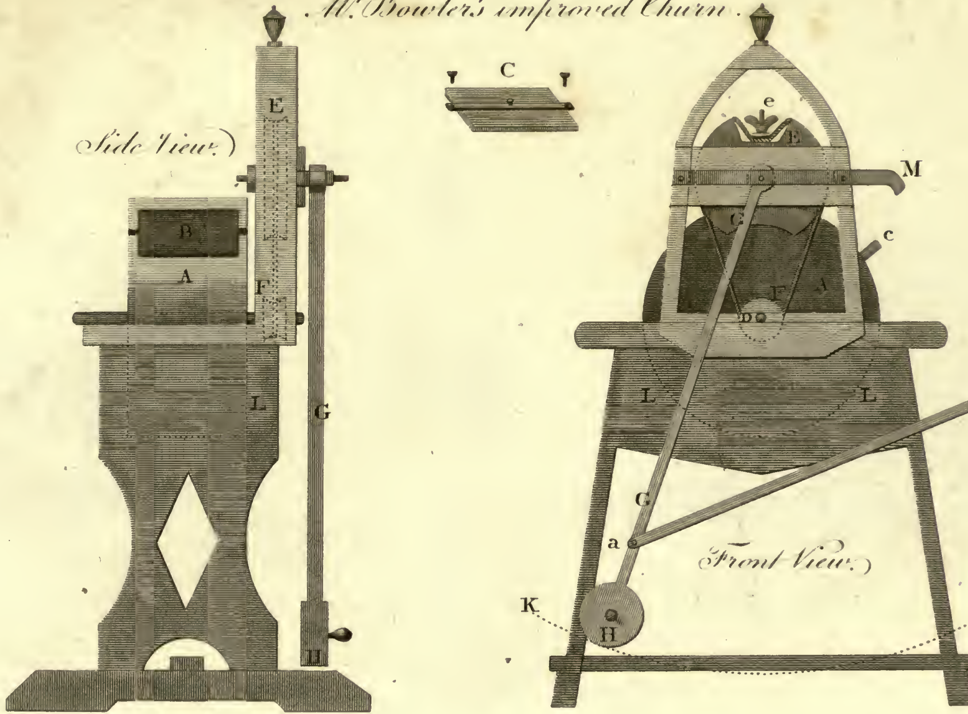
Bowler's

END OF THE NINETEENTH VOLUME.

R. Taylor and Co. Printers, Black-Horse Court.

Mr. Bowler's improved Churn.



No. 73.

S. Porter sculp.

Fig. 1.

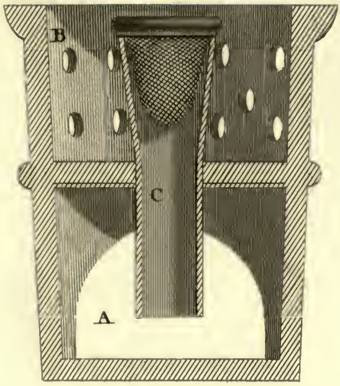


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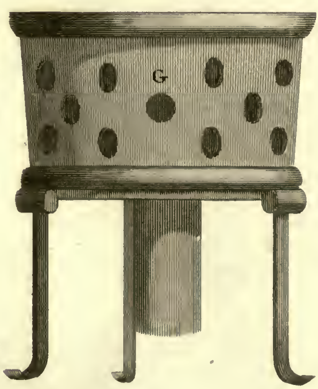
Fig. 2.

Fig. 4.



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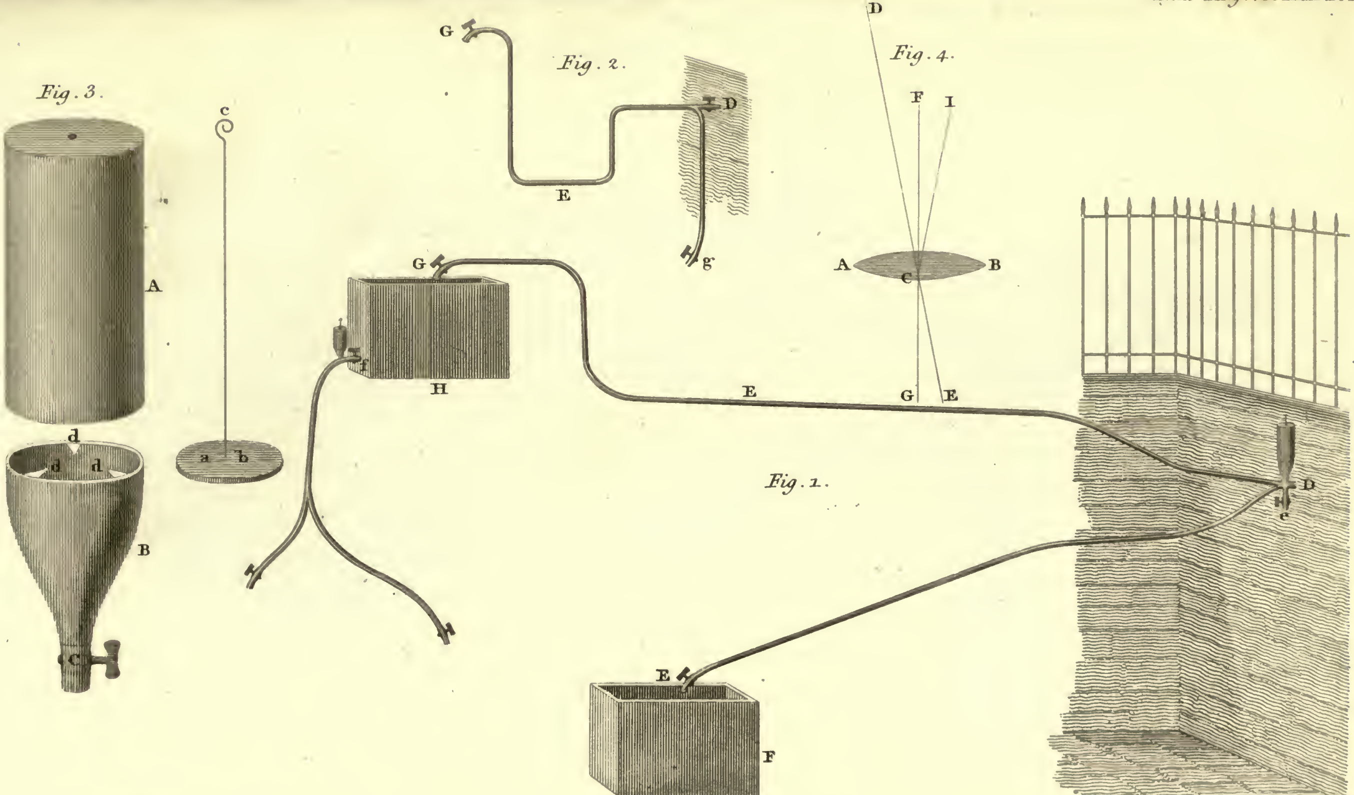
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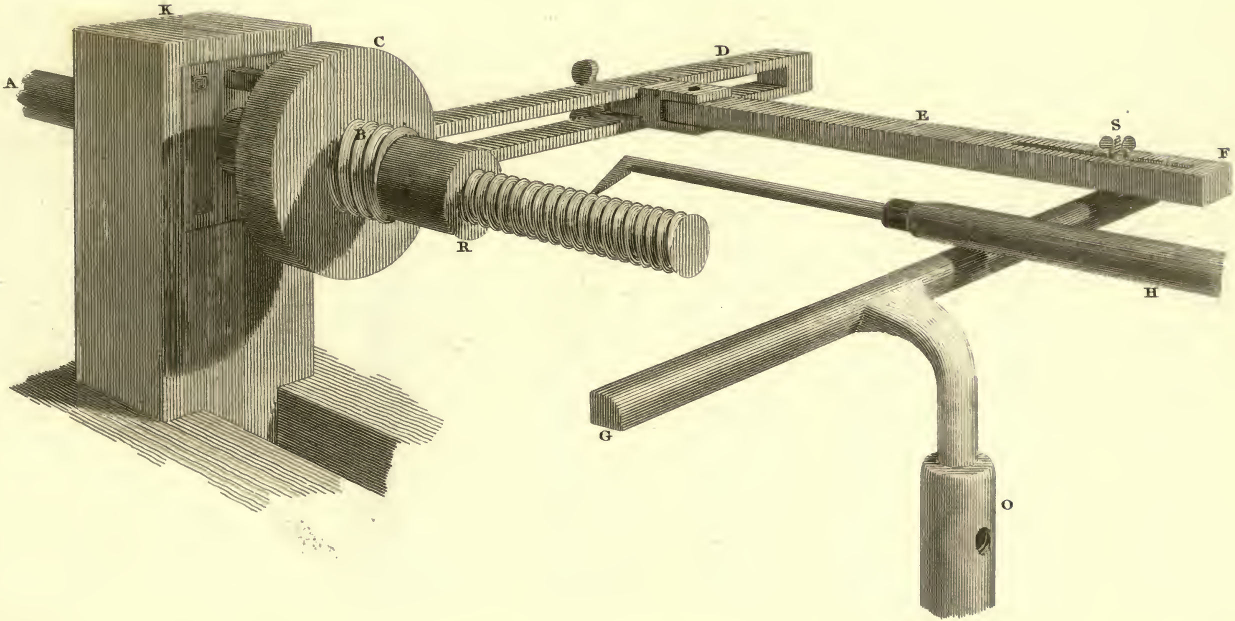

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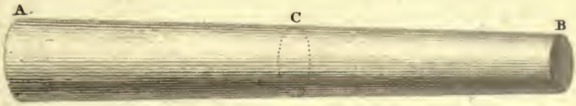
Lowry sculp.

Fig. 1.



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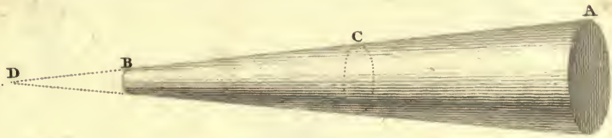

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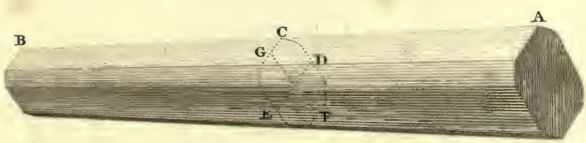

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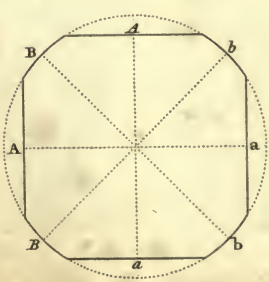

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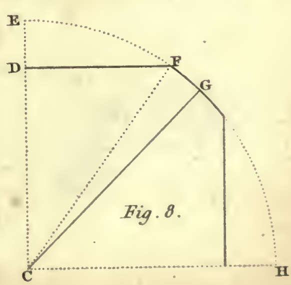

Fig. 8.

Lowry sculp

Fossils of Vestina nova in the Veronais

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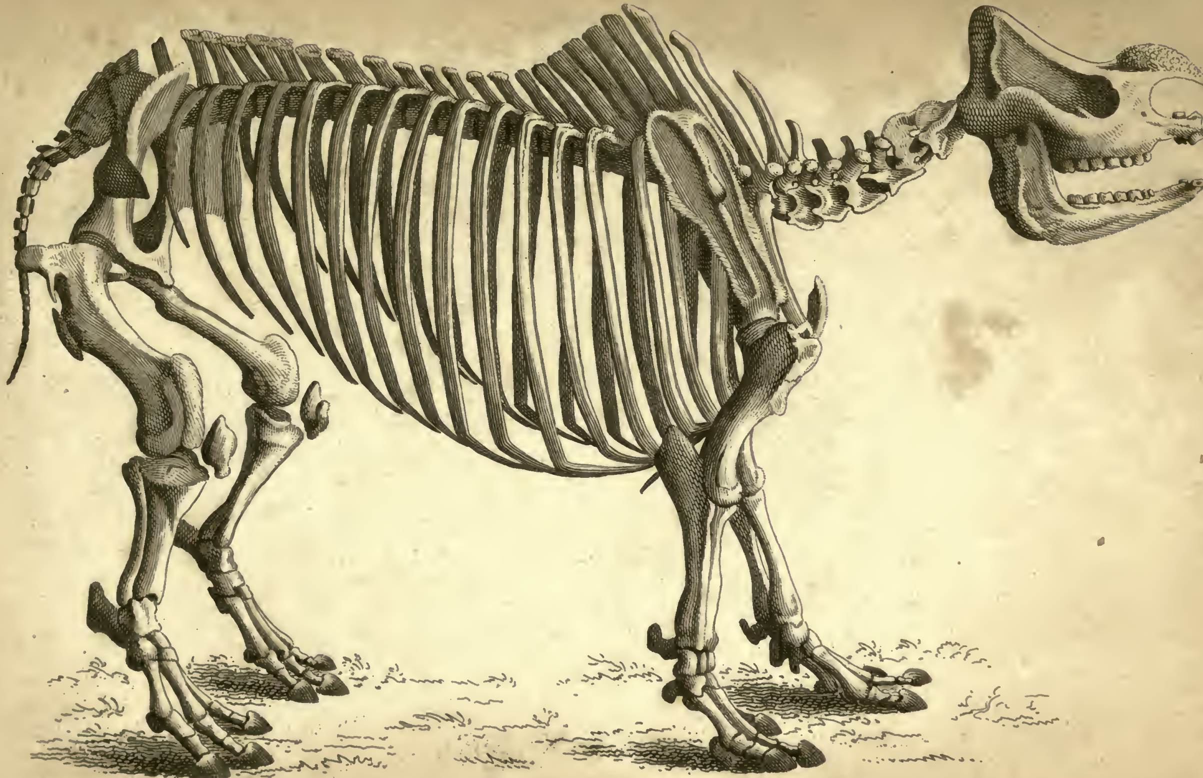
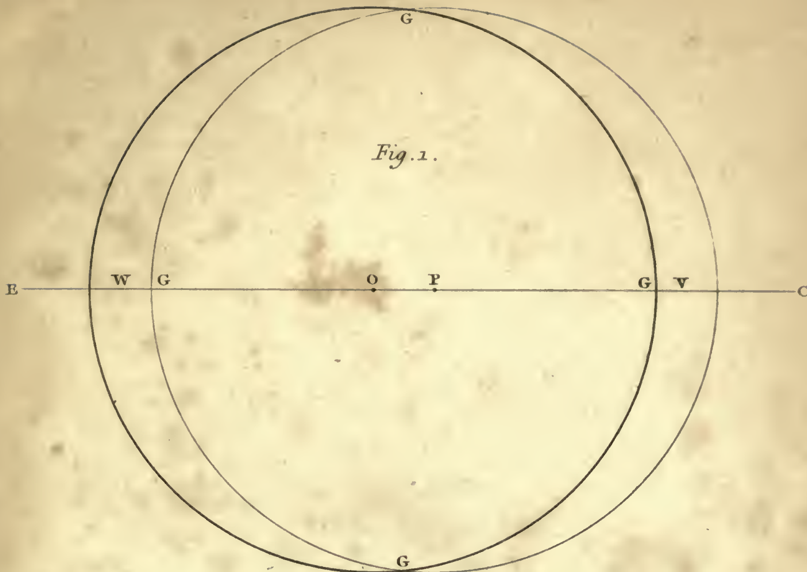


Skeleton of the one-horned Rhinoceros.

Jn° Lee sculp



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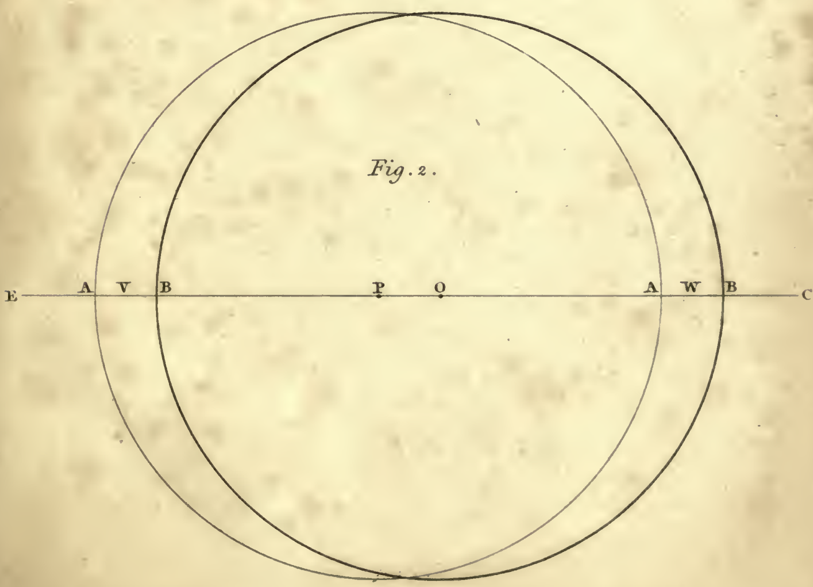

Fig. 2.