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PHILOSOPHICAL MAGAZINE.

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Lavoisier.

THE

PHILOSOPHICAL MAGAZINE.

COMPREHENDING

THE VARIOUS BRANCHES OF SCIENCE,

THE LIBERAL AND FINE ARTS,

AGRICULTURE, MANUFACTURES,

AND

COMMERCE.

BY ALEXANDER TILLOCH,

MEMBER OF THE LONDON PHILOSOPHICAL SOCIETY.

"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.

VOL. I.

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PREFACE.

HAVING concluded our Firſt Volume, we would be deficient in gratitude did we not return thanks to the Public, in general, for the favourable reception our labours have experienced; and to thoſe Scientific Gentlemen, in particular, who have aſſiſted us with Communications, as well as Hints reſpecting the future conducting of the Work.

As the grand Object of it is to diffuſe Philoſophical Knowledge among every Claſs of Society, and to give the Public as early an Account as poſſible of every thing new or curious in the ſcientific World, both at Home and on the Continent, we flatter ourſelves with the hope that the ſame liberal Patronage we have hitherto experienced will be continued; and that Scientific Men will afford us that Support and Aſſiſtance which they may think our Attempt entitled to. Whatever may be our future Succeſs, no Exertions ſhall be wanting on our part to render the Work uſeful to Society, and eſpecially to the Arts and Manufactures of Great Britain which, as is well known, have been much improved by the great Progreſs that has lately been made in various Branches of the Philoſophical Sciences.

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JUNE 1798.

I. *Account of Mr.* CARTWRIGHT'*s Patent Steam Engine.*

THE ſteam engine is conſidered, and with juſtice, as the firſt mechanical invention of modern times. The parent idea of this new and ſtupendous power originated, it is well known, in the fertile mind of the Marquis of Worceſter, in the time of the Charles's; though Captain Savary ſeems to have been the firſt who actually pointed out to the public its practical application. In his hands, however, it was but Hercules in the cradle. Newcomen and his aſſociate have the merit of bringing it to maturity, and giving to its energies a valuable direction. The principal improvements that have been added to it for the laſt thirty years, it has received from the hand of the juſtly celebrated Mr. Watt. From the many fruitleſs attempts which have been made ſince the date of Mr. Watt's patent, ſtill further to improve the ſteam engine, the public has been led to believe, either that it has already arrived at its higheſt ſtate of perfection, or that its defects admitted not of remedy. Theſe defects, as every one knows, are an imperfect vacuum, much friction, and a complicated conſtruction of parts; liable, without great care and attention, to be frequently out of order. It is to theſe points Mr. Cartwright has immediately, and, we may add, ſucceſsfully, directed his attention. His firſt object ſeems to have been to obtain, as nearly as may be, an abſolute vacuum; which, in conſequence of the elaſtic vapour that ſeparates from water injected in the uſual mode of condenſation, no one in the leaſt converſant with the philoſophy of the ſteam engine need be told is impoſſible. The condenſation, in Mr. Cartwright's engine, is performed by the application of cold to the external ſurface of the veſſel containing the ſteam. Mr. Cartwright is not, however, the firſt who tried this method; the ſame has been attempted by ſeveral; but with ſo little ſucceſs, that one of our firſt engineers in this line has been heard to give it as his opinion, that, were a pipe to be laid acroſs the Thames, the condenſation would not be quick enough to work a ſteam engine with its full effect. The manner Mr. Cartwright manages this buſineſs is by admitting the ſteam between two metal cylinders lying one within the other, and having cold water flowing through the inner one, and encloſing the outer one. By theſe means a very thin body of ſteam is expoſed to the greateſt poſſible ſurface. But this is not all: by means of a valve in the piſton there is a conſtant communication at all times between the condenſer and the cylinder, either above or below the piſton, ſo that, whether it aſcends or deſcends, the condenſation is always taking place.

To reduce the friction of the piſton, which, when freſh packed in the common way, lays a very heavy load upon the engine, Mr. Cartwright makes his ſolely of metal, and expanſive. There is a further advantage in this method, from the ſaving of time and expence in the packing, and from the piſton fitting more accurately, if poſſible, the more it is worked.

Mr. Cartwright has been equally attentive in ſimplifying all the other parts of the engine; his engine having only two valves, and thoſe are as nearly ſelf-acting as may be.

But what will probably be eſteemed one of the moſt important circumſtances attending theſe improvements, is the opportunity they afford of ſubſtituting ardent ſpirit, either wholly or in part, in the place of water, for working the engine. For, as the fluid with which it is worked is made to

circulate

circulate through the engine without mixture or diminution, the uſing alcohol, after the firſt ſupply, can be attended with little or no expence. On the contrary, the advantage will be great, probably equal to the ſaving of half the fuel. When, indeed, the engine is applied, as Mr. Cartwright occaſionally purpoſes, both as a mechanical power and as a ſtill at the ſame time, the whole fuel will be ſaved.

A farther advantage of this invention is its applicability to purpoſes requiring only a ſmall power, and for which any other engine would be too complicated and expenſive.

Plate I. repreſents a ſection of the different parts of the engine. A is the cylinder, which is ſupplied with ſteam from the boiler through the pipe *a*. B the piſton, in the act of going up. I the pipe which conducts the ſteam into C the condenſer, being a double cylinder, between which the ſteam is condenſed, and from thence paſſes through *b* into the pump D. The piſton D when going down preſſes the condenſed water upon the valve *c* and ſhuts it, by which means the water is forced to find a paſſage through *d* into the air box E. What air or elaſtic vapour may have been driven along with the water into E riſes to the upper part of the box, where acting by its elaſticity on the ſurface of the water, the latter, ſhutting the valve *b*, is forced through the tube *f*, and by this means returned into the boiler. When the air is collected in ſuch quantity as to force the float *g* to ſink to a certain depth, the valve *e* opens, and allows a portion of it to eſcape.

F the ſteam valve is opened by the return of the piſton B, which raiſes the rod attached to the under ſide of F, while at the ſame time the valve G is ſhut by its rod being preſſed againſt the top of the cylinder. When the piſton B, preſſed down by the ſteam introduced from the tube *a* through the valve F, reaches the bottom of the cylinder, the valve G is opened by its rod touching the bottom, while at the ſame inſtant the ſpring *i* ſhuts the ſteam valve F.

HH two cranks, upon whoſe axes are two equal wheels working in each other for the purpoſe of giving a rectilinear direction to the pifton rod. M the box that contains the condenfing water. K plan of the pifton, fhewing the metal rings which by the fprings LL are forced outwardly againft the infide of the cylinder, fo that the pifton can adapt itfelf to any inequality that may arife. The pifton rod is alfo made fteam tight in the fame manner at N. O a part of the fly wheel which regulates the motion.

II. *The Genuine Oriental Procefs for giving to Cotton Yarn or Stuff the faft or ingrained Colour, known by the Name of Turkey Red, as practifed at Aftracan. From* Neue Nordifche Beytrage, *by Profeffor* PALLAS.

A METHOD of giving a fixed red to cotton yarn, fo much fought after by the Europeans in the prefent century, is now known in England, and practifed in the fouthern parts of France; but, as it is not univerfally known, and as thefe proceffes are not only different, perhaps, from the oriental method, but, like the one for dyeing cotton with madder defcribed by Hellot, far inferior to that practifed by the Armenians at Aftracan, the prefent information may not be fuperfluous.

Profeffor Oettinger at Tübingen made, long ago, in a fmall publication which appeared in 1764, a difcovery which might have led to the fecret of the oriental procefs for dyeing with madder. He there remarked that the beautiful dye of the Turkifh yarn, which withftands the ftrongeft folvents, becomes immediately diffolved by common olive oil, in fuch a manner that the colour may be transferred from a thread of Turkey yarn to any other undyed thread. Hence it clearly appears, that either the dye itfelf, or the preparing liquor (*appret*), or both, muft be of a fat nature, and foluble in oil: and an ingenious artift might have built with advantage on thefe grounds, as will be fufficiently feen by the following defcription of the oriental procefs employed to dye with madder, which I here give exactly as it was related to

me,

me, and I fhall leave the improvement of it to thofe to whofe department it belongs, and who have a tafte for technical chemiftry.

The greater part of the filk and cotton manufactories at Aftracan are carried on by Armenians, the number of whom on account of the troublefome ftate of Perfia is continually increafing; and the dye-houfes are kept going only from the firft warm days in the fpring till towards the end of autumn. The madder they employ comes partly by land over Kitzlar from Terek, and partly by fea over Derbent from the Perfian Ghilan. In both places the plant grows wild in the fields in great abundance and great perfection, and is dug up alfo in the uncultivated meads. The roots are generally as thick as the barrel of a quill, fometimes as one's finger, and throughout the whole fpongy part of an agreeable pale red colour: the bark on the other hand is for the moft part very thin, and appears to be of little value. At Terek the frefh gathered roots are placed above each other in a ftove, or in a pit dug in vifcous earth which has been ftrongly heated. Earth is then thrown over the madder, and it muft fweat until the ftove or pit becomes cold; when the roots, the fecond or third day, are taken from it, and either fpread out or hung up to dry. The fame procefs is ufual alfo in Perfia, and abundance of madder is brought from the remote parts of that country to Ruffia. At Aftracan it is fold, according to the importation, at from four to feven rubles for every forty pounds.

This madder is ground at Aftracan, for the ufe of the dyers, in horfe-mills kept by the common people, and conftructed in the following manner: In the middle of the mill, which is built on a level fpot of ground, a circular place is walled round with bricks to the height of four fpans, the inner face of which is made to flope gently from the circumference towards the centre, and a groove goes round the infide of this brick-work to receive the mill-ftone. The whole furface of the brick-work is covered with plane fmooth boards, and in the middle of it ftands a perpendicular

 fpindle,

ſpindle, which at the top is inſerted in a croſs beam, and at the bottom reſts in a ſocket. The ſpindle is turned by means of an oblique beam paſſing through it, to the ſhorter end of which is faſtened a mill-ſtone moveable like a wheel round its axis, and a horſe is yoked to the other end, which reaches beyond the brick-work. The madder, which has been well dried in the ſun, muſt be firſt coarſely broken in the groove under the mill-ſtone, and afterwards ground until it become a very fine powder.

In the ſame mills are ground the round leaves of the ſumach (*rhus cotinus*), which gives a yellow dye, and which is brought to Aſtracan from the neighbourhood of Terek, where it grows wild under the Tartarian name *balga*, or, as the Armenians expreſs it, *belge*, and is employed ſometimes in dyeing with madder, ſometimes in dyeing dark yellow, and ſometimes in the preparation of Turkey leather. Theſe leaves, when whole, have a pleaſant green colour; but when bruiſed they exhibit that yellow dye with which they are impregnated, and which is produced alſo by the woody part and branches: but as theſe are not ſo eaſily cleaned, they are carefully ſeparated from the ground duſt of the leaves by means of a ſieve. A pud or forty pounds of theſe leaves, in the ſtate in which they are brought to Aſtracan, coſts five, ſix, and often ſeven and a half rubles.

The dye-ſtuffs neceſſary for dyeing red, beſides the two already mentioned, are gall-nuts, alum, an indigenous bad kind of ſoda, called *kalakar*, which is burnt in the wilds of Kiſlar and Aſtracan, from the ſalſuginous or ſoda plants, that grow there in abundance, and laſtly fiſh-oil. The latter is boiled in the fiſheries on the lower part of the Volga, and on the Caſpian ſea, from the entrails of the ſturgeon and other large fiſh, but chiefly from thoſe of the *perca lucioperca*, the ſhad, and other kinds little eſteemed in thoſe parts. The proof of its being proper for dyeing is, that when mixed with a lixivium of ſoda it muſt immediately aſſume a milky appearance. Should that not be the caſe, it cannot be uſed by the

the dyers. The soda is burnt partly at Kislar by Armenians, and partly in the wilds of Astracan by the Calmucks. The latter, because it is very impure, sells at Astracan for only fifteen copeks per pud, but the former is worth more than thirty.

The cotton to be dyed red is first washed exceedingly clean in running water, and, when the weather is clear, hung up on poles to dry. If it does not dry before the evening, it is taken into the house, on account of the saline dews so remarkable in the country around Astracan, and again exposed to the air next morning. When it is thoroughly dry it is laid in a tub, and fish-oil is poured over it till it is entirely covered. In this state it must stand all night, but in the morning it is hung up on poles, and left there the whole day; and this process is repeated for a week, so that the cotton lies seven nights in oil, and is exposed seven days to the atmosphere, that it may imbibe the oil and free itself from all air. The yarn is then again carried to a stream, cleaned as much as possible, and hung up on poles to dry.

After this preparation a mordant is made of three materials, which must give the grounds of the red colour. The pulverised leaves of the sumach are first boiled in copper kettles; and when their colouring matter has been sufficiently extracted some powdered galls are added, with which the liquor must be again boiled; and by these means it acquires a dark dirty colour. After it has been sufficiently boiled the fire is taken from under the kettle, and alum put into the still hot liquor, where it is soon dissolved. The proportion of these three ingredients I cannot determine with sufficient accuracy, because the dyers make use of different quantities at pleasure. The powder of the sumach leaves is measured into the kettle with ladles; the water is poured in according to a gauge, on which marks are made to shew how high the water must stand in the kettle to soak six, eight, ten, &c. puds of cotton yarn. The galls and alum are added in the quantity of five pounds to each pud of cotton. In a word, the whole mordant muft be fufficiently yellow, ftrong, and of an aftringent tafte.

As foon as the alum is diffolved, no time muft be loft in order that the mordant may not be fuffered to cool. The yarn is then put into hollow blocks of wood fhaped like a mortar, into each of which fuch a quantity of the mordant has been poured as may be fufficient to moiften the yarn without any of it being left. As foon as the workman throws the mordant into the mortar, he puts a quantity of the yarn into it, and preffes it down with his hand till it becomes uniformly moiftened, and the whole cotton yarn has ftruck. By this it acquires only a pale yellow colour, which however is durable. It is then hung up on poles in the fun to dry; again wafhed in the ftream, and afterwards dried once more.

By the yellow dye of the fumach leaves, the madder dye becomes brighter and more agreeable; but the galls damp the fuperfluous yellow, and together with the alum prepare the yarn for its colour. Some dyers however omit the ufe of thefe leaves altogether, and prepare their mordant from galls and alum only, by firft boiling the galls in due proportion with the requifite quantity of water, then diffolving the alum with boiling water in a feparate veffel, afterwards pouring both liquors together into a tub, and fuffering the cotton to remain in them an hour, or an hour and a half; after which it is dried gradually, then wafhed, and again dried once more. By this procefs the yarn acquires a dirty reddifh colour.

The next part of the procefs is to prepare the madder dye. The madder, ground to a fine powder, is fpread out in large troughs, and into each trough is poured a large cup full of fheep's blood, which is the kind that can be procured with the greateft facility by the dyers. The madder muft be ftrongly mixed in it by means of the hand, and then ftand fome hours in order to be thoroughly foaked by it. The li-

quor

quor then assumes a dark red appearance, and the madder in boiling yields more dye.

After this process water is made hot in large kettles, fixed in brick-work; and as soon as it is warm the prepared red dye is put into it, in the proportion of a pound to every pound of cotton. The dye is then suffered to boil strongly; and when it is enough, which may be tried on cotton threads, the fire is removed from under the kettle, and the prepared cotton is deposited near it. The dyer places himself on the edge of the brick-work that encloses the kettle; dips the cotton yarn, piece by piece, into the dye; turns it round, backwards and forwards; presses it a little with his hands; and lays each piece, one after the other, in pails standing ready for the purpose. As soon as all the cotton has received the first tint, it is hung up to dry: as the red, however, is still too dull, the yarn which has been already dyed once, and become dry, is put once more into the dyeing-kettle, and must be left there to seethe for three hours over a strong fire, by which it acquires that beautiful dark red colour which is so much esteemed in the Turkey yarn. The yarn is now taken from the dye with sticks; the superfluous dye which adheres to it is shaken off; the hanks are put in order, and hung up, one after another, to dry. When it is thoroughly dry, it is washed in the pure stream and again dried. The only fault of the Astracan dyers is, that the colour is sometimes brighter and sometimes darker, probably because they do not pay sufficient attention to the proportions, or because the madder is not always of the same goodness.

In the last place, the abovementioned soda (kalakar) is dissolved with boiling water in tubs destined for that purpose, and it is usual here to allow twenty pounds of soda to forty pounds of cotton, or half the weight. Large earthen jars, which are made in Persia of very strong clay, a yard and a half in height, almost five spans wide in the belly, and ending in a neck a span and a half in diameter, enclosed by means of cement in brick-work over a fire-place, in such a

manner

manner that the necks only appear, are filled with the dyed cotton yarn. The ley of diſſolved ſoda, which is blackiſh and very ſharp, is then poured over it till the jars be filled; and ſome clean rags are preſſed into their mouths, that the uppermoſt ſkains of yarn may not lie uncovered. A fire is then made in the fire-place below, and continued for twenty-four hours; and in the mean time the ſteam which ariſes from the jars is ſeen collected among the rags in red drops. By this boiling the dye is ſtill more heightened, and is made to ſtrike completely; every thing ſuperfluous is removed, and all the fat matter which ſtill adheres to the yarn is waſhed out: nothing more is then neceſſary for completing the dye of the yarn but to rinſe it well ſeveral times in running water, and then to dry it.

That the dye of madder might be made very penetrating by other methods, and through the means of other oily and reſinous ſubſtances, is ſhewn by the proceſs of the Tunguſians to dye horſe', goat's and rein-deer's hair, which they uſe for ornamenting their dreſſes, of a beautiful red colour, by the roots of the croſs-wort, or northern madder (*gallium*), and narrow-leaved woodroof (*aſperula tinctoria*), which have a reſemblance to thoſe of madder. They boil the freſh or dried roots with about the ſame quantity of agaric (*agaricus officinarum*), which, as is well known, is abundant in reſinous gummy particles, and is uſed by the people of Jakut inſtead of ſoap; they then lay in it the white hair which they wiſh to dye, and ſuffer it to ſeethe ſlowly until it be ſufficiently red.

Cotton cloth is dyed with madder at Aſtracan in the ſame manner: but many purſue a fraudulent proceſs, by dyeing with red wood, and then ſell their cloth as that which has been dyed in the proper manner.

Note by the Editor.

One circumſtance in the preceding proceſs deſerves particular attention, as it furniſhes a hint which, if properly followed

lowed up, may perhaps enable our dyers to give to cotton all, or at leaſt a number of the colours which at preſent can only be communicated to woollen. We allude to the uſe of fiſh oil and ſheep's blood, both of which animal ſubſtances are conſidered as being indiſpenſably neceſſary to the ſucceſs of the operation.

Mr. Vogler, an able German chemiſt, after long and frequent trials to give to linen and cotton a laſting black colour, found that, to gain this end, it was previouſly neceſſary to dip the yarn or ſtuff into a ſolution of glue in water, in ſuch proportion as to give to the water when warm, being tried between the fingers, a ſticky or glutinous conſiſtence; and recommends that care be taken only to wring, not to waſh out the glue-water, part of which muſt be allowed to dry upon the yarn. Profeſſor Beckmann has noticed ſimilar circumſtances.

The inference, as has been obſerved by M. Berthollet and others, is, that to ſucceed in giving ſome particular fixed colours to vegetable productions, it is neceſſary that they be previouſly animaliſed, as it were, by the application of oil, blood, glue, or other animal matter.

III. *Method of purifying Lead from Gold and Silver, ſo as to make it fit for the Purpoſe of Aſſaying. By* PET. JAC. HJELM. *From the* New Tranſactions of the Royal Academy of Sciences at Stockholm.

ON many occaſions, particularly in trying the fineneſs of gold, it is neceſſary to employ lead free from the mixture of any other metal. For ſuch experiments, above all, one muſt not make uſe of lead which already contains gold or ſilver, or both theſe metals, without knowing the quantity, which, at all times, occaſions difficulty and often uncertainty. In its natural ſtate lead, for the moſt part, is found ſo mixed with

with these noble metals, that after being smelted it cannot be employed for the above purpose; and though there be lead ore which exhibits only a very few or no traces of their presence, and in the first case the proportion must never be more than a quarter of a grain in the pound (*mark*), it is exceedingly rare in the common course of mining to find pieces of such a nature, and people often have not leisure to search for them. As I have sometimes been exposed to great inconvenience for want of a proper piece of lead, I endeavoured to find out an easy method of procuring, without a tedious process, such a quantity of pure lead as would be sufficient for the before-mentioned test; and as I do not remember to have heard of its being any where described or employed, I have reason to think that an account of it may be of some use, at least in the art of assaying, in case a more extensive application of such a smelting process be not possible on a large scale, or if it should not be found profitable. When one begins to reflect on this object, the first idea that occurs is to accomplish the end in view, by dissolving the lead in an acid, and then precipitating either the lead or the finer metals; but on closer examination there is no process of this kind which will not be either too expensive, when it is necessary to prepare several pounds at once, or require longer time than one can possibly bestow. For these reasons I gave up this method, and adhered to that only which was performed merely by fusing in a crucible with the assistance of a requisite degree of heat.

First Experiment.

Litharge, a cheap article that can be easily procured, was the first substance with which I thought it necessary to make experiments. As it seemed possible that it might be free from any mixture of silver, that circumstance was first examined before I proceeded further. I then melted some ounces of litharge with equal quantities of pot-ash and tartar; but the lead obtained from this mixture contained still about half a grain

grain in the pound. It was therefore of no use for proofs by scorification and for assaying; and the principal point now was to free the litharge from its mixture. This object I accomplished by a few meltings, in the following manner:

I placed a crucible, in which half a pound of litharge found good room, and which was fitted with a close cover, in a wind-furnace filled with dead coals. I then put into the crucible a mixture of four ounces of potash and the same quantity of powder of flint. When the whole was well melted by strengthening the draught and making the coals glow, I took off the cover, and laid hold of the crucible with a pair of tongs, in order to take it out, and to suffer this very fusible glass to cover the inside of the crucible, to secure it from the glass of the lead which I meant to melt in it. The superfluous glass was poured out; the crucible again placed on its foot, and half a pound of litharge thrown into it with a shovel. The cover was placed upon it while the litharge was melting; and when it was thoroughly glowing and fluid, charcoal dust was sifted into the uncovered crucible through a sieve, so that the surface of the litharge was completely covered with it. This immediately produced an effervescence, and the rising of bubbles, by means of the separation of the air occasioned by the reduction of the lead. During this process the cover was put on and a few coals thrown into the furnace: when these were burnt every thing in the crucible was quiet, and the melted mass was poured into a warm conical mould. The crucible was then again filled with half a pound of the same kind of litharge, and put into the furnace, and charcoal dust was several times sifted over the melted surface, till it was well covered before the mass was thrown out, a sufficient space being every time left for the effervescence. The first mass had, in the mean time, become cool, and, on examination, contained four ounces of lead at the bottom, and litharge at the top. When this litharge was reduced with potash and crude tartar, the lead thence obtained,

tained, which weighed 23 ounces, was found to contain leſs than $\frac{1}{2}$ grain of ſilver in the pound. In the ſecond maſs there was found ſomewhat more than ſix ounces of lead, which contained all the ſilver that had been before mixed with the litharge, becauſe in the lead which had been reduced from the litharge in the above manner there were no perceptible traces of ſilver. This lead was then melted over a ſlow fire, and caſt into bars, which were rolled ſmooth and formed into maſſes of a known weight, to be uſed for aſſaying gold and ſilver, and for other purpoſes of the ſame kind. All theſe meltings were made in one crucible, which, according to every appearance, remained unhurt. If the ſame experiments were made with red lead, the like reſult would infallibly follow.

The cauſe of this proceſs, and of the effects thence produced, is, that when lead, which contains a ſmall quantity of ſilver, is calcined and brought into the ſtate of litharge, the ſilver in it, if not ſcorified, is diffuſed in infinitely fine particles, ſo that it is impoſſible for it to ſink through the melted litharge and ſettle at the bottom. When the lead calx is revived on the ſurface, the leaden grains, as they are formed, ſink down through the litharge, and carry with them the ſcattered grains of ſilver, in ſo far as this leaden ſhower, if I may ſo name it, is compact and powerful enough to collect them. Were the opinion of thoſe juſt, who aſſert that a calx of lead free from ſilver, when revived by tartar, acquires again, by the creation of new ſilver, a portion of that metal, litharge ought not to be revived by tartar, or any thing of the like kind from the vegetable kingdom; but on this occaſion I found no ſuch effect produced.

Second Experiment.

With the ſame view of obtaining lead free from ſilver, I melted, in the like manner, half a pound of white lead, which produced half an ounce of lead. When the litharge ſtanding over it was revived, the lead obtained was ſtill found

found to contain too much silver. I therefore precipitated another half pound of white lead by charcoal powder, after the lead that fell from it had been separated; and then it produced, by reviving, a mass of lead without any mixture of silver.

Third Experiment.

Cupels, employed for refining silver, imbibe about the half of their weight of lead calx. One might therefore believe, that when this lead calx is revived it would produce lead free from silver. Besides the observation of others, which confirms the contrary, I have made experiments with the ashes of such cupels in which assaying had been performed with the utmost accuracy; but I found that the lead thence made into ingots contained sometimes more than one quarter of a grain of silver in the pound. The bone ashes, from which cupels are generally cast, are, by themselves, almost infusible; and this, on account of the great number of fluxes which must be employed to bring them to a fluid state, makes the fusion of them difficult and expensive. To four parts of fine pounded cupel ashes, I put four parts of potash, four parts of salt, three parts of tartar, and one part of clay, which mixed together produced, after being melted, $1\frac{1}{4}$ part of lead, making almost 44 parts in the hundred *. But this still contained the above-mentioned quantity of silver, and could not therefore be proper for the proposed end.

As the two first-mentioned experiments will completely answer the purpose, it is perhaps unnecessary to seek for other methods; as it will be hardly possible to find any less complex, or easier to be put in practice.

* There must here be an error in the original. Instead of $1\frac{1}{4}$ part of lead, we ought, perhaps, to read $1\frac{3}{4}$

IV. On

IV. *On the Irregularity in the Rate of Going of Time-pieces occasioned by the Influence of Magnetism. An original Communication, by Mr.* VARLEY.

HAVING studied the theory of clock and watch-making many years, as well as been, part of that time, concerned in an extensive manufactory of watches, I have had many opportunities of observing a circumstance which has surprised every one in the trade as well as myself; that watches of considerable price, and from the hands of excellent workmen, often perform no better than a plain one of inferior workmanship and much lower price. Being anxious, as may naturally be supposed, to furnish my friends with watches or clocks which would go well, I made it my business to pay particular attention to whatever could contribute to their perfection. With this view, I made almost numberless experiments and observations on the various escapements now in use, the different constructions of balances, pendulums, pendulum springs and compensations, both for clocks and watches, which have been applied by very ingenious mechanics and excellent workmen to correct the errors in the rate of going, especially of watches, occasioned by the various degrees of heat and cold, change of position, external agitation, influence of oil, friction, variation of maintaining power, and other causes.

Some of these contrivances are extremely well adapted to answer the intended purpose; but, notwithstanding all their advantages, the maker and purchaser are frequently disappointed in the performance of the machine to which they are applied. Many instances might be produced where the best workmen have been employed, no expence spared by the maker, and the above-mentioned improvements applied with the utmost care and attention; and yet the rate of going of the watch has been more irregular than in some ordinary watches. When such a circumstance occurs, it is extremely unpleasant: the purchaser not understanding the difficulties

difficulties which the maker has to encounter, thinks himself ill used, and the latter suffers at the same time in his reputation as an artist, and in his character as a man; and when the watches happen to have been made for nautical purposes, or for exportation, the whole community, in some measure, become sufferers.

The intention of the present paper is to point out a defect in the construction of time-pieces of every description in which balances are used, and at the same time a source of error in their performance, which has been hitherto little if at all suspected, but which, where it occurs, completely defeats all the ends intended to be answered by the application of the above-mentioned ingenious contrivances: and that it does occur very frequently, will be made sufficiently obvious by a simple detail of facts supported by actual experiments.

That the balances of watches, when manufactured of steel, as they mostly are, might be in a small degree magnetic; and consequently have some influence in disturbing their vibrations, has been suspected by some and denied by others: but that a circular body, such as a balance is, should possess polarity; that a particular point in it should have so strong a tendency to the north, and an opposite point an equal tendency to the south, as to be sufficient materially to alter the rate of going of the machine when put in different positions, has never, I believe, been even suspected. If it had, the use of steel balances would have been laid aside long ago, particularly where accurate performance was indispensible, as in time-pieces for astronomical and nautical purposes. Though I have frequently examined, with great care, watches that did not perform well, even when no defect in their construction or finishing was apparent, and suspected the balance to be magnetic, yet I never could have imagined that this influence, operating as a cause, could produce so great an effect as I found upon actual experiment; for I did not expect to find that a balance, even when magnetic, ſhould have diſtinct poles. Happening to have a watch in my poſſeſſion, of excellent workmanſhip, but which performed the moſt irregularly of any watch I had ever ſeen, and having repeatedly examined every part with particular attention, without being able to diſcover any cauſe likely to produce ſuch an effect, it put me upon examining whether the balance might not be magnetic enough to produce the irregularity obſerved in it's rate of going.

I took the balance out of its ſituation in the watch, and, after removing the pendulum ſpring, put it into a poiſing tool, intending to approach it with a magnet, but at a conſiderable diſtance, to obſerve the effect, while at the ſame time the diſtance of the magnet ſhould preclude the poſſibility of the magnetic virtue being thereby communicated to the balance. I had no ſooner put it into the tool than I obſerved it much out of poiſe; that is, the one ſide appeared to be heavier than the other: but, as it had been before examined, in that particular, by a very careful workman, more than once, I was at a loſs to determine what to think of the effect I ſaw; when happening to change the poſition of the tool upon the board, the balance then appeared to be in poiſe. As there could be no magic in the caſe, it appeared that the balance had magnetic polarity, as no other cauſe could produce the effect I had witneſſed, and which was repeated as often as I choſe to move the tool from the one poſition to the other. It happened that I was then ſitting with my face to the ſouth: a circumſtance that led me, in placing the plane of the balance vertically, to put it north and ſouth, and of courſe the axis eaſt and weſt—the only poſition in which the magnetic influence could make itſelf moſt apparent, and which will account for the circumſtance not having been obſerved by the workman who examined the poiſe of the balance before I did; for, as often as I placed the plane of the balance vertically between eaſt and weſt it was in poiſe, whichever end of its axis was placed towards the ſouth.

Having

Having pretty well satisfied myself as to the cause, I now proceeded to determine the poles of the balance. With that view I placed its axis in a vertical situation, and of course its plane was horizontal; and I was much surprised to find that, in that position, it possessed sufficient polarity to overcome the friction upon its pivot; for it readily turned on its axis to place its north pole towards the north. Making a mark on that side that I might know its north pole, I then repeatedly turned that point towards the south; and, when left at liberty, it as often resumed its former position, performing a few vibrations before it quite settled itself in its situation and came to rest—exactly as a needle would do if suspended in the same manner.

I was extremely happy that I had observed these effects before I brought a magnet to make the experiment I first intended, as I might, and as others also might have concluded, that the polarity had been produced by the approach of the magnet. I now, however, brought a magnet into the shop, and, presenting its south pole to the marked side, that is, to the north pole of the balance, the balance continued at rest; but upon presenting the north pole to the marked place, it immediately receded from the magnet, and resumed its former position whenever the magnet was withdrawn.

No doubt now remaining as to the facts, and being in possession of the position of its poles, I proceeded to examine the effects produced by this cause upon the watch's rate of going. Having put on the pendulum spring, and replaced the balance in the watch, I laid the watch with the dial upwards, that is, with the plane of the balance horizontally, and in such a position that the balance when at its place of rest should have its marked side toward the north:—in this situation it gained 5′ 35″ in twenty-four hours. I then changed its position so that the marked side of the balance when at rest should be towards the south, and, observing its rate of going for the next twenty-four hours, found it had lost 6′ 48″—producing, by its change of position only, a difference of

12′ 23″ in its rate. It must be obvious to every person, that even this difference, great as it was, would be increased or diminished as the wearer should happen to carry in his waistcoat pocket a key, a knife, or other article made of steel. This circumstance, taken along with the amount of the variation occasioned by the polarity of the balance, was fully sufficient to produce all the irregularity observed in the going of the watch.

I then took away the steel balance, substituted one made of gold, and, having brought the watch to time, observed its rate of going, and found it as uniform as any watch of the like construction; for, though it was a duplex escapement, which is perhaps the best yet invented, at least for common purposes, it had no compensation for the expansion and contraction occasioned by heat and cold, and therefore a perfect performance was not expected.

Steel balances being commonly in use, and, on that account, easiest to be procured, and being on many accounts preferable to any other, I was unwilling to abandon them entirely; but resolved to take the precaution of always trying them before I should apply them to use. The mode I adopted was, to lay them upon a slice of cork sufficient to make them float upon water, and I was in hopes that out of a considerable number I might be able to select sufficient for my purpose; but to my surprise, out of many dozens which I tried in this manner, I could not select one that had not polarity. Some of them had it but in a weak degree, and not more than one or two, out of the whole quantity, appeared to have it so strong as the one which gave birth to these experiments and to the present paper, which is perhaps more prolix than could be wished: but the subject appeared to be not uninteresting, and I hope the remarks I have offered will not be altogether useless, as every thing that can tend to add to the perfection of time-pieces, or to remove any cause that operates against their perfection, is of some importance.

My only motive in sending this for publication in the

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Philosophical Magazine is to render some service to a science which I at first studied for amusement only, having never been instructed in any part of it, and for some years without the most distant idea of ever following it as a business. Should it prove acceptable, I may perhaps follow it up with a demonstration, and a few diagrams to illustrate the foregoing experiments, and to cast some light on other branches of this science; particularly on the various escapements now in use, and the advantages and disadvantages of their different constructions and applications in clock and watch work. In doing this a compensation for pendulums will be pointed out, simple and cheap in its construction, yet calculated to obviate the inconveniences attending the ingenious but expensive contrivances that have hitherto been resorted to, and at the same time capable of the nicest adjustment possible. This improvement, for such I consider it, will serve at the same time to shew how our very amusements, and the study of our leisure hours, when directed to useful objects, though with slender abilities and under many disadvantages, may eventually be of service to our friends in particular, and beneficial to society in general.

Hatton-house, S. VARLEY.
May 31, 1798.

P.S. As I am persuaded a Journal carried on upon the plan you have proposed cannot fail to be useful to the community, and as even hints may sometimes pave the way to greater improvements, I shall look over my memorandums, from among which I may perhaps be able to furnish you with some, on a variety of subjects, for the amusement of your scientific readers.

V. *Method of preparing a cheap Subſtitute for Oil Paint, as durable as that prepared with Oil, and free from any bad Smell. By* M. LUDICKE. *From the* Bibliotheque Phyſico-économique, 1792.

IT often happens that people do not chooſe, or cannot employ oil-painting in the country, either becauſe it does not dry ſoon enough and has an inſupportable ſmell, or becauſe it is too dear. M. Ludicke employed, with the greateſt ſucceſs, the following method for painting ceilings, gates, doors, and even furniture.

The Proceſs.

Take freſh curds, and bruiſe the lumps on a grinding-ſtone or in an earthen pan or mortar with a ſpatula. After this operation, put them in a pot with an equal quantity of lime well quenched and become thick enough to be kneaded; ſtir this mixture well, without adding water, and you will ſoon obtain a white-coloured fluid, which may be applied with as much facility as varniſh, and which dries very ſpeedily. But it muſt be employed the ſame day, as it will become too thick the day following.

Ochre, Armenian bole, and all colours which hold with lime, may be mixed with it, according to the colour which you wiſh to give to the wood; but care muſt be taken that the addition of colour made to the firſt mixture of curds and lime may contain very little water, elſe the painting will be leſs durable.

When two coats of this paint have been laid on, it may be poliſhed with a piece of woollen cloth or other proper ſubſtance, and it will become as bright as varniſh. It is certain that no kind of painting can be ſo cheap: but it poſſeſſes, beſides, other advantages: in the ſame day two coats may be laid on and poliſhed, as it dries ſpeedily and has no ſmell. If it be required to give it more durability, in places expoſed

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to moisture, do over the painting, after it has been polished, with the white of an egg: this process will render it as durable as the best oil painting.

VI. *On the Antiquity and Advantages of Encaustic Painting, with an Examination of the Process employed in that Art by the Ancients. From a Treatise entitled* Antichita, Vantaggi e Metodo della Pittura Encausta; Memoria del Ch. Sig. Giov. Fabbroni, &c. Roma, 1797. Quarto.

ITALY is much indebted to the penetration of the learned Abbé Requeno for again bringing forward to the notice of modern painters wax-painting, (*pittura encausta,*) which was forgotten, and considered as entirely lost.

The stimulus of curiosity always keeps alive and vigilant that laudable ambition to which we owe the most valuable discoveries; and writers are ever ready to catch the new idea, either to appropriate it to themselves, or at least to participate in the honour of it. By the collision of their various attacks on each other, truth is thrust forwards so as to be more distinctly seen than before, and the discovery thus acquires more value, and can be employed with more advantage.

No sooner had Requeno, whose merit entitles him to so much praise, made known the result of his researches, than a numerous body appeared to examine the advantages of it, or to share in the approbation bestowed on it. Some explained the classics in a manner different from what he had done, and others proposed methods which they considered as superior. Wax, in all probability, forms the only ground of encaustic painting. Requeno, from his own ideas, adds mastic; but Lorgna converts no less absolutely his wax into soap; as Bachelier does with the alkali of soda. The ingenious Astori, displeased with both their readings, wishes no less absolutely to add gum and honey, as he affirms that it would render the wax far more yielding, and much softer for the brush.

I contented myself with considering, in my closet, the result of the laudable dispute of these able and meritorious writers, and thought I could clearly perceive that none of them had come near enough to the mark, though each of them had done essential service to the art.

Some of the ancient writers who have thrown light on this subject, among whom are Varro, Vitruvius, and Pliny, expressly ascribe to the ancient painters the use of Punic, that is Carthaginian, wax. It was said to be the best, as it exceeded in whiteness the Sardinian and Corsican; and the reason of this probably lay in its being better purified; for the Africans, as Pliny tells us, were accustomed to use alkali in order to render this substance whiter, and, in my opinion, to free it from all greasy matter. It was then called Punic wax, as Venetian turpentine, soap, and wax, are now prescribed in books of receipts in order to signify the best; and we must conclude, if, instead of considering the wax to have been merely bleached, we convert it into real soap, arising from the close combination of the wax with the alkali, that we change and pervert the meaning of these authors. The idea which I formed of the period of encaustic painting, and the country where invented, was considerably different, and I have had the pleasure of finding it afterwards confirmed by experiments and facts.

The knowledge and use of encaustic painting is certainly older than the time of the Greeks and the Romans, to whom the learned Requeno seems to assign the exclusive possession of this art; because the Egyptians, who with the Etruscans were the parents of the greater part of the inventions known among mankind, and from whom the Greeks learned so much, were acquainted with and employed encaustic painting in the ancient ages of their greatness and splendour, as is proved by the valuable fragments of the bandages and

coverings

coverings of a mummy painted in this manner, which, by the favour of our gracious prince, the noble patron and promoter of the arts and sciences, is exposed to the view of every connoisseur, in his elegant museum. The existence of wax on this Egyptian mummy may be discovered on a bare view; but I convinced myself by other proofs of a less dubious nature.

Most of the mummies, however, preserved in collections, are painted with a size, which appears to be not unlike that used in paintings with water colours (*pittura a tempera*); but it is certain that the Egyptians differed much in their ornaments, and the bandages of the mummy above-mentioned are, on this account, more valuable and more worthy of notice.

I saw in the British Museum a mummy which was entirely covered with glassy grains; and the colour of some of them gave me reason to conjecture that these ancient people were acquainted with the effects of cobalt in smalt, which has however been considered as a new invention. I saw another mummy at Paris, which had formerly belonged to the celebrated Count Caylus: among other singularities it had some ornaments of leaf gold upon a ground of chalk and bolus, which is at present employed by the European gilders. In the Royal Museum at Florence there is, besides others, one with gilding of the like kind and very lively colours. But I will not here enter into a panegyric of the Egyptians, who accomplished so great things, and much earlier than the Greeks or the Romans; it will be sufficient to have shewn, as a point unknown in the history of the arts, that these people practised encaustic painting, as appears beyond a doubt from the before-mentioned fragment: but I will confess that this would be a barren knowledge if it did not lead us to other useful researches. I must observe, in the first place, that no oil-painting, perhaps of only two or three hundred years old, exhibits a white paint that has kept so well as that seen on the above fragment; and this circumstance sufficiently proves

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the valuable advantage that method has over the common oil-painting, which, notwithstanding the general opinion, cannot have been unknown to the ancients; for, besides olive-oil, they were acquainted with that of sesamum, turpentine, cedar, and nut oils. It is impossible that in Egypt and Phœnicia, where so much use was made of flax, the oil procured in abundance from that plant should have been unknown. Those who have kept oil, or who have spilt any of it, whether nut or lintseed oil, must have remarked that it possesses the property of soon drying by the effects of the atmosphere; and therefore it may be easily believed that mankind must soon have conceived the idea of employing it, particularly for ships, which, as Herodotus says, were painted with red ochre in the earliest periods, and adorned with figures and ornaments. The use of oil afforded painting a much simpler and easier method than that of wax; it must therefore have been first adopted, and the transition from oil to wax must be considered as a step towards bringing the art to perfection; because encaustic painting is not exposed to the irremediable inconveniencies that arise in oil-painting, the value of which we extolled through ignorance, and praised as a new invention.

Oil in general, and in particular drying oil which the painters use, has naturally a strong inclination to combine itself with the vital air or oxygen of the atmosphere, and by imbibing oxygen it becomes dry, and assumes the character of resin; but the colour then becomes darker, as is the case with transparent turpentine, which gradually becomes a black pitch.

According to the new and more accurate method of decomposing bodies, oil consists principally of hydrogen and carbon. By coming into contact with the atmosphere, and absorbing its oxygen and light, it undergoes a slow and imperceptible combustion, which is not essentially different from the speedy and violent which it would undergo in the common mode of burning. It first passes, by imbibing oxygen,

gen, into the ſtate of a more or leſs dark reſin; loſes gradually its eſſential hydrogen, which makes a new combination, and afterwards the oxygen itſelf which has attracted the carbon; and at length leaves behind a thin layer of actual carbon, which in the end becomes black in the courſe of time, and conſiderably obſcures the oil-painting. By a continuance of the before-mentioned ſlow combuſtion the carbon itſelf, as it were, burns alſo: if it be ſtrongly acted upon by the light, it attracts the oxygen of the atmoſphere, and again brings forward the carbonic acid or fixed air, which gradually flies off. By this, which I may call the ſecond degree of combuſtion, the painting muſt become duſty and friable, like crayon painting (*il paſtello*); a phenomenon which may be clearly perceived on oil-paintings, which are generally covered with wood and iron-work, that they may the better withſtand the atmoſphere.

The aſhes, oxydes, or calces of metals, which are often uſed as paints, are nothing elſe than metals actually brought to a burnt or ſaline ſtate by different doſes of oxygen. When the oil, during the time of the before-mentioned combuſtion, deprives them of ſome part of their oxygen by means of its well-known affinity, the metal again proportionably aſſumes its natural ſtate and colour; and as the calces or aſhes of the iron, and particularly white lead, return to their former metallic character, they become, in various ways, black, by the loſs of the oxygen, which, as is well known, is drawn from them merely by the contact of the light, eſpecially when ſtrong.

It appears from the preceding theoretical obſervations, that one can hope only for a tranſient or deceitful effect from the refreſhing of oil-paintings with oil, becauſe the harmony of the tones, which the painter eſtabliſhes as ſuited for the moment, does not proceed with equal ſteps, and cannot preſerve itſelf in the like meaſure for the courſe of a few years, as each tint, as they ſay, ought to increaſe, or, to ſpeak more properly, to burn in proportion to its antiquity. It thence follows, that

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mere washing may be prejudicial to an old painting; and that the method of refreshing paintings, as it is called, by daubing over the surface from time to time with new drying oil, is highly prejudicial and ill calculated for the intended purpose, since the oil when it becomes dry contracts in its whole surface, carries with it the paint under it, and occasions cracks in the painting. New oil of this kind gives occasion to mineral paints to be restored; but covers the picture with a new coat of resin, and then of carbon, which arises from the gradual combustion, and always causes more blackness, and the decay of the painting which one wishes to preserve. Wax, on the other hand, undergoes a change which is very different from that of drying oil. The wax, instead of becoming black by the contact of the atmosphere, increases in whiteness, and, according to its natural quality, is not decomposed in the air, and it does not strongly attract the oxygen of the calces or metallic ashes which are commonly used in painting. Moreover, the so called earths, which are in themselves white, and are never variable either by the presence or absence of oxygen, cannot be employed in oil-painting, because that fluid makes them almost transparent, and causes them to remain as it were without body (*corpo*), and not to produce the wished-for effect. That beautiful white, which may be observed on the before-mentioned Egyptian encaustic, is nothing else than a simple earth, and according to my chemical experiments a chalk (*creta*,) which is also unalterable. If we consider this encaustic fragment as belonging to the epoch of the first violent change which the religious system of the Egyptians experienced, it will be a specimen of painting of about 2500 years old; for such is the number of the years that have elapsed since Cambyses overturned the ceremonies and religious worship of the Egyptians, not only by the sword, but by the still more powerful weapons of ridicule. Dead bodies were embalmed there in the time of Herodotus; but the cloth in which they were wrapped, or the bandages bound round them, were no longer

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painted with sacred characters. The bodies were only inclosed in wooden cases, which were more or less ornamented. Many are of opinion, that an expression of the bishop of Hippo gives reason to assert that the people in Egypt continued to prepare mummies even till the fifth century; but it must be observed that the Egyptians then had adopted the Christian religion; that they no longer used hieroglyphical inscriptions, which in the time of Apuleius were said to be unintelligible and forgotten; and that it was not mummies which were prepared then, but gabbara, as St. Augustine says in his Orations, that is, dead bodies dried after the manner of mummies. If Bochart and Menage be not mistaken, the name *mummia* is derived from *muim*, which signifies wax: and one might therefore believe that the dress of embalmed bodies was thus named because wax was employed for painting it; and thence it would follow, that the fragment in question may be classed among the oldest.

Mummies, since the earliest periods of the Egyptian ceremonies, were exposed to a variety of situations; for on certain occasions they were taken up from the subterranean repositories in which they were deposited, and placed in the highways, or at the doors of the houses. On other occasions they were carried into the halls where entertainments were celebrated, and they were also given as pledges of fidelity in various transactions.

After the fall of Egyptian grandeur, the mummies were left buried and neglected in dark vaults, amidst a damp soil, from which they were drawn forth only at a late period, by European curiosity, in order to ornament collections, or by the avarice of the Mahometans, who hoped to make them an article of gain.

Many have remarked, and in particular Maillet during his consulship at Cairo, that the Arabs, when they find mummies of good appearance, usually cut them to pieces, in order to examine whether any thing of value is concealed in their clothing.

clothing. I can assign no other cause for the fragment in question; and this would enhance the value of it, and render more important, as well as more useful, its great antiquity, and the beautiful painting to be seen on it.

In all probability the ancients, as I have already said, were once acquainted with the use of oil-painting, and lost or neglected it afterwards, so that it was perhaps employed only sometimes by a few.

Petronius praises the fresh appearance which the valuable works of Zeuxis and Apelles had, even in his time; but Cicero, on the other hand, speaks of the paintings of the ancients having suffered from blackness. The former speaks of wax-painting, and the latter certainly alludes to paintings in oil. It is well known that paintings with wet chalks or water colours do not become black by age, and that this is the case also with encaustic. Of this any one may be convinced, not only by the expressions of the above quoted authors, but by one's own eyes on surveying the Egyptian fragment alluded to. Galland proves, on various grounds, that a painting was made with oil so early as the reign of Marcus Aurelius; and if no specimens of that period have reached us, this is perhaps to be ascribed to the frail and perishable nature of this species of painting.

The oldest oil-painting now in existence, as far as I know, is a Madonna and child on her arm with an eastern countenance. It has marked on it the date, which is thus expressed ƆCCCLXXXVJ. If we express these with Arabic characters, it would make, in my opinion, 886, and the period of this piece would fall about the time of Basilius or Charlemagne. This singular and valuable painting, found in the old palace (*palazzo vecchio*) of the Florentine republic, is preserved at present in the chapel of the noble and learned director Bencivenni otherwise Pelli, who purchased it of a broker in the street for a few livres. I must however remark, that if instead of the above date we ought to read MCCCLXXXVI, which

which appears to me probable, it would ſtill be one of the oldeſt of its kind in Italy, and belong to the oil-paintings of the fourteenth century, ſome of which are mentioned by Dominici and Tiraboſchi prior to the diſcovery of the celebrated Van Eyc.

(To be concluded in the next Number.)

VII. *Method of diſcovering whether Wine has been adulterated with any Metals prejudicial to the Health. By M.* HANHEMANN. *From* Bibliotheque Phyſico-économique.

THE property which liver of ſulphur (alkaline ſulphures) and hepatic air (ſulphurated hydrogen) poſſeſs of precipitating lead in a black form, has been long ago made public; and this property has been employed to determine the quality of wines by means of the *liquor probatorius Wirtembergenſis*, or Wirtemberg proving liquor.

But, in trying wines ſuppoſed to have been adulterated, this proof does more hurt than ſervice, becauſe it precipitates iron of the ſame colour as the pernicious lead. Many wine-merchants therefore of the greateſt reſpectability, rendered by theſe means ſuſpected, have been ruined.

There was wanting then a re-agent, which ſhould diſcover in wine thoſe metals only which are prejudicial to the health of man.

The following liquor precipitates lead and copper in a black form, and arſenic of an orange colour, &c. but does not precipitate iron. The laſt, which is not noxious, and rather ſalutary to the conſtitution, frequently gets into wines by accident.

Method of preparing the Proving Liquor.

Mix equal parts of oyſter ſhells and crude ſulphur in a fine powder, and put the mixture into a crucible. Heat it

in

in a wind furnace, and increase the fire suddenly, so as to bring the crucible to a white heat, for the space of fifteen minutes. Pulverise the mass when it is cool, and preserve it in a bottle closely stopped.

To prepare the liquor, put 120 grains of this powder and 120 grains of cream of tartar (acidulous tartarite of potash) into a strong bottle; fill the bottle with common water, which boil for an hour, and then let it cool; close the bottle immediately, and shake it for some time: after it has remained at rest to settle, decant the pure liquor, and pour it into small phials capable of holding about an ounce each, first putting into each of them 20 drops of muriatic acid. They must be stopped very closely with a piece of wax, in which there is a small mixture of turpentine.

One part of this liquor mixed with three parts of suspected wine, will discover, by a very sensible black precipitate, the least traces of lead, copper, &c. but will produce no effect upon iron, if it contains any of that metal. When the precipitate has fallen down, it may still be discovered whether the wine contains iron, by saturating the decanted liquor with a little salt of tartar (tartareous acidulum of potash), by which the liquor will immediately become black.

Pure wines remain clear and bright after this liquor has been added to them.

VIII. *On the Solar and Lunar Period of Six Hundred Years: By Professor* BURJA, *Member of the Royal Academy of Sciences at Berlin. Extracted from a Paper read on the 13th of December 1792.*

THE historian Josephus says that God prolonged the lives of the patriarchs to at least six hundred years, that they might become more perfect in the knowledge of astronomy, because

because the great year is always completed at the end of that period.

No other ancient writer, however, makes any mention of this great year; but Pliny in his Natural History relates, that Hipparchus had fixed the course of the sun and moon at six hundred years; which seems to refer to a period of that duration: and it is to be conjectured, that it was established by the ancients in order to compare the course of the moon with that of the sun, and to foretel for a considerable time beforehand the phases of the moon.

This, indeed, was one of the principal objects of the ancient astronomy. Meto invented the period of nineteen years, because he believed that nineteen tropical solar years made exactly 235 lunar months. Calippus quadrupled this period, and made a new one of 76 years. Hipparchus quadrupled these 76 years, and by these means obtained a more accurate period of 304 years.

Now it may be readily supposed, that Hipparchus, in the hopes of deviating still less from the truth, at length doubled his period, and brought it to 608 years; for, otherwise, why should he have fixed his period even at 600 years?

According to every conjecture, the great year is nothing else than the last doubled period of Hipparchus; for, though Pliny and his cotemporary Josephus speak in round numbers of 600 years, or six centuries, yet we know that mathematical accuracy is not always observed in the language of common life and of historians.

Mr. Bailly explains the period of six hundred years in a manner totally different. That astronomer finds, like all those conversant with the subject, that 600 solar years form no whole number of lunar months without a fraction: but as that would be the case if the year were assumed a little longer, as it really is, he thence concludes that the year in ancient times was actually so long as the precision of the period of 600 years requires; and besides, that those ages

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produced very able and expert aſtronomers, who diſcovered this period by an aſtoniſhingly long ſeries of obſervations. In this manner every period, however aſſumed at pleaſure, might be juſtified. It would be only neceſſary to reckon what length of year it would require; to aſſume a certain acceleration in the revolution of the earth; to determine thereby at what time the year had the requiſite length; and then to be aſtoniſhed how accurate mankind were in their aſtronomical calculations at that period.

The reader may determine between both theſe explanations. It might ſtill be ſuppoſed, that the ancients really had a period of exactly 600 years, neither more nor leſs, and that they deduced it from a falſe determination of the length of the year. But this would not agree well with the reſt of their known periods.

IX. *On the Irritability of Sea Sponges. From* Neue Nordiſche Beyträge, *by Profeſſor* PALLAS.

I HAVE for a long time remarked in different kinds of ſponge *(ſpongiæ)*, particularly the *ſpongia villoſa*, and all tough ſea ſponges, and even the commoneſt ſponge employed in bathing-houſes, when not too much uſed, certain remains of irritability, which, in theſe bodies kept ſo long out of their own element, cannot be conſidered but as mechanical. If the above ſponges be ſoaked in cold water until they extend to their full magnitude, and hot water be poured over a part, or the whole of them, they inſtantaneouſly contract themſelves, particularly in the irritated part, with a wonderful velocity and force, as if alive. As ſoon, however, as the irritation of the heat ceaſes, they again extend to their former ſize. This experiment may be repeated with a ſponge, until its whole conſiſtence and texture are deſtroyed by the hot water. An accidental obſervation made on a tubular piece of the before-mentioned *ſpongia villoſa* firſt induced me to repeat the ſame experiment on other kinds of tough ſea ſponges.

X. *On the Theory of the Structure of Cryſtals.*

[*With a Plate,* No. II.]

WHEN we reflect on the rapid progreſs which has been of late made in moſt branches of natural knowledge, and particularly in chemiſtry and mineralogy, and conſider how much theſe may be facilitated by a competent knowledge of thoſe regular forms which all mineral and ſaline ſubſtances aſſume, in certain circumſtances; it appears ſurpriſing, that, though we have a number of books which treat on chemiſtry, we have not one Engliſh work on the theory of the ſtructure of cryſtals. To remedy this defect in ſome degree, and as an introduction to original papers on the ſubject promiſed to us by an eminent mineralogiſt, we think proper to lay before our readers the following tranſlation of

The Abbé HAUY*'s Theory of Cryſtallization. From Vol. XVII. of the* Annales de Chimie.

I GAVE in this Journal, ſome years ago, a ſhort account of the theory of cryſtallization; but that paper may be conſidered only as a ſhort ſketch, and more calculated for thoſe who wiſh not to be entirely ignorant of the ſubject, than for thoſe deſirous of becoming thoroughly acquainted with its principles and reſults. In the preſent paper I propoſe to afford the latter an opportunity of obtaining their object, by preſenting them with the theory required, and with all the facts neceſſary to give them a juſt idea of the laws to which it is ſubject, and of the progreſs by which it has been carried to ſuch a degree of generality, that an immenſe number of facts, formerly unconnected, now become arranged, as if of themſelves, around a ſingle one on which they depend, and which ſerves to connect them all by mutual relations.

I confeſs, however, that this theory can be well underſtood only by the help of analytical calculations *. Beſides the advantage which analyſis has of involving in the ſame formula the ſolutions of an infinite number of different problems, it alone can give to the theory the character of abſolute certainty, by producing reſults perfectly agreeable to thoſe we receive from obſervation.

Notwithſtanding theſe conſiderations, I thought it would be better for thoſe unacquainted with the ſcience of calculation, if I adhered to ſimple reaſoning, accompanied by geometrical figures, which are ſo uſeful in aſſiſting the imagination to conceive the arrangement of thoſe ſmall ſolids that concur to form a cryſtal, but which were wanting to the firſt paper.

This arrangement I call *ſtructure,* as oppoſed to the term *organization,* which expreſſes the far more compound mechaniſm of animals and plants.

If this procedure be leſs direct, leſs expeditious, and leſs preciſe; and if it requires us to attend to thoſe details which algebra paſſes over in order to conduct us ſpeedily to its object, it is at leaſt attended with this advantage, that the mind by its means perceives better the connexion of the different parts of the whole under its conſideration.

I. *Mechanical Diviſion of Cryſtals.*

It is known that the ſame mineral ſubſtance is ſuſceptible of many different forms well defined, ſome of which do not preſent, on the firſt view, any common point of reſemblance that ſeems to indicate their relation. If we compare, for example, calcareous ſpar in a regular hexaedral priſm with

* See Memoires de l'Acad. des Sciences, An 1790.

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the rhomboid * of the ſame ſpar whoſe large angle is about $101\frac{1}{2}°$, we ſhall, at firſt, be inclined to believe that each of theſe two forms is entirely foreign to the other. But that point of union which eſcapes our notice, when we confine ourſelves to the conſideration of the exterior form, becomes ſenſible when we penetrate into the internal mechaniſm of the ſtructure. Let me here then be permitted to trace things from their origin, by relating how the obſervation from which I ſet out, and which has become the key of the whole theory, firſt preſented itſelf to my mind.

I was holding in my hand a hexaedral priſm of calcareous ſpar, ſimilar to the one I have mentioned, and which had fallen from a group of which it formed a part. The fracture preſented a very ſmooth ſurface, ſituated obliquely, like the trapezium *p ſ u t* (*fig.* 1), and which made an angle of 135°, both with the reſidue *a b c ſ p h* of the baſe, and with the remainder *t u e f* of the plane *i n e f*. Obſerving that the cuneiform ſegment *p ſ u t i n* ſeparated by this fracture from the cryſtal had for vertex one of the edges of the baſe, that is to ſay the edge *i n*, I wiſhed to know if I could detach a ſecond ſegment in the part to which the next edge *c n* belonged, by employing for that purpoſe the blade of a knife

* I give the name of rhomboid to a parallelopipedon *ae* (fig. 4) terminated by ſix rhombuſes equal and ſimilar. In every rhomboid two of the ſolid angles ſuch as *a*, *e*, oppoſite to each other, are formed by the junction of three equal plane angles. Each of the other ſix ſolid angles is formed by a plane angle equal to each of the preceding, and by two other angles of a different meaſure, but equal to each other. The points *a*, *e*, are the ſummits, and the line *a e* the axis. In any one whatever *a b d f* of the rhombuſes, which compoſe the ſurface, the angle *a*, contiguous to the ſummit, is called the *ſuperior angle*; the angle *d* the *inferior angle*; and the angles *b* and *f* are the *lateral angles*. The ſides *ab*, *af*, are the *ſuperior edges*; and the ſides *bd*, *df*, the *inferior edges*; *b f* is the *horizontal diagonal*; and *a d* the *oblique diagonal*. The rhomboid is obtuſe or acute according as the angles of the ſummits are obtuſe or acute. The cube is the boundary of the rhomboids.

directed in the ſame degree of obliquity as the trapezium *p ſ u t*, and aſſiſted by the ſtrokes of a hammer. This attempt was fruitleſs; but having tried the ſame operation towards the following edge *b c*, I uncovered a new trapezium ſimilar to the firſt. The fourth edge *a b* reſiſted the inſtrument like the ſecond; but the next one *a h* yielded eaſily to the mechanical diviſion, and preſented a third trapezium of as fine a poliſh as the other two. It is almoſt unneceſſary to add, that the ſixth edge *i h* remained indiviſible, like the fourth and the ſecond.

I then proceeded to the inferior baſe *d e f g k r*, and obſervation proved to me that the edges of this baſe, which admitted ſections like the preceding, were not the edges *ef*, *dr*, *gk*, correſponding with thoſe I had found diviſible towards the upper part, but the intermediate edges *de*, *vy*, *gf*. The trapezium *l q y v* repreſents the ſection made below the edge *kr*. This ſection is evidently parallel to that of the trapezium *p ſ u t*, and in the like manner the four other trapeziums are parallel two to two. But theſe different ſections being in the direction of the natural joining of the laminæ, I eaſily ſucceeded to obtain more ſections parallel to each of them, while it was impoſſible to divide the cryſtal in any other direction. By continuing this mechanical diviſion, determined by the parallelism above mentioned, I came to new ſections, always nearer the axis of the priſm; and when theſe ſections had made the remainders of the two baſes to diſappear, the priſm was transformed into the ſolid OX (*fig.* 2) terminated by twelve pentagons, parallel two to two, of which thoſe at the extremities SAOIR, GIODE, BAODC, on the one ſide, and KNPQF, MNPXU, ZQPXY, on the other, were the reſults of the mechanical diviſion, and had their common vertices O, P, ſituated in the centres of the baſes of the priſm (*fig.* 1). The ſix lateral pentagons RSUXY, ZYRIG, &c. (*fig.* 2) were the remains of the planes of the ſame priſm.

In proportion as I multiplied the ſections, always parallel to the preceding, the lateral pentagons decreaſed in height; and

and at a certain term the points RG becoming confounded with the points YZ, the points SR with the points UY, &c. there remained nothing of the pentagons in queſtion but the triangles YIZ, UXY, &c. (*fig.* 3). Beyond that term the ſections happening to paſs over the ſurface of theſe triangles diminiſhed gradually their extent, until, at length, theſe triangles were loſt; and then the ſolid which aroſe from the hexaedral priſm became a rhomboid *a e* (*fig.* 4) entirely like that commonly diſtinguiſhed under the name of Icelandic ſpar.

A reſult ſo unexpected made me immediately conceive the idea of ſubjecting the other calcareous cryſtals to the ſame proof; and all yielded to the mechanical diviſion in ſuch a manner, that, when the external faces had diſappeared, the kind of nucleus which remained under the inſtrument was ſtill a rhomboid of the ſame form as the firſt. The only thing neceſſary was to find the direction of the ſections which conducted to the central rhomboid.

To extract, for example, this rhomboid from that ſpar called commonly the *lenticular*, and which is a much more obtuſe rhomboid, having its great plane angle equal to 114° 18′ 56″, it was neceſſary to begin at the two vertices, making the ſections paſs through the leſſer diagonals of the faces. If it were wiſhed, on the contrary, to get at the nucleus of the rhomboidal ſpar with acute vertices *, it would be neceſſary to direct the ſections of the planes parallel to the edges adjacent to the vertices, and in ſuch a manner that each of them ſhould be equally inclined to the planes it cuts.

Theſe reſults are the more worthy of attention, as it would at firſt ſeem that cryſtallization, after having once adopted the rhomboid, in regard to one determined ſpecies of mineral, ought always to re-produce it with the ſame angles. But

* This rhomboid, as well as the preceding, will be farther explained in the courſe of the preſent article.

the paradox ariſing from this diverſity of appearance is explained by the double uſe of the rhomboidal form, which ſerves here to diſguiſe itſelf, and which conceals fixed and conſtant characteriſing marks under a variable outſide.

If we take a cryſtal of another nature, ſuch as a cube of fluor ſpar, the nucleus will have a different form. This, in the preſent caſe, will be an octaedron, to which we ſhall arrive by taking off the eight ſolid angles of the cube. Heavy ſpar will produce, for nucleus, a right priſm, with rhomboidal baſes ; feld ſpar an oblique-angled parallelopipedon, but not rhomboidal * ; the apatite or beryl a right hexaedral priſm ; the adamantine ſpar a rhomboid, a little ſharpened ; blend a dodecaedron, with rhomboidal planes ; iron of the iſland of Elba, a cube, &c. and each of theſe forms will be conſtant in regard to the whole ſpecies, ſo that its angles will undergo no variation of importance ; and if an attempt be made to divide the cryſtal in any other direction, we ſhall not be able to find a joining. Nothing will be obtained but undefined fragments : in a word, it will be broken rather than divided.

Theſe ſolids, inſcribed, each, in all the ſolids of the ſame ſpecies, ought to be conſidered as the real primitive forms on which all the other forms depend. All minerals, I confeſs, are not ſuſceptible of being divided mechanically, but there are a greater number than I at firſt thought ; and with regard to thoſe cryſtals which have hitherto reſiſted my efforts to find their natural joinings, I have remarked that their ſurface, ſtriated in a certain direction, or the relation of their different forms among thoſe which belong to the ſame ſubſtance, often preſent indications of their ſtructure ; and that, reaſoning from their analogy with other diviſible cryſtals, we may determine that ſtructure at leaſt with great probability.

I call *ſecondary forms* all thoſe that differ from the primitive form. We ſhall ſee, hereafter, that the number of theſe

* Mem. de l'Acad. des Sciences, An 1784, p. 237.

forms

forms has limits, which can be determined by theory, according to the laws to which the ſtructure of cryſtals is ſubjected.

The ſolid of the primitive form, obtained by means of the operation above explained, may be ſubdivided in a direction parallel to its different faces: all the enveloping matter is equally diviſible by ſections parallel to the faces of the primitive form. It thence follows that the parts detached by the help of all theſe ſections are ſimilar, and differ only in their bulk, which continues to decreaſe in proportion as the diviſion is carried ſtill farther. We, however, muſt except thoſe which are near to the faces of the ſecondary ſolid; for, theſe faces not being parallel to thoſe of the primitive form, the fragments which have one of their facets taken in the ſame faces cannot entirely reſemble thoſe detached towards the middle of the cryſtal. For example, the fragments of the hexaedral priſm (fig. 1), the external facets of which make part of the baſes or of the planes, have not, in that reſpect, the ſame figure as thoſe ſituated nearer the centre, and of which the facets are all parallel to the ſections *p ſ u t*, *l q y v*, &c. But theory, as I ſhall ſhew, removes all the embarraſſment which, on the firſt view, ariſes from that diverſity, and reduces the whole to an unity of figure.

But the diviſion of the cryſtal into ſmall ſimilar ſolids has a term beyond which we ſhould come to particles ſo ſmall, that they could no longer be divided without analyſing them; that is to ſay, without deſtroying the nature of the ſubſtance. I ſtop at that term; and I give to the corpuſcula we ſhould inſulate, if our organs and inſtruments were ſufficiently delicate, the name of *integral moleculæ.* It is very probable that theſe moleculæ are thoſe which were ſuſpended in the fluid in which the cryſtallization was effected. But my readers may judge for themſelves. We may, however, with truth, aſſert, that, by the aſſiſtance of theſe moleculæ, theory reduces to ſimple laws the different metamorphoſes of cryſtals,

cryſtals, and arrives at reſults which exactly repreſent thoſe of nature; and this is the only end I propoſed.

When the nucleus is a parallelopipedon, that is to ſay, a ſolid with ſix parallel faces, two to two, like the cube, the rhomboid, &c. and this ſolid does not admit of any other diviſions than thoſe made in the direction of the faces, it is evident that the moleculæ reſulting from ſubdiviſion, both of the nucleus and of the enveloping matter, are ſimilar to the nucleus. In other caſes the form of the moleculæ differs from that of the nucleus. There are alſo cryſtals which, by help of the mechanical diviſion, yield particles of different figures, combined together throughout the whole extent of theſe cryſtals. I ſhall explain hereafter my conjectures on the manner of reſolving the difficulty preſented by theſe kinds of mixed ſtructures; and it will be ſeen that this difficulty does not affect the theory at bottom.

II. *Laws of Diminution.*

1. Diminution at the edges.

The primitive form and that of the integral moleculæ being determined, after the diſſection of the cryſtals, it was neceſſary to diſcover the laws according to which theſe moleculæ were combined to produce, around the primitive form, thoſe ſpecies of envelopes, terminated ſo regularly, and from which reſulted polyedra ſo different from each other; though originally of the ſame ſubſtance. But ſuch is the mechaniſm of the ſtructure ſubject to theſe laws, that all the parts of the ſecondary cryſtal, ſuperadded to the nucleus, are formed of laminæ, decreaſing regularly by the ſubtraction of one or more ranges of integral moleculæ; ſo that theory determines the number of theſe ranges, and, by a neceſſary conſequence, the exact form of the ſecondary cryſtal.

To give an idea of theſe laws, I ſhall firſt make choice of a very ſimple and very elementary example. Let us conceive

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EP (*fig.* 5) to repreſent a dodecaedron, whoſe faces are equal and ſimilar rhombuſes; and that this dodecaedron is a ſecondary form, which has a cube for its nucleus or primitive form. The poſition of this cube may be eaſily conceived by inſpecting *fig.* 6, where it is ſeen that the ſmall diagonals DC, CG, GF, FD, of the four faces of the dodecaedron, united around the ſame ſolid angle L, form a ſquare, CDFG. But there are ſix ſolid angles compoſed of the four planes, viz. the angles L, O, E, N, R, P, (*fig.* 5); and, conſequently, if ſections are made to paſs through the ſmall diagonals of the faces which concur to the formation of theſe ſolid angles, we ſhall ſucceſſively uncover ſix ſquares, which will be the faces of the primitive cube, and three of which are repreſented (*fig.* 6), viz. CDFG, ABCD, BCGH.

This cube would evidently be an aſſemblage of integral cubic moleculæ, and it would be neceſſary that each of the pyramids, ſuch as LDCGF (*fig.* 6), which reſt on the faces, ſhould itſelf be compoſed of cubes equal to each other, and to thoſe forming the nucleus.

To make it more apparent how this might take place, I ſhall point out the means of making an artificial dodecaedron, by employing a certain number of ſmall cubes, the aſſortment of which will be an imitation of that of the moleculæ employed by nature in the formation of the dodecaedron we are here conſidering.

Let ABGF (*fig.* 7) be a cube compoſed of 729 ſmall cubes equal to one another, in which caſe each face of the whole cube will contain 81 ſquares, nine on each ſide, which will be the external faces of as many partial cubes, repreſentatives of moleculæ. The cube in queſtion will be the nucleus of the dodecaedron which we propoſe to conſtruct.

On one of the faces, ſuch as ABCD of this cube, let us apply a ſquare lamina compoſed of cubes equal to thoſe which form the nucleus, but which towards each edge has a range of cubes leſs than if it had been on a level with the adjacent faces BCGH, DCGF, &c. That is to ſay, let this lamina

lamina be compoſed only of 49 cubes, 7 on each ſide, in ſuch a manner that if its inferior baſe be *o n f g* (*fig.* 8), that baſe may fall exactly on the ſquare marked by the ſame letters (*fig.* 7).

Above this firſt lamina let us apply a ſecond compoſed of 25 cubes, five on each ſide, ſo that if *l m p u* (*fig.* 9), repreſent its lower baſe, this baſe may be found ſituated exactly above the ſquare deſigned by the ſame letters (*fig.* 7).

Let us, in like manner, apply a third lamina upon the ſecond; but containing only 9 cubes, three on each ſide, ſo that *v x y z* (*fig.* 10) being the inferior baſe, this baſe may correſpond with the ſquare marked by the ſame letters (*fig.* 7). Laſtly, on the middle ſquare *r*, in the preceding lamina, let us place the ſmall cube *r* (*fig.* 11), which will repreſent the laſt.

It may be eaſily ſeen that by this operation we ſhall have formed upon the face ABCD (*fig.* 7) a quadrangular pyramid, of which this face will be the baſe, and which will have the cube *r* (*fig.* 11) for its ſummit. If we continue the ſame operation on the other five faces of the cube (*fig.* 7) we ſhall have, in all, ſix quadrangular pyramids, reſting on the ſix faces of the nucleus, which they will envelop on all ſides. But as the different courſes or laminæ which compoſe theſe pyramids project beyond each other a certain quantity, as may be ſeen *fig.* 12, where the parts elevated above the planes BCD, BCG repreſent the two pyramids which reſt on the faces ABCD, BCGH (*fig.* 7), the faces of the pyramids will not form continued planes: they will be alternately re-entering and ſalient; and in ſome meaſure will imitate a pyramidal aſcent of ſteps, which preſents four faces (*eſcalier à quatre faces*).

Let us now ſuppoſe that the nucleus is compoſed of an incomparably larger number of cubes, almoſt imperceptible, and that the laminæ, applied on the different faces, which I ſhall in future call *laminæ of ſuperpoſition*, go on increaſing towards their four edges, by ſubtractions of one range of

cubes

cubes equal to thoſe of the nucleus, the number of theſe laminæ will be found incomparably greater than in the preceding hypotheſis; at the ſame time the cavities (*cannelures*) which they will form, by the alternate ſallying and re-entering of their edges, will be ſcarcely ſenſible; and we may even ſuppoſe the compoſing cubes ſo ſmall that theſe cavities will become imperceptible to our ſenſes, and that the faces of the pyramids will appear perfectly ſmooth.

Now D C B E (*fig.* 12) being the pyramid reſting on the face A B C D (*fig.* 7), and C B O G (*fig.* 12) the pyramid applied on the neighbouring face B C G H, (*fig.* 7), if we conſider that every thing is uniform from E to O (*fig.* 12) in the manner in which the edges of the laminæ of ſuperpoſition mutually project beyond each other, it will readily be conceived that the face C E B of the firſt pyramid ought to be found exactly in the ſame plane as the face C O B of the adjacent pyramid, ſo that the aſſemblage of theſe two faces will form a rhombus E C O B. But for the ſix pyramids we had twenty-four triangles, ſimilar to C E B, which, conſequently, will be reduced to twelve rhombuſes, from which will reſult a dodecaedron ſimilar to that repreſented (*fig.* 5 *and* 6); and thus the problem is reſolved.

The cube, before it arrives at the form of the dodecaedron, paſſes through a multitude of intermediate modifications, one of which is repreſented *fig.* 13. It may be there ſeen that the ſquares *p a e o*, *k l q u*, *m n t s*, &c. correſpond to the ſquares A B C D, D C G F, C B H G, &c. (*fig.* 6) and form the ſuperior baſes of as many pyramids, incomplete for want of the laminæ by which they ought to be terminated. The rhombuſes E D L C, E C O B, &c. (*fig.* 5), by a neceſſary conſequence are reduced to ſimple hexagons *a e* C *l k* D, *e o* B *n m* C, &c. (*fig.* 13) and the ſurface of the ſecondary cryſtal is compoſed of twelve of thoſe hexagons and ſix ſquares. This is the caſe with the boracic ſpar, allowance being made for ſome facets which take the

place

place of the ſolid angles, and which are ſubject to another law of decreaſe, to be ſpoken of hereafter.

If the decreaſe of the laminæ of ſuperpoſition took place according to a more rapid law; if each lamina for example had had on its circumference two, three, or four ranges of cubes leſs than the inferior range, the pyramids produced around the nucleus, by this decreaſe, being more lowered, and their adjacent faces being no longer on a level, the ſurface of the ſecondary ſolid would be compoſed of 24 iſoſceles triangles, all inclined one to the other. I call *decreaſe on the edges* that which takes place parallel to the edges of the nucleus, as in the preceding examples, to diſtinguiſh it from another kind of decreaſe which I ſhall ſpeak of hereafter, and which takes place according to directions altogether different.

(To be continued.)

XI. *Obſervations on Iron and Steel. By* JOSEPH COLLIER. *From the* Tranſactions of the Mancheſter Society.

[*With a Plate*, No. III.]

AFTER examining the works of different authors who have written on the ſubject of making iron and ſteel, I am perſuaded that the accounts given by them of the neceſſary proceſſes and operations are extremely imperfect. Chemiſts have examined and deſcribed the various compound minerals containing iron with great accuracy, but have been leſs attentive to their reduction. This obſervation more particularly applies to ſteel, of the making of which I have not ſeen any correct account. It is ſingular to obſerve how very imperfectly the cementation of iron has been deſcribed by men of great eminence in the ſcience of chemiſtry. Fourcroy ſtates the length of time neceſſary for the cementation of of iron to be about twelve hours; but it is difficult to diſcover whether he alludes to caſt or to bar ſteel: for he ſays, that ſhort bars of iron are to be put into an earthen box with a cement, and cloſed up. Now ſteel is made from bars of iron of the uſual length and thickneſs: but caſt ſteel is made according to the proceſs deſcribed by Fourcroy, with this eſſential difference—the operation is begun upon bar ſteel, and not bar iron.

Mr. Nicholſon is equally unfortunate in the account given in his Chemical Dictionary. He ſays that the uſual time required for the cementation of iron is from 6 to 10 hours, and cautions us againſt continuing the cementation too long; whereas the operation, from the beginning to the end, requires 16 days at leaſt. In other parts of the operation he is equally defective, confounding the making of bar with that of caſt ſteel, and not fully deſcribing either. In ſpeaking of the uſes of ſteel, or rather of what conſtitutes its ſuperiority, Mr. Nicholſon is alſo deficient. He obſerves that "its moſt uſeful and advantageous property is that of becoming extremely hard when plunged into water." He has here forgotten every thing reſpecting the temper and tempering of ſteel inſtruments, of which, however, he takes ſome notice in the ſame page. "Plunging into water" requires a little explanation: for, if very hot ſteel be immerſed in cold water without great caution, it will crack, nay ſometimes break to pieces. It is however neceſſary to be done, in order to prevent the ſteel from growing ſoft, and returning to the ſtate of malleable iron; for, were it permitted to cool in the open air, the carbon which it holds in combination would be diſſipated*. I ſhall at preſent confine my remarks to the operations performed on iron in Sheffield and its neighbourhood, from whence various communications have been tranſmitted to me by reſident friends, and where I have myſelf ſeen the operations repeatedly performed. The iron

* It is the opinion of ſome metallurgiſts, that a partial abſtraction of oxygen takes place, by plunging hot metal into cold water.

made

made in that part of Yorkſhire is procured from ores found in the neighbourhood, which are of the argillaceous kind; but intermixed with a large proportion of foreign matter. Theſe, however, are frequently combined with richer ores from Cumberland and other places. The ore is firſt roaſted with cinders for three days in the open air, in order to expel the ſulphureous or arſenical parts, and afterwards taken to the furnaces, ſome of which are conſtructed ſo that their internal cavity has the form of two four-ſided pyramids joined baſe to baſe; but thoſe moſt commonly uſed are of a conical form, from forty to fifty feet high. The furnace is charged at the top with equal parts of coal-cinder and lime-ſtone. The lime-ſtone acts as a flux, at the ſame time that it ſupplies a ſufficient quantity of earthy matter, to be converted into ſcoriæ, which are neceſſary to defend the reduced metal from calcination, when it comes near the lower part of the furnace. The fire is lighted at the bottom; and the heat is excited by means of two pair of large bellows blowing alternately. The quantity of air generally thrown into the furnace is from 1000 to 1200 ſquare feet in a minute. The air paſſes through a pipe, the diameter of which is from two inches and a quarter to two and three quarters wide. The compreſſion of air which is neceſſary is equal to a column of water four feet and a half high. The ore melts as it paſſes through the fire, and is collected at the bottom, where it is maintained in a liquid ſtate. The ſlag, which falls down with the fuſed metal, is let off by means of an opening in the ſide of the furnace, at the diſcretion of the workmen. When a ſufficient quantity of regulus, or imperfectly reduced metal, is accumulated at the bottom of the furnace (which uſually happens every eight hours), it is let off into moulds, to form it for the purpoſes intended, ſuch as cannon or pig iron.—Crude iron is diſtinguiſhed into white, black, and grey. The white is the leaſt reduced, and more brittle than the other two; the black is that with which a large quantity of fuel has been uſed; and the grey is that

 which

which has been reduced with a ſufficient quantity of fuel, of which it contains a part in ſolution. The operation of refining crude iron conſiſts in burning the combuſtible matter which it holds in ſolution; at the ſame time that the remaining iron is more perfectly reduced, and acquires a fibrous texture. For this purpoſe, the pigs of caſt iron are taken to the forge, where they are firſt put into what is called the refinery; which is an open charcoal fire, urged by a pair of bellows, worked by water or a ſteam-engine; but the compreſſion of air in the refinery ought to be leſs than that in the blaſt-furnace. After the metal is melted, it is let out of the fire by the workmen to diſcharge the ſcoriæ, and then returned and ſubjected to the blaſt as before. This operation is ſometimes repeated two or three times before any appearance of malleability (or what the workmen call coming into nature) takes place; this they know by the metal's firſt aſſuming a granular appearance, the particles appearing to repel each other, or at leaſt to have no ſigns of attraction. Soon afterwards they begin to adhere, the attraction increaſes very rapidly, and it is with great difficulty that the whole is prevented from running into one maſs, which it is deſirable to avoid, it being more convenient to ſtamp ſmall pieces into thin cakes: this is done by putting the iron immediately under the forge-hammer, and beating it into pieces about an inch thick, which eaſily break from the reſt during the operation. Theſe ſmall pieces are then collected and piled to the height of about ten inches upon circular ſtones, which are an inch thick and nine inches in diameter. They are afterwards put into a furnace, in which the fire is reverberated upon them until they are in a ſemi-fluid ſtate. The workmen then take one out of the furnace, and draw it into a bar under the hammer; which being finiſhed, they apply the bar to another of the piles of ſemi-fluid metal, to which it quickly cements, is taken again to the hammer, the bar firſt drawn ſerving as a handle, and drawn down as before. The imperfections in the bars are remedied by putting them

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into another fire called the chafery, and again ſubjecting them to the action of the forge-hammer.

The above method is now moſt in uſe, and is called flouriſhing; but the iron made by this proceſs is in no reſpect ſuperior to that which I am going to deſcribe. It is however not ſo expenſive, and requires leſs labour.

The proceſs for refining crude iron, which was moſt common previous to the introduction of flouriſhing, is as follows:

The pigs of caſt iron are put into the refinery, as above, where they remain until they have acquired a conſiſtence reſembling paſte, which happens in about two hours and a half. The iron is then taken out of the refinery, and laid upon a caſt iron plate on the floor, and beaten by the workmen with hand-hammers, to knock off the cinders and other extraneous matters which adhere to the metal. It is afterwards taken to the forge-hammer, and beaten firſt gently, till it has obtained a little tenacity; then the middle part of the piece is drawn into a bar about half an inch thick, three inches broad, and four feet long, leaving at each end a thick ſquare lump of imperfect iron. In this form it is called ancony. It is now taken to the fire called the chafery, made of common coal; after which the two ends are drawn out into the form of the middle, and the operation is finiſhed.

There is alſo a third method of rendering crude iron malleable, which, I think, promiſes to be abundantly more advantageous than either of the two former, as it will diſpenſe both with the refinery and chafery; and nothing more will be neceſſary than a reverberating furnace, and a furnace to give the metal a malleable heat, about the middle of the operation. The large forge-hammer will alſo fall into diſrepute, but in its place muſt be ſubſtituted metal rollers of different capacities, which, like the forge-hammer, muſt be worked either by a water-wheel or a ſteam-engine.

It is by the operation of the forge-hammer or metal rollers, that the iron is deprived of the remaining portion of impurity, and acquires a fibrous texture.

The iron made by the three foregoing proceſſes is equally valuable, for by any of them the metal is rendered pure; but after thoſe different operations are finiſhed, it is the opinion of many of the moſt judicious workers in iron, that laying it in a damp place for ſome time improves its quality; and to this alone ſome attribute the ſuperiority of foreign iron, more time elapſing between making and uſing the metal. To the latter part of this opinion I can by no means accede, as it is well known that the Swediſh * ores contain much leſs heterogeneous matter than ours, and are generally much richer, as they uſually yield about 70 *per quintal* of pure iron, whereas the average of ours is not more than 30 or 40 †: add to this, that the Swediſh ores are ſmelted in wood fires, which gives the iron an additional ſuperiority.

Iron inſtruments are caſe-hardened by heating them in a cinder or charcoal fire; but if the firſt be uſed, a quantity of old leather or bones muſt be burnt in the fire, to ſupply the metal with carbon. The fire muſt be urged by a pair of bellows to a ſufficient degree of heat, and the whole operation is uſually completed in an hour.

The proceſs for caſe-hardening iron is in fact the ſame as for converting iron into ſteel, but not continued ſo long, as the ſurface only of the article is to be impregnated with carbon. Some attempts have been made to give caſt-iron, by caſe-hardening, the texture and ductility of ſteel; but they have not been very ſucceſsful. Table and pen-knife blades have been made of it; and, when ground, have had a pretty good appearance; but the edges are not firm, and they ſoon loſe their poliſh. Common table knives are frequently made of this metal. The cementation of iron converts it into

* Steel is commonly made of Swediſh iron.

† The iron made from the ore found in the neighbourhood of Sheffield contains a great deal of phoſphate of iron or ſiderite, which renders the metal brittle when cold.

 ſteel,

ſteel, a ſubſtance intermediate between crude and malleable iron.

The furnaces for making ſteel are conical buildings; about the middle of which are two troughs of brick or fire-ſtone, which will hold about four tons of iron in the bar. At the bottom is a long grate for fire. The ſteel furnace, however, is not well adapted for deſcription. I ſhall therefore avail myſelf of an accurate drawing, which was communicated to me by a gentleman converſant with the manufacture, and which is copied in the plate. A layer of charcoal-duſt is put upon the bottom of the trough, and upon that a layer of bar iron, and ſo on alternately until the trough is full. It is then covered over with clay to keep out the air; which, if admitted, would effectually prevent the cementation. When the fire is put into the grate, the heat paſſes round by means of flues, made at intervals, by the ſides of the trough. The fire is continued until the converſion is complete, which generally happens in about eight or ten days. There is a hole in the ſide, by which the workmen draw out a bar occaſionally, to ſee how far the tranſmutation has proceeded. This they determine by the bliſters upon the ſurface of the bars.

If they be not ſufficiently changed, the hole is again cloſed carefully, to exclude the air; but if, on the contrary, the change be complete, the fire is extinguiſhed, and the ſteel is left to cool for about eight days more, when the proceſs for making bliſtered ſteel is finiſhed. For ſmall wares, the bars are drawn, under the tilt hammer, to about half an inch broad and $\frac{3}{16}$ of an inch thick. The change wrought on bliſtered ſteel by the tilt hammer, is nearly ſimilar to that effected on iron from the refinery by the forge hammer. It is made of a more firm texture, and drawn into convenient forms for uſe. German ſteel is made by breaking the bars of bliſtered ſteel into ſmall pieces, and then putting a number of them into a furnace; after which they are welded together and drawn to about eighteen inches long; then doubled and welded again, and finally drawn to the ſize and ſhape required for use. This is also called shear steel, and is superior in quality to the common tilted steel. Cast steel is also made from the common blistered steel. The bars are broken, and put into large crucibles with a flux. The crucible is then closed up with a lid of the same ware, and placed in a wind furnace. By the introduction of a greater or smaller quantity of flux, the metal is made harder or softer.

When the fusion is complete, the metal is cast into ingots, and then called ingot steel; and that which afterwards undergoes the operation of tilting, is called tilted cast steel. The cast steel is the most valuable, as its texture is the most compact, and it admits of the finest polish. Sir T. Frankland has communicated a process, in the Transactions of the Royal Society*, for welding cast steel and malleable iron together; which, he says, is done by giving the iron a malleable, and the steel a white heat; but, from the experiments which have been made at my request, it appears, that it is only soft cast steel, little better than common steel, that will weld to iron: pure steel will not; for, at the heat described by Sir T. the best cast steel either melts, or will not bear the hammer. It may here be observed, as was mentioned before, that steel is an intermediate state between crude and malleable iron, except in the circumstance of its reduction being complete; for, according to the experiments of Reaumur and Bergman, steel contains more hydrogen gas than cast iron, but less than malleable iron;—less plumbago than the first, but more than the latter;—an equal portion of manganese with each;—less siliceous earth than either;—more iron than the first, but less than the second. Its fusibility is likewise intermediate between the bar iron and the crude. When steel has been gradually cooled from a state of ignition, it is malleable and soft, like bar iron; but when ignited and plunged into cold water, it has the hardness and brittleness of crude iron. From the foregoing facts we are justified in drawing the same conclusions with Reaumur and

* Phil. Transf. 1795.

Bergman, but which have been more perfectly explained by Vandermonde, Berthollet, and Monge, that crude iron is a regulus, the reduction of which is not complete; and which conſequently will differ according as it approaches more or leſs to the metallic ſtate. Forged iron, when previouſly well refined, is the pureſt metal; for it is then the moſt malleable and the moſt ductile, its power of welding is the greateſt, and it acquires the magnetic quality ſooneſt. Steel conſiſts of iron perfectly reduced and combined with charcoal; and the various differences in bliſtered ſteel, made of the ſame metal, conſiſt in the greater or leſs proportion of charcoal imbibed. Iron gains, by being converted into ſteel, about $\frac{1}{180}$ part of its weight. In order to harden ſteel, it muſt be put into a clean charcoal, coal or cinder fire, blown to a ſufficient degree of heat by bellows. The workmen ſay, that neither iron nor ſteel will harden properly without a blaſt. When the fire is ſufficiently hot, the inſtrument intended to be hardened muſt be put in, and a gradual blaſt from the bellows continued until the metal has acquired a regular red heat: it is then to be carefully quenched in cold water. If the ſteel be too hot when immerſed in water, the grain will be of a rough and coarſe texture; but if of a proper degree of heat, it will be perfectly fine. Saws and ſome other articles are quenched in oil. Steel is tempered by again ſubjecting it to the action of the fire. The inſtrument to be tempered we will ſuppoſe to be a razor made of caſt ſteel. Firſt rub it upon a grit ſtone until it is bright, then put the back upon the fire, and in a ſhort time the edge will become of a light ſtraw colour, whilſt the back is blue. The ſtraw colour denotes a proper temper, either for a razor, graver, or pen-knife. Spring knives require a dark brown; ſciſſars a light brown or ſtraw colour; forks or table-knives a blue. The blue colour marks the proper temper for ſwords, watch-ſprings, or any thing requiring elaſticity. The ſprings for pen-knives are covered over with oil before they are expoſed to the fire to temper.

Expla-

Explanation of the Plate.

Fig. 1 is a plan of the furnace, and fig. 2 is a section of it taken at the line AB. The plan is taken at the line CD. The same parts of the furnace are marked with the same letters in the plan and in the section. EE are the pots or troughs into which the bars of iron are laid to be converted. F is the fire-place; P the fire-bars; and R the ash-pit. GG, &c. are the flues. HH is an arch, the inside of the bottom of which corresponds with the line IIII, fig. 1, and the top of it is made in the form of a dome, having a hole in the centre at K, fig. 2. LL, &c. are six chimneys. MM is a dome similar to that of a glass-house, covering the whole. At N there is an arched opening, at which the materials are taken in and out of the furnace, and which is closely built up when the furnace is charged. At OO there are holes in each pot, through which the ends of three or four of the bars are made to project quite out of the furnace. These are for the purpose of being drawn out occasionally to see if the iron be sufficiently converted.

The pots are made of fire-tiles or fire-stone. The bottoms of them are made of two courses, each course being about the thickness of the single course which forms the outsides of the pots. The insides of the pots are of one course, about double the thickness of the outside. The partitions of the flues are made of fire-brick, which are of different thicknesses, as represented in the plan, and by dotted lines in the bottom of the pots. These are for supporting the sides and bottoms of the pots, and for directing the flame equally round them. The great object is to communicate to the whole an equal degree of heat in every part. The fuel is put in at each end of the fire-place, and the fire is made the whole length of the pots, and kept up as equally as possible.

XII. *Account of a Violet Dye produced from the Leaves of Succotrine Aloes, which resists the Action of Oxygen, Acids and Alkalis. By Mr.* FABBRONI. *From the* Annales de Chimie, *Vol. XXV.*

TO increase the number of dyeing substances, and to be able to vary the tone and shades of the different known colours, is an object of no small utility. Several manufactures, as is well known, have been indebted for their reputation and credit to the possession of a particular dye.

Without speaking of the Tyrian purple, who is ignorant how much value the modern scarlet has given to the Dutch cloths and to those of the Gobelins? Who does not know that the beautiful black of Florence, which has never yet been imitated, has raised the Florentine stuffs all over Europe to a price to which that of no other country ever attained?

Scarlet and black belong to that class of colours called *noble* or *fixed*, because they are not susceptible of being stained, and because they experience no alteration either from the air or from light. The beautiful red colour also given to silk by safflower is reckoned among the noble colours, though it does not withstand the influence of these two agents, which soon destroy it or render it pale.

All other red dyes for silk, in order to be durable, must be composed, in part, of cochineal, which is a colouring substance exceedingly constant.

Argol and all the other lichens produce a very beautiful violet; but the sun alters this colour and makes it turn blue.

I am of opinion, therefore, that if means could be discovered to compose, without cochineal, colours graduated from the most delicate to the darkest violet purple, which might be proof against the action of acids and of the air, infinite advantages would thence result to the manufacturers of cloth and to the public.

It

It was in hopes of diſcovering ſuch a colour that I directed my reſearches towards a ſubſtance which hitherto has not been ranked among thoſe called colouring ſubſtances.

I was perſuaded that the matter of the brilliant colours preſented to us in thoſe fruits, flowers, and plants, which have undergone a ſpontaneous alteration, pre-exiſts in the maſs of the fluids that circulate in thoſe organs, where it is diſperſed or concealed; and that to be able to turn it to advantage, nothing would be wanting but a method to ſeparate it, and to modify it in a proper manner.

The cochineal inſect, which lives on the nopal (*cactus coccenilifer*), can extract with its proboſcis the red juice, or juice ſuſceptible of becoming red, of that plant; which afterwards communicates its colour to the inſect, and which, in my opinion, is the ſame as that exhibited to us naked in the ripe fruit of the ſame plant.

The beautiful ſcarlet colour aſſumed by the dead leaves of ſome ſpecies of ſtrawberry blite (*blitum*) is not perhaps brought forwards but in conſequence of the decompoſition of the dead leaf. Would it be impoſſible then for art to ſeparate this colour, and to modify it in the like manner?

Having obſerved that the ſucculent leaves of the *aloe ſuccotrina anguſtifolia*, as they dried on the plants, aſſumed an agreeable violet colour, I tried to ſeparate the colouring matter, or principles of that fine colour, from the living leaves.

I found by experiments, that acids as well as alkalis ſpeedily gave to this almoſt colourleſs juice a red colour, and formed a ſucceſſive precipitation of colouring moleculæ which had the ſame colour.

Oxygen gas produced the like effect; and it is highly pleaſing to ſee how the juice of aloes, merely by being expoſed to the air, with or without the contact of the light, ſucceſſively reddens, beginning at the parts more immediately in contact, and is gradually converted into a very dark and lively violet purple.

This

This juice then produces a ſuperb tranſparent colour without body, highly proper for works in miniature, and which when diſſolved in water may ſerve alſo, either cold or warm, for dyeing ſilk from the lighteſt to the darkeſt ſhade.

Silk, even without a mordant, ſtrikes and becomes impregnated with this dye. It is equally attracted by ſulphurated ſilk, though the latter is ſo little diſpoſed to aſſume any colour whatever.

The aloe, indeed, is not a plant indigenous in our climates; but this is an inconvenience which it has in common with almoſt all ſubſtances uſed for dyeing, and even with a great number of thoſe which ſerve us as food. The juice might be procured from Socotora itſelf, not ſuch as it is found in commerce inſpiſſated by fire, but dried in the air, or prepared by an acid.

Beſides, as this plant grows without any difficulty in our botanical gardens, we may hope to multiply it enough by cultivation, particularly in the ſouthern parts of Italy, in order to extract from it the juice ourſelves.

The value of this new colour may be readily diſcovered, when we obſerve that, by its property of not being altered by acids or alkalis, it poſſeſſes the uncommon quality of not being ſuſceptible of becoming ſpotted.

When we conſider alſo that the oxygen, which diſcolours our cloths and ſilks ſo as to render them white, is, as one may ſay, the principle which develops the colour of the aloe; it ought to be inferred, that the air cannot alter a quality which it communicates itſelf; and we may therefore conclude, that we have diſcovered in the aloe one of the moſt durable colours known in nature.

XIII. *A curſory View of ſome late Diſcoveries and Improvements in different Branches of Science. Extracted chiefly from* DE LA METHERIE'*s Introduction to the* Journal de Phyſique *for* 1798.

MATHEMATICS.

THIS ſublime part of knowledge, though carried in all appearance to its utmoſt extent, ſtill continues to make ſome progreſs. Lagrange has finiſhed a very important work, which he began ſeveral years ago, entitled, *The Theory of the Analytical Functions, &c.* in which he ſhews that every thing hitherto called the differential calculus, whether one follows the method of Leibnitz or that of Newton, may be reduced to the ordinary calculation of finite quantities.

ASTRONOMY. Herſchel, who has paid great attention to the ſpots of the ſun, conſiders that luminary as ſimilar to the planets, and not a flaming body. It contains mountains, ſome of which he ſuppoſes to be 200 leagues in height. Its atmoſphere is compoſed of different elaſtic fluids, ſome of which are luminous or phoſphoric, and others only tranſparent. The former make the ſun appear like a maſs of light or fire; but the parts of that atmoſphere which are only tranſparent, ſuffer his body to be ſeen. Theſe are the ſpots. He believes the ſun to be inhabited like the other planets.

Lalande, on the other hand, thinks that the ſun is really a ſolid body, but that his ſurface and part of his maſs are compoſed of an incandeſcent fluid. This fluid, by any movement, leaves uncovered ſometimes a portion of the body of the ſun or his mountains, and theſe are the ſpots. Wilſon conſiders the ſpots of the ſun as eruptions or volcanoes.

Shroeter has ſhown that in Venus there are very high mountains, as is the caſe on the earth and in the moon. The greater part of theſe mountains in Venus, like thoſe of the

the moon, are in the ſouthern part of that planet, while on the earth the greater part of the mountains are towards the north. The day in Venus appears to that aſtronomer to be 23 hours 21 minutes. It differs therefore very little from the ſidereal day of the earth, which is 23 hours 56 minutes 4 ſeconds.

The volcano of the moon has been ſeen ſeveral times by the naked eye. Caroché ſaw it at Paris on the ſecond of March 1797. It exhibited the appearance of a candle juſt going out. It reſembled a brilliant ſpot leſs ſenſible than the greateſt ſatellite of Jupiter, but larger. Its exiſtence therefore can no longer be doubted.

La Place has publiſhed an excellent memoir on the movements of the moon.

Hennert ſays that the diurnal movement of the earth may undergo ſome variations; but that its variations are compenſated in ſuch a manner, that they may be conſidered as uniform.

Herſchel has obſerved around Saturn a quintuple belt of ſpots. By theſe means he has ſhown the length of the day of that planet, and determined its diurnal rotation, which he eſtimates at 10 hours 16 minutes 2 ſeconds.

Lalande calculated the orbit of the 83d comet to the month of December 1793; but an 84th comet was ſeen by Bode at Berlin, on the 11th of November 1795, near the conſtellation of Hercules. It was ſeen alſo by Bouvard, at Paris, on the 14th of the ſame month. It was ſmall, had no tail, and was not viſible to the naked eye. Its orbit has been calculated by Zach. It was in its perihelion on the 14th of December at 15 hours 32 ſeconds mean time at Gotha. Its diſtance then from the ſun was 0,22.

An 85th comet was diſcovered in Virgo by Olbers, at Bremen, who calculated its orbit.

An 86th was diſcovered from the obſervatory at Paris, by Bouvard, on the 14th of Auguſt 1797, at ten o'clock at night. It was ſeen next day, at Leipſic, by Rudiger. It was

ſeen

seen also by various astronomers in other places. It passed the earth six times nearer than the sun, which was the cause of its apparent motion being very rapid. It was small, appeared only like a faint white spot, and had no tail. Zach, at Gotha, makes the number of the comets now known to be 90.

One of the most difficult labours of astronomy is what relates to the stars. Their immense number indeed is sufficient to deter any one from the task of numbering them; for those which we see, and we are far from seeing them all, may be estimated at more than a hundred millions. Many of these it is well known have peculiar motions, some of which are very considerable. It is to them, however, that we are obliged to refer all the motions of the sun, the planets, and the comets. It is of importance then to endeavour to determine the motions of the stars; and this object has at all times engaged the attention of astronomers. Maskelyne has determined with the utmost precision the position of 34 stars. Zach has accomplished the same thing in regard to 1200. Lalande, with his nephew and niece, have undertaken a labour far greater, to determine the position of more than 40,000 stars, from the arctic pole to the tropic of capricorn. This sublime task is already very much advanced, as the positions of 42,700 are already known.

Hydrostatics.—Venturi has made interesting experiments on the lateral efflux of fluids. He shews that the efflux is more considerable, when a pipe, rather a little long, is adjusted to the aperture of the vessel, than when there is no pipe, or only one that is short. Thus, when one wishes to draw wine, the jet will be more considerable by putting a cock into the aperture of the cask, than if there were no cock; and if the cock be some inches in length, the quantity that flows out will be greater than if it were very short.

It is well known, that when small bits of camphor and other substances, such as the juice of the euphorbium, are placed upon water, they appear agitated in a very remarkable

able manner. Romieu ascribed this phenomenon to electricity, but Volta has proved that electricity has no connection with it. Lichtenberg was of opinion, that camphor, losing a great deal by evaporation, continually decreases in bulk, and that these small fragments of it change their configuration, which makes a variation in their respective attractions. Volta thinks that the vapours which exhale from these bodies strike the air and the water with sufficient force to cause the moleculæ, from which these vapours are exhaled, to be agitated as above mentioned.

Brugnatelli has convinced himself that this phenomenon takes place with all substances that contain much essential oil, such as the leaves of laurel, sage, thyme, vanilla, the nutmeg-tree, the *rhus toxicodendron* (the poison oak), the *rhus vernix* (the poison-ash). He found also that small bodies which did not move on the water acquired that property after being impregnated with essential oil. A piece of bread, for example, rubbed against a piece of lemon-peel and impregnated with essential oil of lemons, moved, after being placed upon water a little warm.

These experiments prove that it is jets of essential oil thrown out with rapidity from these bodies, which make them move on the water. These jets experience a resistance from the air and the water, as a lighted rocket experiences a resistance from the air by which it is made to ascend; that is to say, in a direction opposite to the jet of the flame.

Venturi, who repeated all these experiments, made several small sticks of camphor, which he placed on water, adding to them a bit of lead by way of ballast. They all moved as usual; but he observed them become a little smaller above the surface of the water, and at length break in two. This effect is more speedy if the water be a little warm, and is occasioned by the continual evaporation of the parts.

Botany.—Though the number of plants is so considerable, being estimated at about twenty thousand, that the most retentive memory can scarcely remember their names, the ardour for this branch of science does not seem to decrease.

La Billardiere, who went round the world with d'Entrecafteaux, brought back with him a valuable collection in every part of natural hiftory. His herbal is moft beautiful; and though nearly one fourth of it has been loft, he has ftill about three thoufand plants, of which from twelve to fifteen hundred are new.

He carried with him from the Friendly Ifles twenty-two bread-fruit-trees, twelve of which were left at the Ifle de France. Of the eight brought to France, five died; two have been fent to Cayenne; and the other was brought to Paris, where it is now in the *Jardin des Plantes.*

La Billardiere brought with him alfo about three hundred birds, a third of which almoft are unknown. His collection of infects has been much damaged; but he has ftill a great many in fufficient prefervation to be defcribed. Riché, who went on the fame expedition, brought with him a variety of objects, and particularly birds. He died not long ago.

Michau has returned from South America, and brought with him a great number of plants in excellent prefervation. He will no doubt foon publifh an account of them, as well as of thofe which he brought from Perfia.

Coulomb having ordered fome poplars to be cut down in the fpring time, obferved, that when the axe approached the centre of the tree, a very large quantity of air was difengaged, but that none was difengaged when the inftrument attacked the other parts of the tree. It is well known that the *medullary part*, in which the air circulates particularly, is fituated towards the centre. From this medullary part proceed thofe tranfverfal veffels which extend to the bark of the tree for the circulation of the air. The plant contains alfo other veffels for the circulation of the fap and of all the vegetable juices. There are alfo glands where the fecretion of all thefe different liquors is performed to produce the *propolis, pollen, &c.* A vegetable, therefore, in the fimpleft cafe, may be confidered as an affemblage of feveral pliable elaftic fibres,

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composing a great number of vessels of different calibres, in which water, air, and various kinds of fluids drawn from the bosom of the earth and the atmosphere, circulate.

Light also has a great iufluence on vegetation. Humboldt has shown that the light of a lamp may, in this respect, supply that of the sun; and that plants which receive the light of a lamp are coloured green, as if they received that of the sun. Excess of light hurts plants, especially when they begin to rise.

According to Ingenhouz, plants suffer oxygen to be disengaged in the light, and the carbonic acid in darkness. Senebier is of opinion that the latter changes the oxygen into the carbonic acid, by furnishing it with carbon.

Humboldt has observed that mushrooms furnish hydrogenous gaz in the day, as well as the night-time.

MEDICINE.—The carbonate of barytes and pure caustic barytic earth are most active poisons. Pelletier killed several dogs by making them take from twelve to eighteen grains of these substances.

Mankind have been long employed in attempting to discover means for the prolongation of life. Valli, after laying down principles well known, viz. that old age comes on naturally, because the calcareous phosphate or calcareous carbonate is continually accumulating in the greater part of the solids, such as the bones, the arteries, veins, tendons, &c. says, that this accumulation can be guarded against only two ways; either by preventing that substance from being formed in the mass of the fluids, or by expelling it as soon as it is formed.

1. To prevent too abundant a production of that earth, one must use aliments which contain the least quantity of it, such as vegetables, milk, fish (but fishes contain a great deal of the phosphoric acid).

2. The means which he thinks most proper for expelling that calcareous earth, or calcareous phosphate, are, bathing, frictions, diuretics, pure water, and beverages cooled

with

with ice. In ſhort, he conſiders the oxalic acid given in ſmall doſes as the beſt remedy. That acid, ſays he, decompoſes the calcareous phoſphate : the oxalate of lime which thence reſults will be carried into the torrent of circulation, and will be driven outwards.

Vauquelin and Brogniard have proved that the acetic acid diſſolves the vegetable gluten and the animal fibres.

It is well known that there is a diſeaſe called by noſologiſts *malacoſteon*, or *mollities oſſium*, where the bones become entirely ſoft. The calcareous phoſphate is almoſt entirely carried away, and there ſcarcely remains any thing but the cellular tiſſue of the bones, with the gelatinous and greaſy part, or the marrow. Were it poſſible to find out the means of diſſolving, gradually, in this manner the calcareous phoſphate, without depriving the bones of their ſolidity, and without hurting the other animal functions, the fountain of youth would be diſcovered. It appears therefore that it may not be altogether impoſſible to retard age at leaſt.

PHYSIOLOGY.—Spallanzani having deſtroyed the eyes of bats and ſet them at liberty in an apartment, obſerved that they could guide themſelves from one place to another as before. They avoided every obſtacle that was preſented to them, and even paſſed through rings which he placed before them : and for this reaſon he aſks, " May not theſe animals poſſeſs a ſenſe with which we are not acquainted, and which may ſupply that of ſight ? or, May not ſmell be ſufficient for that purpoſe ?"

Jurine is of opinion that it is hearing which ſupplies the above want. He filled with wax one of the ears of thoſe animals which he had deprived of ſight, and he obſerved that they flew about with difficulty : when he filled both their ears, they could not fly at all.

[*To be continued.*]

XIV. *An Account of two singular Meteors.*

A LUMINOUS body was observed in the canton of Calvire, on the evening of the 8th of March last. It appeared to direct its course from the east to the west, traversing the heavens from Calvire to Mont-d'Or, where it fell. It made itself be distinguished in its course by a noise like that of a long and violent discharge of musketry. Lalande has published the following note respecting these singular meteors:

"One frequently observes," says he, "globes of fire in the atmosphere. I have mentioned above 36 instances of that kind in the *Connoissances des Temps* for the year 1779. That observed on the 18th of Ventose (March 8) in the department of Ain, at seven in the evening, was attended with some singular circumstances. The heavens were serene, and a large globe, as big as the moon, was seen to proceed from the east, and to advance with a rapid motion towards the west. It was followed by a train of light, the rays of which, collected into bundles, were terminated by small globes. Six or seven sprigs of stars were seen on each side of the train. At the end of some seconds there was an explosion like a lengthened clap of thunder, or the loud report of a cannon. This meteor diffused such a light that day seemed to have returned, and people in dark apartments could see each other.

"This globe was at such a distance, that it could be seen, at the same time, in places seven or eight leagues asunder. A description of it was sent to me by citizen Riboud, at Josseran, and citizen Langeron, at Thorsey. Had it been at a greater distance, it would have appeared only like those falling stars which are observed so frequently. The common cause of these phenomena appears to be hydrogenous gas, set on fire, by some means, in the atmosphere."

On the 25th of March the following curious phenomenon was observed at Niort: Between the hours of six and eight in the morning the sun appeared accompanied by two radiart circles refembling two other funs, one on the right and the other on the left, and which with the real fun as a bafe feemed to compofe a triangle. Thefe two fupernumerary funs were fo exceedingly bright, that it was impoffible to keep the eyes fixed on them for any length of time. They difappeared gradually; that on the eaft difappeared firft, and at the end of two hours they were both invifible.

The wind for ten days had been E.N.E., and a cold much greater than ufual for the feafon had fome days before fucceeded mild weather accompanied with a little rain. On the 18th of March the mercury in the barometer had fallen to 26,8. On the 20th of the fame month there were feveral heavy fhowers of large hail at different times. On the 24th the electrical machine emitted very ftrong fparks almoft without being folicited; and at the time when the phenomenon appeared, a few clouds fcarcely perceptible were to be feen in the high regions of the atmofphere.

Phenomena of the above kind, though not frequent, have been feen at different periods. Auguftine takes notice of two mock funs which were feen before the chriftian æra, Zonaras mentions two feen after the death of Chrift, Palmerius three feen in 1466, Surius three funs, i. e. two parhelia feen at Wirtenberg in 1514, Fromundus three funs feen in 1619, Cardan three at Venice in 1532.

In Britain, if we may credit our old chronicles, five funs were plainly feen at one time, and a great diftance from one another, in the year 346: three were feen in 812; three in 953; and five in 1233. Lilly mentions three feen on the 19th of November, 1644; and three feen on the 28th of February, 1648. A moft remarkable phenomenon of this kind, where five parhelia were feen at once, is mentioned in the 8th volume of the New Tranfactions of the Imperial Academy at Peterfburg; an account of which, with an engraving, will be given in a fubfequent number.

XV. *On a new Acid procured from Animal Subſtances, called the Zoonic Acid.* By Mr. BERTHOLLET. *From the* Annales de Chimie, *Vol. XXVI.*

THE liquid procured by diſtillation from animal ſubſtances has appeared hitherto to contain only carbonate of ammoniac and an oil; but I have found in it an acid, to which I have given the name of the *zoonic acid.* I obſerved this acid in the liquid obtained from the gluten of wheat, the yeaſt of beer, bones, and woollen rags, diſtilled for the preparation of the muriate of ammoniac. I think myſelf therefore authoriſed to conſider it as produced by the diſtillation of all animal ſubſtances.

To ſeparate this acid, I mix quicklime with the diſtilled liquid after having ſeparated the oil, and then boil or diſtil the mixture. The carbonate of ammoniac is exhaled; and when the odour ceaſes to be ſharp (*piquant*), I filter, and add a little quicklime to the liquid, which I boil again, till the ſmell of the ammoniac goes off entirely. What remains is zoonate of lime, which I filter again. I then pour upon it water impregnated with carbonic acid, or I blow into the liquid with my mouth, through a tube, in order to precipitate, by the carbonic acid of the reſpired air, the quicklime which may be held in ſolution without being combined. Zoonate of lime may therefore be employed to effect combinations by complex affinities; but to obtain the zoonic acid pure I make uſe of the following proceſs: I mix the ſolution of zoonate of lime in water, made pretty ſtrong (*rapprochée*) in a tubulated retort with the phoſphoric acid; I then diſtil it. The diſtillation, as the zoonic acid has very little volatility, requires a degree of heat nearly equal to that of boiling water. The liquor muſt then be made to boil. If two veſſels be adapted, one after the other, nothing will paſs into the ſecond. It appears that a part of the acid is deſtroyed by the action of the heat; for the liquid which

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is in ebullition becomes brown, and grows black at the end of the operation. It may thence be concluded that this acid contains carbon. I have not been able to collect the other principles which are disengaged during the decomposition.

The zoonic acid has an odour like that of meat when frying, and is indeed formed during that process. It has an austere taste. I have been able, as yet, to make on this acid only a small number of experiments, which exhibited no remarkable property. It gives a strong red colour to paper tinged with turnsol, and produces an effervescence with alkaline carbonates. It did not appear to me to produce with alkaline and earthy bases salts which crystallize. It forms a white precipitate in a solution of acetite of mercury in water, and in that of the nitrate of lead; so that it has more affinity with the oxyde of mercury than the acetous acid, and with the oxyde of lead than the nitric acid. It acts on the nitrate of silver only by complex affinity; and the precipitate it then forms grows brown with time, which shews that this precipitate contains hydrogen. The zoonate of potash calcined did not form prussiate of iron with a solution of that metal. A liquid, which had all the indications of acidity, separated from flesh which I kept a long time in a state of putrefaction, but it was an ammoniacal salt with excess of acid: this acid combined with lime appeared to me like zoonate of lime; but I had too little of it to establish exactly its identity with the zoonic acid.

XVI. *Biographical Memoirs of the late* Peter Nieuwland. *From his Eloge read at Amsterdam, Nov. 24, 1794, in the Society* Felix Meritis.

Peter Nieuwland, professor of mathematics and natural philosophy in the university of Leyden, was born at Diemermeer, a village near Amſterdam, on the 5th of November, 1764. His father, by trade a carpenter, having a great fondneſs for books, and being tolerably well verſed in the mathematics, inſtructed his ſon himſelf till he attained to his eleventh year. Young Nieuwland appears to have diſplayed ſtrong marks of genius at a very early period. When about the age of three, his mother put into his hands ſome prints by John Luiken, which had fifty verſes at the bottom of them by way of explanation. Theſe verſes ſhe read to him aloud, without any intention that her ſon ſhould learn them; and ſhe was much ſurpriſed ſome time after to hear him repeat the whole from memory with the utmoſt correctneſs, on being only ſhewn the prints. Before he was ſeven years of age he had read more than fifty different books, and in ſuch a manner that he could frequently repeat paſſages from them both in proſe and in verſe. When about the age of eight, Mr. Aeneæ at Amſterdam, one of the greateſt calculators of the age, aſked him if he could tell the ſolid content of a wooden ſtatue of Mercury which ſtood upon a piece of clock-work. "Yes," replied young Nieuwland, "provided you give me a bit of the ſame wood of which the ſtatue was made; for I will cut a cubic inch out of it, and then compare it with the ſtatue." Poems which diſplay the utmoſt livelineſs of imagination, and which he compoſed in his tenth year, while walking or amuſing himſelf near his father's houſe, were, though written at ſo tender an age, received with admiration and inſerted in different poetical collections.

Such an uncommon genius muſt ſoon burſt through thoſe obſtacles which confine it. Bernardus and Jeronimo de Boſch, two of the firſt and wealthieſt men at Amſterdam, became young Nieuwland's benefactors, and contributed very much to call forth his latent talents, and to enable the powers of his mind to expand. He was taken into the houſe of the former in his eleventh year, and he received daily inſtruction from the latter for the ſpace of four years. While in this ſituation he made conſiderable pro-

greſs

grefs in the Latin and Greek languages, and he ftudied philofophy and the mathematics under Wyttenbach. In the year 1783 he tranflated the two differtations of his celebrated inftructors, Wyttenbach and de Bofch, on the opinions which the ancients entertained of the ftate of the foul after death, which had gained the prize of the Teylerian theological fociety.

From the month of September 1784 to 1785, Nieuwland refided at Leyden as a ftudent in the univerfity, and afterwards applied with great diligence, at Amfterdam, to natural philofophy and every branch of the mathematics, under the direction of Profeffor van Swinden. In thefe purfuits, indeed, he had fcarcely any occafion for a mafter; for he poffeffed the peculiar talent of uniting different fciences, and of comprehending their principles with the utmoft facility. He had fcarcely begun to turn his attention to chemiftry, when he made himfelf mafter of the theory of the much-lamented Lavoifier, and could apply it to every phenomenon. He could read a work through with uncommon quicknefs, and yet retain in his mind the principal part of its contents.

Nieuwland's attention was directed to three principal purfuits: poetry, the pure mathematics, and natural philofophy. In the latter part of his life he added to thefe alfo aftronomy. Among the poems which he publifhed, his Orion alone has rendered his name immortal in Holland. Of the fmall effays which he publifhed in his youth, the two following are particularly deferving of notice: 1. *A comparative view of the value of the different branches of fcience*; and 2. *The beft means to render general, not learning, but foundnefs of judgment and good tafte.*

One of his great objects was to bring the pure mathematics nearer to perfection, to amend many faults in them, to clear up and connect their different parts, and in particular to apply them to natural philofophy and aftronomy. Cornelius Douwes difcovered an eafy method of determining the latitude of a place at fea, not by the meridian altitude of the ſun, but by two obſervations made at any other period of the day. This method, however, being ſtill imperfect, Nieuwland turned his thoughts towards the improvement of it, and in the beginning of the year 1789 wrote a paper on the ſubject, which he tranſmitted to M. de Lalande at Paris, from whom it met with great approbation. In the year 1792, when Nieuwland reſided two months at Gotha with Major von Zach, theſe two learned men often converſed on this method of finding the latitude, and calculated the reſult of obſervations which they had made with a ſextant and an artificial horizon. The above paper, enlarged by theſe obſervations, was inſerted by Major von Zach with Nieuwland's name in the firſt Supplement to Bode's Aſtronomical Almanack, Berlin, 1793.

The above, however, was not the only ſervice rendered by this learned man to aſtronomy. Newton was the firſt philoſopher who ſpoke of the mutual attraction of the heavenly bodies, and who explained the laws of this attraction from mathematical principles. D'Alembert, Euler, and Clairaut brought ſtill nearer to perfection what Newton had not ſufficiently illuſtrated, and deſcribed the motion of the moon, the mutual effect which the planets have on each other, the perturbations that muſt thence be produced in their courſes and the periods of their revolutions, and alſo the laws to which theſe perturbations are ſubject. There however ſtill remained to be explained ſome irregularities in the phenomena of the planets, and that ſlow variation which takes place in the inclination of the ecliptic. De la Place alſo made ſome very accurate calculations on this ſubject. All theſe great men adopted a truth, which they knew only from obſervations, that the axes of the planets do not ſtand perpendicular, but inclined to the plane of their orbits. The axis of the earth, for example, makes with the plane of its orbit, that is, with the ecliptic, an angle of almoſt ſixty-ſix degrees and a half, and this inclination alone produces the ſeaſons; whereas, if the axis of the earth ſtood perpendicular, we ſhould continually have the ſame ſeaſon, and the days and the nights always equal. The cauſe, however, of this inclination was ſtill unknown to all the great aſtronomers. Du Sejour ſays, in his analytical treatiſe on the apparent motion of the heavenly bodies, that it is highly probable that this phenomenon depends on ſome phyſical cauſe; but he does not venture to mention it. Nieuwland proceeded farther. He laid down principles from which he drew this concluſion, that the above phenomenon is intimately connected with the whole ſyſtem of attraction. On theſe principles he made calculations, the reſult of which was exactly equal to the angle of the inclination of the earth's axis to the plane of its orbit. Nieuwland communicated his diſcovery with much modeſty to the celebrated Profeſſor Damen at Leyden, who propoſed ſome objections to it which diſcouraged Nieuwland, and induced him to reviſe his calculations with more accuracy. Major von Zach tranſmitted the paper which contained them to M. De la Place at Paris, and cauſed it to be printed alſo, for the opinion of the learned, in the Supplement to Profeſſor Bode's Aſtronomical Almanack for the year 1793.

Nieuwland's talents and diligence ſoon recommended him to the notice of his country. When in his twenty-ſecond year, he was appointed a member of the commiſſion choſen by the College of Admiralty at Amſterdam for determining the longitude and improving marine charts. On this labour he was employed eight years, and undertook alſo to prepare a nautical almanack, and to calculate the neceſſary tables. The mathematical part was in general entruſted to Nieuwland; but he aſſiſted alſo his two colleagues van Swinden and van Keulen, in the departments aſſigned to them, with ſuch aſſiduity, that moſt of the work publiſhed on the longitude, together with the three additional parts, were the fruits of his labour. In the ſecond edition of the explanation of the nautical almanack, he had alſo the principal ſhare, and he was the author, in particular, of the explanation of the equa-

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tion of time, the method of determining the going of a timepiece, and of calculating the declination of the moon.

Soon after Nieuwland engaged in this employment it appeared as if his deſtination was about to be changed. In the year 1787 he was choſen by the States of Utrecht to ſucceed Profeſſor Hennert; but on account of certain circumſtances this appointment did not take place. He was however invited to Amſterdam by the magiſtrates of that city, to give lectures on the mathematics, aſtronomy, and navigation. While in this ſituation he wrote his uſeful and excellent treatiſe on navigation, the firſt part of which was publiſhed at Amſterdam in 1793, by George Hulſt van Keulen; and it is much to be wiſhed that M. van Swinden would complete this work from the papers bequeathed to him by his deceaſed friend the author.

In aſtronomical purſuits, Nieuwland applied not only to the theoretical but alſo to the practical part; and in this ſtudy he was encouraged and aſſiſted by Major von Zach, with whom he reſided ſome time in the courſe of the year 1792, after the death of his wife, and who inſtructed him in the proper uſe of the ſextant. This affectionate friend publiſhed alſo all his obſervations and calculations in the beforementioned Supplement to Bode's Aſtronomical Almanack.

In the year 1789 Nieuwland was choſen member of a learned ſociety whoſe object was chemical experiments; and ſo apt was his genius for acquiring knowledge, that in a little time he made himſelf completely maſter of the theory of chemiſtry. A proof of this is the treatiſe which he read on the 24th of May 1791, in the ſociety diſtinguiſhed by the motto of *Felix Meritis*, and which has been printed in the firſt part of the New General Magazine (*Niew Algemeen Magazyn*). At the ſame time he was able to examine the important diſcoveries made by the ſociety, to aſſiſt in preparing an account of them for the preſs, and to publiſh them with ſufficient accuracy in the French language. Three parts of this work appeared under the title of *Recherches*

Phyſico-

Physico-chymiques. The first part appeared in 1792, and was afterwards re-printed in the *Journal de Physique.* The second was published in 1793, and the fourth in 1794. Some letters of his on chemistry may be found also in the Messenger (*Letterbode*).

This ingenious and diligent man was of great service also in the philosophical department to the above society, *Felix Meritis*, of which he was chosen a titular member on the 25th of January 1788, and an honorary member on the 15th of March 1791. The papers for which it was indebted to him are as follows :—1. *On the newest discoveries in astronomy, and the progress lately made in that science*, 1788. This is an extract from a Latin oration which he intended to have delivered at Utrecht when he expected to succeed Professor Hennert.—2. *On the figure of the earth*, 1789.—3. *On the course of comets, and the uncertainty of the return of the comet now expected*, 1790.—4. *On the nature of the mathematics.* The principal object of this paper was to illustrate the idea, that the mathematics may be considered as a beautiful and perfect language.—5. *On the periodical decrease or increase in the light of certain fixed stars, and particularly of the star Algol*, 1790.—6. *On the solution of spherical trigonometry by means of a new instrument invented by Le Guin*, 1791. M. le Guin having transmitted to the College of Admiralty at Amsterdam an instrument which might be used with great advantage in trigonometrical operations, and by which, in calculating the longitude, one could deduce the real from the apparent distance, the Admiralty charged Nieuwland to examine this instrument; and he found that it might be of excellent service for the above purpose.—7. *On the relative value or importance of the sciences*, 1791.—8. *On the system of Lavoisier*, 1792.—9. *On the Selenotopographia of Schröder*, 1793.—10. *On what is commonly called cultivation, instruction, or enlightening*, 1793.

Nieuwland had applied closely to the mathematics, astronomy and navigation for six years; during which time he made

made confiderable improvements in nautical charts, and filled up his vacant hours with the ftudy of philofophy and chemiftry. In the month of July 1793 he was invited to the univerfity of Leyden, to be Profeffor of Philofophy, Aftronomy, and the Higher Mathematics, in the room of the celebrated Damen; and the Admiralty of Amfterdam requefted him to continue his nautical refearches, which he did with great affiduity till the period of his death. The only variation which he now made in his ftudies related to natural philofophy, for with the mathematics he was already fufficiently acquainted. He applied therefore to the experimental part, and fpared no pains nor labour to become perfect in it; which would certainly have been the cafe, had he not been fnatched from fcience and his friends at the early age of thirty. He died of an inflammation in his throat, accompanied with a fever, on the 13th of November 1794.

In his external appearance, Nieuwland was not what might be called handfome, nor had he ever paid much attention to acquire that eafe of deportment which diftinguifhes thofe who have frequented polite company. His behaviour and converfation were however agreeable, becaufe he could difcourfe with facility on fo many fubjects, and never wifhed to appear but under his real character. On the firft view one might have difcerned that he was a man of great modefty and the ftricteft morality. His father was a Lutheran, and his mother a baptift; but he himfelf was a member of the reformed church, and always fhewed the utmoft refpect for the Supreme Being both by his words and his actions.

XVII. *Deſcription of M. DES VIGNES's improved Apparatus for ſaturating Water, Solutions of Mineral and Vegetable Alkali, &c. &c. with Carbonic Gas; or for making artificial Mineral Waters. Communicated by the Inventor.*

[*With a Plate,* No. IV.]

A, FIG. 1. a bottle or veſſel in which marble, chalk, or any other proper ſubſtance, is to be put with a little water. B a bottle containing ſulphuric acid, and having its neck ground to fit in the firſt bottle at C, and a cock *a* by which any quantity of the acid can be introduced to the chalk or other ſubſtance. As the gas is extricated, it paſſes through the tube D into the veſſel E, which contains the liquid to be ſaturated: the gas by its elaſticity preſſes the liquor, and forces it through the tube F into G. At H is a ſmall hollow glaſs ball I with a ſtem ground to fit the mouth of the veſſel G, which it ſhuts as a valve by the preſſure of the liquor, aſſiſted with a ſpiral ſpring, until the water or other liquid, which has been forced through the tube F into G, preſſes down by its weight the ball I, and returns back into E. When it accumulates to a certain point in E, the valve is again ſhut, and it riſes through the tube F as before.

At *b* is a ſtopper to which hangs a ſmall weight, about half an ounce, which acts as a ſafety valve to prevent the preſſure from reaching that point which would endanger the burſting of the veſſels.

The advantage which this apparatus poſſeſſes, is, that it not only gives the ſame preſſure of the gas upon the ſurface of the liquor to be impregnated, which the common machines do, but, by the conſtant agitation which is kept up, by the aſcent and deſcent of the fluid, continually expoſes a freſh ſurface of it to its action: by which means water or other liquors may be as fully ſaturated in two hours as they can in twelve, by any apparatus in common uſe.

Fig. 2 is a ſection of the valve ball I, the ſpiral ſpring K, and

and the cork L, to which the two former are faſtened. At *c* is a piece of lead, which ſerves at the ſame time to adjuſt the weight of the ball, and to keep it in an upright poſition.

Fig. 3 is a plan of the cork, ſhewing the apertures through which the liquor deſcends. The tubes D and F are each in two parts, joined by pieces of elaſtic gum, by which means the apparatus admits of being moved without danger of breaking. There is alſo a glaſs rod *e* in the veſſel A for the purpoſe of ſtirring the materials. This rod paſſes tight through a piece of gum elaſtic (the mouth end of one of the common bottles made of that ſubſtance), the other end of which is fitted cloſe to the mouth of the veſſel A, by means of wire or catgut wound round it, to prevent the eſcape of the gas.

XVIII. *Extract from a Memoir by Profeſſor* KLAPROTH, *on a new Metal called Tellurium, read in a public Sitting of the* Academy of Sciences at Berlin, *Jan. 25th*, 1798.

PROFESSOR Klaproth, on ſubjecting to a chemical analyſis the ore of the auriferous mine known under the denomination of the mine of white gold, *aurum paradoxum, metallum vel aurum problematicum**, found in that mineral a metal abſolutely different from any hitherto known, and to which he gave the name of *tellurium*, as a companion to the *uranium* and *titanium*, new metals diſcovered ſome time ago by the ſame chemiſt. M. Muller of Reichenſtein had, ſo early as 1782, ſuſpected that this ore contained a peculiar metallic ſubſtance, and his ſuſpicion was confirmed by Bergman, to whom he had ſent ſome of the ore; but on account of the ſmall quantity with which he had made his experiments he would not venture to decide, whether it contained a new

* This ore is found in the mine called *Mariahilf* in the Fatzbay mountains near Zalethna in Tranſylvania. See Emmerling *Elemens de Mineralogie*, t. xi. p. 124.

metal,

metal, or whether what had been taken for a particular kind of metal might not be only antimony. The repeated and ingenious experiments made by M. Klaproth on a more confiderable quantity of the ore, which had been tranfmitted to him by M. de Reichenftein, fully confirmed the conjectures of the latter as well as thofe of Bergman.

Procefs for obtaining the Metal from the Ore.

1. The ore is gently heated with fix parts of the muriatic acid; three parts of the nitric acid being then added, the mixture is boiled; upon which there arifes a very confiderable effervefcence, and a complete folution is obtained.

2. The filtered folution is diluted with as much water as it can bear without becoming turbid, which is a very fmall quantity, and a folution of cauftic potafh is then added to the liquor, until the white precipitate which is at firft formed difappears again, and nothing remains but a brown flaky fediment.

3. This laft precipitate is the oxyde of gold mixed with the oxyde of iron, and a feparation is effected by the common means.

4. The muriatic acid is added to the alkaline folution (2) in fufficient quantity to faturate the alkali entirely: an excefs of the acid muft be avoided. A white precipitate, which, by heat, fettles at the bottom of the veffel under the form of a heavy powder, is produced in great abundance. After the precipitate has been wafhed and dried, it is formed into a kind of pafte with a fufficient quantity of any fat oil; and this mafs is put into a fmall glafs retort, to which a recipient is flightly fitted. When this arrangement is made, it is gradually brought to a red heat; and in proportion as the oil is decompofed, there are obferved, as in the diftillation of mercury, brilliant and metallic drops which cover the upper part of the retort, and which, at intervals, fall to the bottom of the veffel, and are immediately replaced by others. After it has cooled, metallic fixed drops are found adhering to the fides of the retort and at the bottom of the veffel, and the remainder

remainder of the metal reduced and melted with a brilliant ſurface, and almoſt always cryſtallized.

Eſſential characteriſing Marks of this new Metal.

1. It has the white colour of tin, approaching to the grey colour of lead. Its metallic ſplendour is conſiderable, and its fracture laminated. It is highly brittle and friable. By ſuffering it to cool quietly and gradually, it readily aſſumes a cryſtalliſed ſurface.

2. Its ſpecific gravity is 6.115.

3. It belongs to the claſs of the moſt fuſible metals.

4. When heated by the blow-pipe upon charcoal, it burns with a very lively flame of a blue colour, inclining at the edges to green. It is ſo volatile as to riſe entirely in a whitiſh grey ſmoke, and exhales a diſagreeable odour like that of radiſhes. On ceaſing to heat it, without having entirely volatiliſed the ſmall portion ſubjected to this operation, the button which remained, retained for a long time its liquidity, and, by cooling, was covered with a radiated vegetation.

5. This metal amalgamates eaſily with mercury.

6. With ſulphur it forms a grey ſulphure of a radiated ſtructure.

7. A ſolution of it in the nitric acid is tranſparent and colourleſs. When concentrated, it produces, in time, ſmall white light cryſtals, in the form of needles, which exhibit a dendritic aggregation.

8. The new metal diſſolves in the nitro-muriatic acid. When a large quantity of water is added to ſuch a ſaturated ſolution, the metal is precipitated in the ſtate of an oxyde, under the form of a white powder, which, in this ſtate, is ſoluble in the muriatic acid.

9. By mixing cold, in a well-ſtopped veſſel, a ſmall quantity of this metal with a hundred times its weight of concentrated ſulphuric acid, the latter gradually aſſumes a beautiful crimſon red colour. By means of a ſmall quantity of water added, drop by drop, the colour diſappears, and the

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ſmall quantity of the metal diſſolved, depoſits itſelf under the form of black flakes. Heat deſtroys the ſolution: it makes the red colour diſappear, and diſpoſes the metal to ſeparate in the ſtate of a white oxyde.

10. When, on the other hand, the concentrated ſulphuric acid is diluted with two or three parts of water, and a ſmall quantity of the nitric acid has been added, a conſiderable quantity of the metal will then be diſſolved. The ſolution is tranſparent and colourleſs, and is not decompoſed by the mixture of a larger quantity of water.

11. All the pure alkalis precipitate from acid ſolutions of this metal an oxyde, of a white colour, ſoluble in all acids: by an exceſs of alkali, the precipitate which is formed is entirely re-diſſolved. If carbonate be employed inſtead of pure alkali, the ſame phenomenon takes place—with this difference, however, that, by exceſs of the latter, the precipitate formed is re-diſſolved only in part.

12. Exceedingly pure pruſſiate of potaſh produces no precipitate in ſolutions of this metal.

13. Alkaline ſulphures mixed with acid ſolutions occaſion a brown or blackiſh precipitate, according as the metal is combined with more or leſs oxygen. It ſometimes happens that the colour of the precipitate has a perfect reſemblance to mineral kermes, or red ſulphurated oxyde of antimony.

When the ſulphure of tellurium is expoſed on burning charcoal, the metal burns with a blue colour conjointly with the ſulphur.

14. The infuſion of gall-nuts, combined with the ſame ſolutions, gives birth to a flaky precipitate of an Iſabella colour.

15. Iron and zinc precipitate tellurium from its acid ſolutions in a metallic ſtate, under the form of ſmall black flakes, which reſume their ſplendour by friction, and which, on burning charcoal, melt into a metallic button.

 16. Tin

16. Tin and antimony produce the ſame phenomenon with the acid ſolutions of the new metal.

The precipitate formed by the antimony proves, in a ſtriking manner, that tellurium is not a diſguiſed antimony, as has been ſuppoſed. A ſolution of tin in the muriatic acid, mixed with a ſolution of tellurium in the ſame acid, produced alſo a black and metallic precipitate.

17. The oxyde of tellurium, obtained from acid ſolutions by alkalis, or from alkaline ſolutions by acids, are both reduced with a rapidity reſembling detonation, when they are expoſed to heat on charcoal. It burns, and is volatiliſed, as has been already mentioned.

18. By heating for ſome time this oxyde of tellurium in a retort, it melts, and appears, after cooling, with a yellow ſtraw colour, having acquired a ſort of radiated texture.

19. Mixed with fat bodies, the oxyde of tellurium is perfectly reduced by the method above pointed out.

The ore of white gold of Fatzebay, *aurum* vel *metallum problematicum*, contains: tellurium 925.5, iron 72.0, gold 2.5: total 1000.0.

The graphic gold of Offenbanya contains: tellurium 60, gold 30, ſilver 10: total 100.0.

Ore from the mine known under the name of the yellow mine of Nagyag contains: tellurium 45, gold 27, lead 19.5, ſilver 8.5, ſulphur one atom: total 100.0.

Ore from the mine known by the name of the mine of grey foliated gold of Nagyag contains: lead 50, tellurium 33, gold 8.5, ſulphur 7.5, ſilver and copper 1: total 100.0.

XIX. *Some*

XIX. *Some curious Circumſtances reſpecting the two Elephants brought to Paris from the Hague. From a late French Journal.*

THE place for their reception had been long prepared. It is a ſpacious hall in the Muſeum of Natural Hiſtory, well aired and lighted. A ſtove is placed in it to warm it during the winter, and it is divided into two apartments, which have a communication with each other by means of a large door reſembling a portcullis. The encloſure round theſe apartments conſiſts of rails made of ſtrong thick beams, and a ſecond encloſure, breaſt-high, runs round them, to keep the ſpectators at ſome diſtance, and preſerve them from accidents.

The morning after their arrival theſe animals were put in poſſeſſion of their new habitation. The firſt conducted to it was the male, who iſſued from his cage with precaution, and ſeemed to enter his apartment with a degree of ſuſpicion. His firſt care was to reconnoitre the place. He examined each bar with his trunk, and tried their ſolidity by ſhaking them. Care had been taken to place on the outſide the large ſcrews by which they are held together. Theſe he ſought out, and, having found them, tried to turn them, but was not able. When he arrived at the portcullis, which ſeparates the two apartments, he obſerved that it was fixed only by an iron bar, which roſe in a perpendicular direction. He raiſed it with his trunk, puſhed up the door, and entered into the ſecond apartment, where he received his breakfaſt. He ate it quietly, and appeared to be perfectly eaſy.

During this time people were endeavouring to make the female enter. We ſtill recollect the mutual attachment of theſe two animals, and with what difficulty they were parted, and induced to travel ſeparately. From the time of their departure they had not ſeen each other; not even at Cambray, where they paſſed the winter. They had only been ſenſible that they were near neighbours. The male never lay down,

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but always ſtood upright or leaned againſt the bars of his cage, and kept watch for his female, who lay down and ſlept every night. On the leaſt noiſe, or the ſmalleſt alarm, he ſent forth a cry to give notice to his companion.

The joy which they experienced on ſeeing each other after ſo long a ſeparation may be readily imagined.

When the female entered, ſhe ſent forth a cry expreſſive only of the pleaſure which ſhe felt on finding herſelf at liberty. She did not at firſt obſerve the male, who was buſy feeding in the ſecond apartment. The latter alſo did not immediately diſcover that his companion was ſo near him; but the keeper having called him, he turned round, and immediately the two animals ruſhed towards each other, and ſent forth cries of joy ſo animated and loud, that they ſhook the whole hall. They breathed alſo through their trunks with ſuch violence, that the blaſt reſembled an impetuous guſt of wind. The joy of the female was the moſt lively: ſhe expreſſed it, by quickly flapping her ears, which ſhe made to move with aſtoniſhing velocity, and drew her trunk over the body of the male with the utmoſt tenderneſs. She, in particular, applied it to his ear, where ſhe kept it a long time, and, after having drawn it over the whole body of the male, would often move it affectionately towards her own mouth. The male did the ſame thing over the body of the female, but his joy was more concentrated. He ſeemed to expreſs it by his tears, which fell from his eyes in abundance.

Since that moment they have never been ſeparated, and they occupy together the ſame apartment. The ſociety of theſe two animals, their habits, their mutual tenderneſs, and their natural attachment, ſtill excited by the privation of liberty, will furniſh curious obſervations for the hiſtory of their ſpecies.

Theſe two elephants, which are natives of Ceylon, were brought to Holland when very young. They are about fifteen years of age. Their height is ſeven feet and ſome inches. Their tuſks, which are very ſhort, have been broken,

broken, but they will grow up again as they become older. The tail of the male hangs down to the ground: that of the female is much shorter.

XX. *Some Particulars respecting the late Embassy of the Dutch East India Company to the Court of Pekin.*

CITIZEN M. L. E. Moreau de Saint Mery has lately published, at Paris, an extract from Van Braam's Journal of the Embassy of the Dutch East India Company to the Emperor of China, in the years 1794 and 1795, one volume quarto, being the first. The second, accompanied with maps and engravings, is announced as about to appear.

The principal object of those who give an account of their travels to the public, ought to be to make known the usages, public and private manners, the legislation, arts, industry, productions, the temperature, commerce, religion, and government of those countries which they traverse.

Those of Citizen Van Braam have not been written according to this system; nor indeed could they, for the members of the embassy were hardly suffered to have any kind of intercourse with the natives. His work, as the title announces, is only a journal, containing an account of the different places through which the author passed in going from Canton to Pekin, and returning by the same route.

If this Journal, which seems to have been written only for the private satisfaction of the author, does not give an extensive and profound knowledge of China, it contains, at any rate, several details which may be useful to those who wish to collect information respecting this singular and interesting country.

There are three ways of travelling in China. By water, in vessels called yachts; by land, in palankins carried by men called coulis, or in small carriages made like wheel-barrows. The establishment of posting, and suspended carriages, are

 unknown

unknown in that country. The horſe, the moſt beautiful and uſeful animal in Europe, is deſpiſed there. Buffaloes, mules, and dromedaries, are the animals principally employed for tranſportation.

In no country does agriculture flouriſh ſo much as in China. This art is there beheld with almoſt religious veneration. On this ſubject there are treatiſes, brought to perfection by application and the experience of ſeveral ages: theſe treatiſes, ſuited to the ſoil of each canton, are depoſited in the hands of the mandarin who acts as firſt magiſtrate; and he takes care that the neighbouring farmers ſhall be made acquainted with, and turn to advantage, the leſſons which theſe treatiſes contain.

Citizen van Braam ſpeaks of the monuments which he frequently met with on his route, and which he characteriſes under the name of triumphal arches, and octagonal or hexagonal towers conſiſting of ſeven or eight ſtories. He does not explain the uſe of theſe towers, which appear to be in China what obeliſks were among the Egyptians.

With regard to the triumphal arches, Citizen van Braam ſays that they are monuments erected to the memory of warriors who rendered ſervices to their country, and ſometimes to private citizens who ſignaliſed themſelves by their virtues. Some have been erected alſo to young women and wives: to the former on account of their chaſtity, and to the latter on account of their fidelity.

If perpetual virginity could be made to accord with nature, it would be no great merit in China to devote one's ſelf to it; for the manner in which women are there treated, is not much calculated to awaken in young perſons of that ſex a deſire of being chaſte. Parents carry on a kind of traffic with their children. Thoſe who are ſaid to be of good birth give them in exchange for a large dowry, which they put into their own pockets: others ſell them like merchandiſe, without caring what becomes of them. The wives of the rich live in perpetual confinement; thoſe of the ſecond

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order are the servants of their husbands; and those of the lower class of the people are forced to take a share in the severe labour of the men, who treat them as we treat those animals which assist us.

The emperor is revered as a god. The power of the sovereign and of a high-priest are both united in his person. The same homage is paid to the edicts which he issues, the dispatches which he signs, and the presents which come from him, as are paid to himself. That is to say, the people prostrate themselves before a piece of paper, or silk, as they do when they are in his presence. The embassadors were several times obliged to make ridiculous salutations before the remains of bad provisions, or pastry, which the emperor had sent them from his table as a mark of particular consideration and favour.

The court of Pekin presents nothing striking. The most remarkable object is the wall by which it is surrounded. All the apartments are narrow and mean, and confusion prevails in all the ceremonies, which are conducted without any order whatever.

The entertainments to which the embassadors were invited, consisted of a few breakfasts where the emperor was present. Some boiled meat, confections, pastry, a beverage called *samson*, and another called *bean-milk*, served up on tables around which the guests squatted down upon cushions, formed the chief articles at these morning collations.

It appears that the people of China make very bad cheer. The want of the pleasures of the table is not supplied by others. The Chinese spectacles consist only of a few feats of tumbling, and extemporary farces. And these spectacles even are not public. They are exhibited only in the interior part of the palace, and in the houses of some of the chief mandarins.

In this country there is no social communication among the inhabitants, who live insulated and confined to their own homes.

Though the embaſſadors remained more than a month at Pekin, Citizen van Braam ſays nothing of the manners, commerce, or monuments of that city. This will not appear aſtoniſhing, when it is known that the members of the embaſſy, like thoſe which preceded them from England, were confined to their hotel, as if they had been in priſon; that they were narrowly watched; that the letters which they ſent to ſome miſſionaries of their acquaintance were inſpected at the poſt-office; and that they never went out in order to go to court, at three or four o'clock in the morning in the middle of winter, without being eſcorted by conductors. Such is the jealouſy which the Chineſe entertain of Europeans of every deſcription, ever ſince a former emperor, expreſſing his ſurpriſe to a Spaniſh jeſuit, who had leſs cunning than his aſſociates, at the immenſe power and territory which the king of Spain had acquired in South America, was informed by the latter, that, having once gained an eſtabliſhment in the country, miſſionaries were ſent among the people to convert them to the Roman Catholic faith, after which their *ſubjugation* followed as a matter of courſe!

The people to whom Confucius preached his ſimple and ſublime morality, the people who erected temples to that philoſopher, ought to be rational in their worſhip: but they are vilified and degraded by the moſt abſurd idolatry; their pagods are filled with idols of the moſt monſtrous and whimſical figures.

If the Chineſe, however, are idolaters, they are not intolerant; for Citizen van Braam ſpeaks of a Chriſtian to whom they have erected temples, and whom they ſtyle a ſaint.

XXI. *Chemical Experiments respecting different Methods of rendering Paper and the Writing on it indestructible by Fire. By Mr. L.* BRUGNATELLI. *From* Crell's Chemical Annals *for* 1797.

OF all the subſtances I have tried, liquor of flint is that which, after a ſeries of experiments, appears to me to be the moſt incombuſtible, and the moſt proper to ſecure paper from deſtruction by fire. I dipped the ſheet of paper ſeveral times in the above liquor, freſh made, or, I daubed it ſeveral times over the whole paper with a hair bruſh, and dried it in the ſun or in an oven. Paper prepared in this manner loſt ſome of its ſoftneſs, became a little rougher than before, and acquired a lixivious cauſtic taſte. In other reſpects it was not different from common white paper. When this paper was laid upon glowing coals, it did not burn like common paper, but became red, and was converted to a coal, which however did not fall into aſhes like the coal of common paper, ſo that it might therefore be conſidered as petrified paper. This coal, however, is exceedingly friable; for, when it is taken between the fingers, or preſſed together in any manner whatever, it drops to pieces.

As the chemiſts conſider incombuſtibility as one of the principal characteriſtics of ſaline ſubſtances, I made experiments with different kinds of ſalts, to try whether they would render paper incombuſtible, like this liquid ſiliceous potaſh, which is not a ſalt, but a combination conſiſting of two ſubſtances.

I took ſeveral ſheets of common white writing-paper, and dipped each of them, in the ſame manner as I had proceeded with the above liquor of flint, in a particular ſalt, and obſerved how the different leaves withſtood the fire when thrown into it. I ſhall here give an account of my obſervations as they occurred.

No. I. *Paper dipped in nitrite of lime.*—Leaves of paper which had been ſoaked in nitrite of lime diſtinguiſhed them-

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selves neither in whiteness nor smoothness from common paper. They burnt very readily, and were reduced much sooner to ashes than common paper.

No. II. *Paper dipped in nitrite of magnesia.*—Paper dipped in this salt appeared in nothing different from common paper. It burnt as soon as it was brought near a flame, and was converted to a very black coal, which however was not so friable as the first mentioned.

No. III. *Paper dipped in nitrite of ammoniac.*—Leaves of paper soaked in nitrite of ammoniac became again moist, after they had been well dried by the heat of the sun. They burnt in the fire and produced a very friable coal, which was afterwards entirely destroyed by the flame.

No. IV. *Paper dipped in muriate of lime.*—Leaves of paper which were dipped in this salt after it had been dissolved did not appear different, when dried, from other leaves not prepared in the same manner. When put in the flame they burnt very readily, and almost in the same manner as common paper, and were converted into a somewhat white, but highly friable coal.

No. V. *Paper dipped in muriate of barytes.*—Paper dipped in this salt did not seem changed in any of its external properties. It burnt when placed over the fire, and produced a very black shining coal, which was however somewhat less friable than the two last mentioned.

No. VI. *Paper dipped in muriate of soda.*—Paper dipped in muriate of soda acquired more consistence and became rough. It burnt in a flame, and the residue was a very black dense and shining coal, not more friable than the foregoing.

No. VII. *Paper dipped in muriate of potash.*—With muriate of potash the paper became somewhat rough, but in other respects no alteration was observed. It burnt without flaming, and was converted into a very black and friable coal.

No. VIII. *Paper dipped in muriate of ammoniac.*—Paper dipped in this salt underwent no visible change. When put into the fire, it burnt and was converted to a black coal; but when

when continued in the fire it became reduced to ashes like common paper, on account of the muriate which was destroyed by the heat. This paper, then, is in nothing different from common paper.

No. IX. *Paper dipped in sulphite of magnesia.*—Paper dipped in sulphite of magnesia acquired more consistence and more toughness than it had before. When held in a flame it took fire, and was converted into a friable coal of an ash grey colour; when it was however held longer in the fire, it was converted into some grains of a very white colour, which, by the chemical test, I discovered to be sulphure of magnesia.

No. X. *Paper dipped in sulphite of alumine.*—Paper dipped in dissolved sulphite of alumine, in which it was kept some time before it was dried, suffered no visible change, except that it was a little harder. When burnt, there remained a very black coal, which was more friable than that obtained from paper dipped in liquor of flints.

No. XI. *Paper dipped in sulphite of soda.*—Paper dipped in sulphite of soda shewed no visible change. On the fire it was converted into a very bright coal, which was destroyed by the flame of a candle. It became glowing, puffed itself up, and was totally changed into sulphure of soda, which with some acids had the smell of rotten eggs.

No. XII. *Paper dipped in sulphite of potash.*—Some leaves of paper which had been dipped in dissolved sulphite of potash, imbibed this salt exceedingly well; but it afterwards burnt in the fire, and was converted to a black coal, which soon after glowed, and was then totally destroyed. It however afterwards collected itself in small particles of sulphure of potash.

No. XIII. *Paper dipped in sulphite of ammoniac.*—Paper dipped in this salt assumed, after being dried in the sun, the moistness of the atmosphere. When burnt, the residuum was a black shining friable coal, which became afterwards annihilated like the former.

No. XIV.

No. XIV. *Paper dipped in the acetite of magnesia.*—Paper dipped in this salt did not appear to be in the least changed. It burnt with a weak white flame like common paper, and was converted into a very friable ash-coloured coal.

No. XV. *Paper dipped in acetite of barytes.*—Paper dipped in this salt seemed, like the former, to have undergone no visible change. It burnt with a white flame, as common paper, and was at last changed into a coal of the like kind.

From the above observations it appears, that white salts do not deprive paper of its combustibleness like the liquor of flint. Some of them also, instead of defending it from the action of the fire, tend rather to accelerate its destruction, as, for example, the sulphites. The sulphureous acid which they contain loses with the inflammable body its oxygen, is converted into sulphur, and produces a little liver of sulphur, which is destroyed at the same time with the paper by the flames.

[*To be concluded in the next Number.*]

XXII. *Report made to the Council of the Mines in Spain respecting a new Wood proper for Dyeing, called Paraguatan. By* D. DOMINIC GARCIA FERNANDEZ, *Inspector of the Mint. From the* Annales de Chimie.

IN compliance with the orders of the Supreme Council of Commerce and the Mines, I undertook a chemical examination of a wood known in Guiana under the name of Paraguatan. This examination I carried to such a length as I thought necessary for acquiring a knowledge of its nature, and of the advantages that may be derived from it in dyeing. I observed in the first place that the bark, the wood properly so called, and the leaves of the paraguatan produce different colours. The leaves, however, do not merit much attention, as they communicate only a fading and not very agreeable colour. My researches have, therefore, been directed chiefly to the bark, as that part is the most important, and my observations

vations respecting the bark may be applied also to the wood; for, though the latter produces a different colour, it exhibits almost the same phenomena as the bark.

If the bark be boiled in water, the coloured extract thence resulting, when exposed to the action of the sulphuric, muriatic and nitric acids, resists them much longer than an extract of brasil or logwood. The colour, after being destroyed by a combination of acids, may be revived by the means of alkalis.

Vinegar, lemon-juice, and tartar render this dye more brilliant, and communicate to it a fine rose colour, while these acids, on the other hand, destroy the colour of brasil and logwood altogether.

The feculæ of the bark of the paraguatan attach themselves and adhere to woollen, cotton, and silk. The colour is more brilliant on silk than woollen, and more brilliant on the latter than on cotton.

The same feculæ dried may be afterwards dissolved in alcohol, and communicate to it a tint similar to that obtained from cochineal.

By mixing alum with a highly concentrated decoction of the same substance a species of lake may be produced, but neither so lively nor so pretty as that obtained from cochineal by a like process.

The same decoction mixed with that of gall-nuts furnished me with a precipitated pigment of a weak rose-colour. An infusion of brasil or logwood, mixed with an infusion of galls, assumes a darker and browner tint; mine on the other hand became clearer by it, and assumed a delicate rose colour, or one somewhat similar.

It must indeed be acknowledged, that the dye extracted from the paraguatan has not a strength equal to that of cochineal. It is however superior to those of madder, brasil and logwood, since it resists vinegar, lemon-juice and tartar. Soap even does not destroy it so speedily as it does those of brasil and logwood.

The bark is attended with this advantage, that by employing

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it in certain quantities, and giving a ſuitable preparation to ſilk; we by theſe means may produce the various ſhades of roſe and poppy colour, which can be produced only by the carthamus or ſafflower with alkaline mixtures, after a difficult proceſs, tedious waſhings, and other embarraſſing manipulations.

By examining the external form of a piece of the paraguatan, it appears to me to be the ſame tree as that which Francis Correal ſays he obſerved in the province of Popayan*, which is not far from Guiana. The ſame author relates that this tree is different from that of Brazil; that the trunk, which is the ſize of one's thigh, is thirty or forty feet in height; that its bark is full of longitudinal grooves; that the wood when ſtripped of its bark is of a beautiful red; and that the Indians employ the wood mixed with a red earth to dye the cotton which they uſe for dreſſes.

The colour extracted from the paraguatan does not reſiſt the action of light: no colour indeed can ſtand that teſt. This colour, however, will ſtand much longer than that of braſil or logwood; but, on the other hand, theſe two trees furniſh colouring matter in greater abundance.

I conſider the paraguatan, therefore, as one of thoſe valuable productions which America furniſhes to Spain. It may be employed with advantage in the art of dyeing throughout all Europe. It is to be wiſhed that ſearch may be made for it in Popayan, and that ſome of the earth mentioned by Correal may be ſent over to us. The governor of Guiana ought alſo to collect every information poſſible that may relate to the paraguatan, and to tranſmit it to us, as well as other ſpecimens of the wood, with ſome of its leaves and flowers, in order that its ſpecies may be determined.

A knowledge of this wood begins to be extended, as I lately received a portion of its bark and of a red ſubſtance, which were brought from Guiana by an Engliſhman named Milnes. It is to be preſumed that this ſubſtance is the ſame as that mentioned by Correal in his voyages.

* Voyages aux Indes Occidentales, 1722, p. 420.

INTEL-

INTELLIGENCE.

LEARNED SOCIETIES.

FRANCE.

Prizes proposed by the National Institute, in the Sitting of Germinal 15, (*April 4th*, 1798.)

FIRST PRIZE.

VARIOUS artists have already presented several models and machines, destined for giving assistance to the highest stories of houses in cases of fire; but the Institute wishing to neglect nothing in an object of so much importance to humanity, has considered it as a duty to make it the subject of a prize.

It invites therefore ingenious men and artists to present either models or descriptions of machines, or to point out any means which may be used for giving assistance to every story of a house on fire. These means must be of such a nature, that they can be transported with facility to different quarters of a city or town; that they can be speedily erected before the house to which assistance is to be given, and that women and children may be able to descend by them from the highest stories without any danger. It is desired that these means may be as little impediment as possible to fire-engines, and to the manœuvres destined to check the progress of the flames. The competitors are requested to procure information respecting the practices followed at present, in different towns, in the like cases. They are requested also not to neglect to point out particular means which, though not generally used, may be employed in many cases; but these means must be simple, and easy to be put in practice.

The prize will be a kilogramme of gold.

The competition will take place on the 15th of Nivose, the 7th year (January 4th, 1799), and the Institute will proclaim

claim in the public fitting of Germinal (beginning of April) following, the piece which fhall have gained the prize.

Second Prize. To determine by a great number of obfervations, the beft and the moft modern which can be procured, the epochs of the longitude of the apogeum or node of the moon.

Thefe obfervations muft be at leaft five hundred in number.

The prize is a gold medal of the value of a kilogramme. The learned of all nations are invited to this competition, and they may write in any language whatever.

The works will not be received till the laft day of Frimaire, 8th year, (December 21, 1799.)

The Inftitute will proclaim the piece which fhall have gained the prize, in its public fitting of the 15th of Germinal following (April 4th, 1800).

Third Prize. To point out the earthy fubftances and proceffes proper for manufacturing earthen ware, capable of ftanding fudden tranfitions from heat to cold, and fo cheap as to be within the reach of every clafs of citizens.

This art is ftill far from being carried to that degree of improvement fo defirable for the public benefit, while fome neighbouring nations who do not make porcelain, manufacture earthen-ware exceedingly ufeful, and fuperior to that made in France. The Inftitute requefts the competitors to examine the compofition of the beft earthen-ware; the quality of thofe natural earths which may ferve to form it, or that of the artificial mixtures which might be fubftituted for it; the manner in which thefe earths ought to be managed in order to give them the neceffary properties; the art of baking; the degree of heat; the form of the requifite furnaces; and, above all, the proceffes proper for colouring and glazing without the oxydes of pernicious metals.

The competitors will remit to the Inftitute famples of the earths employed in their potteries, and the earthen-wares themfelves which have been manufactured in them.

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These ſamples of earth and pottery will be received till the firſt day of Meſſidor, the year 7 (June 18, 1799).

The Inſtitute in its ſitting of Vendemiaire 5th (Sept. 27) will proclaim the piece which ſhall have gained the prize.

Fourth Prize. To diſcover by accurate experiments what is the influence of the atmoſpheric air, light, water, and earth, on vegetation.

The prize is a gold medal of the value of a kilogramme. The works will not be received till the laſt day of Frimaire the 8th year (December 21, 1799), and the Inſtitute will proclaim the piece which has gained the prize in its public ſitting of Germinal 15, (April 4, 1800).

Claſs of the Moral and Political Sciences.

This claſs has propoſed for the ſubject of the prize of the 6th year, the following queſtion:

To determine the influence of ſigns on the formation of ideas.

The pieces received on this ſubject not having anſwered the conditions of the queſtion, though ſeveral of them contained intereſting reſearches, the claſs propoſes again the ſame ſubject for the 7th year, and invites to the competition thoſe, above all, whoſe firſt efforts have merited its attention.

The prize will be 5 hectogrammes of gold ſtruck into a medal. It will be delivered out in the public ſitting of the 15th of Nivoſe, the 9th year (January 4, 1801).

The works will not be received until the 15th Nivoſe of the 7th year (January 4, 1799).

The learned of all countries, the members and aſſociates of the Inſtitute excepted, are admitted to this competition.

Among the great number of authors who at all times have employed themſelves on the human underſtanding, there are a few only who have paid attention to the means which might augment or direct its powers. Engaged only in reſearches reſpecting its cauſes, or occupied with deſcribing its effects, they have for the moſt part been only able painters or obſcure metaphyſicians.

On the ſuggeſtions, however, of ſome men of genius, it has been found neceſſary to abandon enquiries into the firſt cauſes, and to direct our attention to the means of improving the underſtanding.

But the moſt powerful means of the progreſs of the human mind have been obſerved in ſigns.

The firſt philoſophers who turned their reflections to the characters of writing, the accents and articulations of the voice, the movements of the viſage, the geſtures and different attitudes of the body, ſaw in all theſe ſigns only means, either eſtabliſhed by nature or invented by men, for the communication of their thoughts.

A more profound examination ſhewed that ſigns were not merely deſtined to ſerve as a communication between minds. Notwithſtanding the authority of ſome great men, who conſidered them as ſhackles to the juſtneſs and rapidity of our conceptions, theſe philoſophers dared to advance that a man ſeparated from any commerce with his fellows, would ſtill have occaſion for ſigns to convey the full meaning of his ideas.

In ſhort, ſome have imagined that they obſerved in ſigns a much more aſtoniſhing ſervice rendered to reaſon; that is, that the exiſtence of the ideas themſelves ſuppoſed the exiſtence of ſigns, and that men would be deprived of all ideas if they were deprived of all ſigns.

So that they have judged ſigns neceſſary not only for the communication of ideas, for combining ideas newly acquired, and for forming new ideas, but ſtill for having firſt ideas—the ideas which proceed more immediately from the ſenſations.

If a certain influence of ſigns on the formation of ideas is a thing inconteſtable and univerſally acknowledged, the caſe is not the ſame with the degree of this influence. Here opinions are divided, and what ſome conſider as axioms, others treat as abſurd paradoxes.

The Inſtitute waits to receive memoirs, which by new reſearches, and new illuſtrations, may diſpel the uncertainties

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that obſcure this important ſubject, and be proper to unite every opinion.

It preſumes, that among the numerous queſtions which the fecundity of the ſubject of the prize may give riſe to, the author ought not to forget to anſwer the following:

1. Is it true that ſenſations cannot be transformed into ideas, but by the means of ſigns? or, what amounts to the ſame thing, Do our firſt ideas eſſentially ſuppoſe the aſſiſtance of ſigns?

2. Would the art of ſpeaking be perfect if the art of ſigns were carried to perfection?

3. In the ſciences where truth is received without conteſtation, are we not indebted for this to the perfection of ſigns?

4. In thoſe which furniſh eternal ſubject for diſputes, is not difference of opinion the neceſſary effect of inexactitude in the ſigns?

5. Are there any means of correcting ſigns badly made, and of rendering all the ſciences equally ſuſceptible of demonſtration?

Medical Society.

THE Society of Medicine at Paris had propoſed as the ſubject of the prize of 300 francs, to be adjudged this year, the following queſtion:

"What are the advantages and inconveniences of the different methods of treating the aneuriſm?" But as this queſtion was not ſufficiently explained, the ſociety decreed, in its public ſitting of Floreal 22d (May 11), that the queſtion ſhould be propoſed anew, and the prize adjudged in the public ſitting of Floreal 22d, 7th year.

It propoſed, in the ſame ſitting, as a ſubject for the prize to be adjudged on the 22d of Brumaire, 8th year,

"To determine by accurate experiments what may be the influence of oxygen in the animal œconomy, and, above all, in the treatment of diſeaſes both internal and external?"

Abstract of the Proceedings of the Class of the Physical Sciences of the French National Institute, from the 15th of Nivose last (January 4) till the 15th of Germinal (April 4).

THE papers presented to the Class of the Physical Sciences of the Institute, by its members and associates, during the above quarter, chiefly related to rural œconomy, the veterinary art, and chemistry.

Experiments lately made on horses, sheep, goats, and rabbits, prove, that these animals die speedily, and with convulsions, when they have eaten a certain quantity of the leaves or berries of the yew. Citizen Daubenton thinks that this tree is dangerous; that it ought not to be transplanted into countries which nature has preserved from it; and that it would be much better to destroy than to cultivate it.

Citizen Celly, in a memoir on the utility of employing analogy in the natural sciences, and on the application of botany to promote the progress of rural œconomy, endeavours to prove, that the properties of bodies being a consequence of their organization, the more relations there are between them, the more the uses for which they can be employed are approximated.

Citizen Gilbert shewed the necessity of subjecting all the operations of agriculture to comparative experiments, in order to enable the rural sciences to make that progress of which they are susceptible. He thinks it would be necessary to form rural establishments destined to enquire into the best processes, both for the cultivation of vegetables and the amelioration of the breeds of domestic animals.

Citizen Tenon presented a memoir, containing a comparison of the methods in which manducation is performed in man, the horse, and the elephant.

Citizen Chabert communicated reflections on a disease among horses, known under the name of immobility (*immobilité*), not yet described, and which has a great affinity with

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that known among the human ſpecies under the name of the catalepſy.

An oſſeous tumour which aroſe in the ham of a horſe, gave occaſion to Citizen Huzard to make ſome reflections on the origin of that malady, and the means of curing it, when it is treated according to its principle.

Citizen Lelievre announced that he had lately diſcovered in France *ſulphate of ſtrontian* in a ſtriated maſs. It was found, at the depth of 15 or 16 feet, in a clay pit (*glaiſiere*), which has been worked for ſome years, at Bouvron, near Toul.

Citizen Dolomieu ſhewed ſome of the *ſulphate of ſtrontian*, which he had brought with him from Sicily, and which, as well as the preceding, had been analyſed by Citizen Vauquelin.

It is well known that the nitro-muriatic acid is the true ſolvent of gold, and that this metal may be recovered from its ſolution by ſulphuric ether. Citizen Sage ſhewed a gold precipitate ſuſpended between the ether and the nitro-muriatic acid, under the form of ſmall threads or flakes, and at the bottom of the flaſk, in little brilliant maſſes, on which were obſerved triangular lamellæ, the elements of the cryſtallization of that metal.

Citizen Chaptal read a memoir on a new mode of manufacturing verdigriſe. This new proceſs, practiſed at Montpellier for ſome years paſt, conſiſts in cauſing the reſidue (*marc*) of grapes to ferment, and of putting it in layers between plates of copper, to develop the metallic oxyd, called verdigriſe.—This method is ſuperior to the old one, as it is much eaſier, and attended with leſs expence, becauſe it requires no wine.

Some experiments of the ſame chemiſt prove alſo that white lead may be made in the ſame manner.

The ſame chemiſt read another memoir on the acetite of copper, or diſtilled verdigriſe. He gave an account of ſeveral experiments to oxydate copper with more advantage, and to render it by these means soluble in the acetous acid.

Citizen Berthollet communicated a notice on a particular acid which he had discovered, and to which he gives the name of the zoonic acid, because it is extracted essentially from animal substances. (*See page* 68 *of this Number.*)

Citizen Dolomieu read a memoir on the tourmalines found in Mount St. Gothard, the object of which was to examine, how far colour, considered as a character of stone, can determine its nature?

Lastly, the new experiments of Citizen Vauquelin, on the red lead of Siberia, and the new earth which he found in the beryl, or *aigue marin*, were the subject of another memoir.

HAMBURGH.

THE society for promoting the arts and useful manufactures have proposed a prize of 40 ducats, to be given to the author of the best answer to the following question:

"What are the best means, confirmed by experience, to secure wooden work washed by the sea, such as sluices, buoys, signals for ships, &c. and even ships themselves, from being destroyed by the shell-worm (*teredo navalis*), which, as is well known, pierces through wood and hastens its decay?"

The society will consider that essay as the best, which proposes means of a cheap nature, known by experience to be effectual, and which are either as durable as the wood itself to withstand the effects of the waves and the ice, or can be renewed from time to time without inconvenience, and without injury to the works they are intended to preserve. All the means hitherto proposed for the like purpose, such as covering the wood with copper, lead, &c. are excluded from the prize; because these, besides being perishable in water, are liable to be stolen, and in many cases cannot be applied. No paper, also, can be entitled to the prize, unless the means proposed in it have been proved by experience

experience to be effectual. The society, however, will with thankfulness receive papers of this kind; the means proposed will be subjected to a trial of two years; and if they are then found to answer the purpose, a suitable reward will be adjudged to the inventor.

The essays on this subject, inscribed with a motto, and accompanied by a sealed note containing the name of the author, must be transmitted to the society before Christmas 1798.

HOLLAND.

THE members of the Teylerian second society at Haerlem have proposed the following prize question for the year 1799:

"What are the causes why most nations have made choice of metals, particularly gold and silver, as the representative signs of wealth and riches? What are the advantages of this circulating medium, so generally adopted, and what are the disadvantages connected with it? And can nothing else, equally durable, and attended with benefit and advantage, be invented in its stead?"

The premium for the best answer is a gold medal equal in value to 400 Dutch florins.

The answers in Dutch, Latin, French, English, or German, with a sealed letter containing the name of the author, must be transmitted to Teyler's foundation-house at Haerlem, before the first of April 1799; for the prize will be adjudged on the first of November, the same year.

The society have also announced, that as no answer had been sent in before the expiration of the fixed period to the prize-question of 1796, respecting the constitution and form of government of the Grecian republics, and their influence on the happiness or unhappiness of their citizens, they propose it once more in the following form:

"What influence has a republican form of government on the happiness or unhappiness of citizens? and, How far can this influence be explained and confirmed by examples drawn from the hiſtory of the ancient Greek and Roman republics?"

The ſociety require the anſwer to this queſtion to be tranſmitted in the like manner before the firſt of April 1799, that the adjudication of the prize may be made alſo on the firſt of November.

ROME.

IN conſequence of the 368th article of the Conſtitution of the new Roman Republic, the citizens who are to compoſe the members of the National Inſtitute were nominated in April laſt by the French general. It is divided into two claſſes:—that of the ſciences, mathematics and phyſic; and that of philoſophy, the belles lettres, and the fine arts. The firſt is ſubdivided into ſix ſections—The mathematics, chemiſtry, anatomy, phyſics, natural hiſtory, and agriculture; and the ſecond into ſix ſections alſo, viz. philoſophy, hiſtory and antiquities, poetry and muſic; the political ſciences, grammar and eloquence; the art of deſign.

ASTRONOMY.

Mr. Herschel has lately diſcovered four new ſatellites to his planet; ſo that there are now ſix. This diſcovery was made by a teleſcope of 30 feet, which he had conſtructed for the Obſervatory of Madrid. The firſt notice that Lalande had of this diſcovery was from Gotha, the Prince of which is fond of aſtronomy: he laments, in a ſhort notice which he publiſhed upon this ſubject, that for ſome years he has not received from Mr. Herſchel any account of his diſcoveries in the heavens.

Paris, 30 Pluvioſe, (Feb. 18.)

Mercury and Venus have been obſerved to paſs over the Sun's diſk, under the form of black ſpots; but no perſon ever before ſaw a comet in the like ſituation. Citizen Dangos, an able aſtronomer of Tarbes, on the 18th of January laſt made

made an observation of this kind. He saw, during twenty minutes, a black body, round, and well defined, cross the face of the sun, and he remembers to have seen something similar in the year 1784. LALANDE.

Paris, 2 Germinal, (March 22, 1798.)

The sun had been seen some days without any spot, but on the 29th of Ventose (March 19) there appeared a small one on its eastern limb. It had arrived there in the night-time, as well as that which was formed in the present decade. It will employ thirteen days and a half to traverse the sun's disk, according to the time of the sun's rotation, in regard to the earth, which I have determined to be 27 days 7 hours and 37 minutes. In comparing with each other the large spots visible by the naked eye in the years 1752, 1764, 1777, and 1778, I consider them to be the same spot, or at least formed at the same point of the solar globe, where there is probably a local cause which from time to time produces at the same place the same phenomenon. LALANDE.

Citizen Messier, astronomer of the National Institute, about seven in the evening on the 23d of Germinal (April 11) discovered from his observatory a new comet in Taurus, near the Pleiades, and in the parallel of the principal star of that constellation, with which it was compared at 8h. 58m. 16sec. of true time; its right ascension being 49h. 19m. 47sec. and its declination 23h. 22m. 55sec. north. Next morning, the 24th, the comet was compared again with the same star, at 8h. 25m. 46sec. Its right ascension was found to be 50h. 52m. 55sec. and its declination 25h. 18m. 58sec.

This comet, which is small, round, and brilliant, has no tail, and cannot be seen by the naked eye. On the 25th its light was increased; which seems to shew that it is approaching the earth.

This is the 20th comet which Citizen Messier has discovered ſince 1758, and the 39th which I have obſerved. The number of the comets known now amounts to 88, according to the catalogue which is given in my Aſtronomy.

LALANDE.

Francis Lalande, nephew of the aſtronomer of that name, has lately carried to 45,000 the number of the ſtars which he engaged to determine.—An immenſe labour, which no aſtronomer before ever ventured to undertake, and which was a deſideratum in aſtronomy.

Dr. Burckard, an able aſtronomer of Gotha, now at Paris, has calculated the orbit of the comet lately diſcovered. He finds that it paſſed its perihelium on the 3d of April, at 7 hours, in 3 ſigns, 12deg. 56m. at the diſtance of ,0487 from the ſun: the inclination of its orbit is 45deg. 18m. and it interſects the ecliptic at 4 ſigns, odeg. 44min.

M. de Lalande, in a letter which he lately wrote to Major von Zach, at Gotha, informs him, that the Turkiſh ambaſſador at Paris is remarkably fond of aſtronomy, and attends regularly the Lyceum, where he has a ſopha appropriated for his own uſe. His interpreter Codrika has tranſlated one of M. de Lalande's works into the Greek language. The Turks at preſent ſeem to apply with ſome attention to the cultivation of mathematical knowledge.—M. de Lalande ſays that a mathematical ſchool has been eſtabliſhed at Conſtantinople with four profeſſors, and that the number of pupils amounts to fifty. Logarithmical tables are now printing in that city, with Turkiſh types.

EARTHQUAKES.

LETTERS received from Bencoolen, Taponooly, and Padang, of the 5th and 7th of March 1797, give the following relation of an earthquake that happened on the weſt coaſt of Sumatra on the 20th of February:

The vibratory ſhocks of this earthquake are ſtated, on competent authority, to have continued for three minutes, and

and to have recurred at intervals, during a ſpace of three hours, from its beginning, till the ſhock had completely ceaſed. At Padang, the houſes of the inhabitants are almoſt totally deſtroyed, and the public works much damaged. The ſnow Padang, lying at anchor in the river, was thrown, by the ſudden riſe of the ſea, upwards of three miles in ſhore, where ſhe ſtill remains. The number of lives loſt at Padang on this melancholy occaſion exceeded 300. Of theſe, ſome were cruſhed under the ruins of falling houſes; ſome were literally entombed alive by the earth cloſing upon them; and others were drowned by the ſudden irruption of the waters of the ocean. The effects of this awful convulſion of nature do not appear to have extended to the northward of Taponooly; as at that place little or no damage was ſuſtained. It appears to have come from the ſouthward, and is ſuppoſed to have extended as far as Bencoolen; but no accounts having been received at Taponooly or Padang, from the ſouthward, between the time of the occurrence of the earthquake and the date of the letters, the extent of this calamity has not been aſcertained.

At Natal, the reſidence of a ſubordinate of Bencoolen, very conſiderable damage was ſuſtained, and ſeveral houſes thrown down, but no lives were loſt. It is however feared, when the particulars ſhall have been collected from the different quarters on the weſt coaſt, where the earthquake was felt, that the ſum, both of lives and property deſtroyed, will be found much greater than yet apprehended.

A letter from Metz, dated Ventoſe 30, (March 20) ſtates, that at ſix in the morning of the 24th a ſhock of an earthquake had been felt at Sarreguemines, Bliſcatel, and other communes of the department of la Meurthe. No preciſe obſervations were made on its direction. It was ſo violent at Bitche that it raiſed up part of the arch of the bridge, ſo as to render it dangerous to be paſſed.

A fact which ſeems to explain this phenomenon is, that the circumference where it took place contains ſeveral mines of of naphtha. One of these burns continually, like the *solfaterra* at Naples.

Some days before a flaming meteor rose from the earth, between Fey and Veron, three leagues to the south of Metz. Its disappearance was followed by a detonation which shook the atmosphere to a considerable distance around.

VOYAGES AND TRAVELS.

CITIZEN OLIVIER, who has been travelling through Persia by orders of the French government, writes from Constantinople, dated Frimaire the 18th last, that he has brought from Persia, Babylon, the deserts of Arabia, the environs of Aleppo, Cyprus, the mountains of Caramania and Asia Minor, more than two hundred seeds in good preservation; many medals of gold, silver, and bronze, Roman, Greek and Parthian; some mummies of children, and of the sacred birds of the Egyptians; some interesting manuscripts, &c. Proceeding then to the actual situation of Turkey, he concludes, from its depopulation; the great diminution of its revenues; the deserted state of its plains, which daily increases, by the oppression and impunity of the Pachas; the revolts of the latter; the mutinies and insubordination of the Janissaries, that this extensive empire is approaching to a sudden fall.

A gentleman of the name of Brown, who resided seven years in Abyssinia, is now in Egypt. He is said to have proceeded much farther west than Mr. Bruce, with whom he agrees in most points: he intends to publish an account of his travels, which no doubt will afford much information as well as amusement.

Frederick Horneman, the only son of a clergyman's widow at Hildesheim, a young man of an athletic constitution, a great mechanical genius, possessed of considerable knowledge and firmness of character, impelled with an insuperable impulse to a journey of discovery in Africa, is now on his way from Cairo over Caschna to Tombuctu. He travels at the expence of the African Association.

BOTANY, GARDENING, AGRICULTURE.

A LETTER from Mr. Anderſon, Director of the Botanic Garden of St. Vincent's, dated the 24th of December laſt, has been received by the Society of Arts, Manufactures, and Commerce, which brings very pleaſing accounts reſpecting the thriving ſtate of the bread-fruit-tree. In 1793, fifty young plants were carried from Otaheite by Captain Bligh. They were then from 6 inches to 2 feet high. They are now 30 feet and upwards, and the circumference of the ſtems from 3 to 3½ feet.

It was feared, when they were firſt carried over, that they would not have ſtrength to ſtand againſt the violent hurricanes of the Weſt Indies; but the wood is found, on the contrary, to be extremely tough, and well qualified to reſiſt the ſevereſt guſts of wind.

The bread-fruit weighs from 4 to 10lbs. each, and is in its greateſt perfection about a week before it is quite ripe. When baked, which is the beſt method of cooking it, it is equal, if not ſuperior, to bread. From its firſt appearance, it is three months before it is fit for eating.

The trees are propagated by ſuckers, which ariſe in abundance.

The Society alſo received ſome biſcuit made from the fruit, which they agreed was an excellent ſuccedaneum for bread.

Some curious experiments, which promiſe important benefits to mankind, have lately been made by Sir Francis Ford, to determine whether oxygene, or vital air, has any effects upon vegetation different from common atmoſpheric air. He found by repeated trials, that flowers, and other plants, ſprinkled with water that had been previouſly impregnated with oxygene gas, grew much more vigorouſly, and even diſplayed more beautiful tints than ſimilar plants on the ſame ground treated with common water. The water was impregnated by a very ſimple proceſs—Bottles filled with water

were

were inverted over a common pneumatic apparatus, and oxygene gas introduced till a third or fourth part of the water was difplaced: the bottles being then ftopped, were agitated for fome time till it was believed the water had taken up all the gas that it could receive.

We know not whether the refiduum of the gas has yet been fubmitted to any teft, to determine whether it undergoes a change by being thus wafhed by the water; but, no doubt, the fubject will receive that attention which it merits from thofe who have the means and opportunity of repeating and following out the experiments.

It appears to be a fubject worthy of enquiry, what would be the beft and eafieft methods for impregnating water with oxygene? or, which would be perhaps ftill better, what would be the beft fubftance to be thrown upon land to enable it, or the moifture it contains, to abforb the greateft quantity of oxygene from the atmofphere?

Some experiments have been lately made in the neighbourhood of Briftol, under the immediate infpection of one of the members of the Bath Agricultural Society, with refpect to the culture of madder; the refult of which is, that madder may be produced in large quantities in England, and fold to the dyers at a cheaper rate than that imported, being of a quality equal to that grown in Zealand. In 1756 the king of France iffued an edict, exempting from land-tax for the fpace of 20 years (that is to fay, in all fields newly broken up) all cultivators of madder in drained marfhes and other wafte and neglected grounds. In 1762 the Board of Agriculture held at Beauvais made it plain to all perfons concerned in dyeing, that madder raifed in that diftrict, and ufed while the roots were frefh gathered, gave a finer tincture than the Zealand madder, and went further in the proportion of eight to five. In the fame year it was ordered in council, that no tax, for the fpace of 20 years, fhould be levied upon grounds newly broken up, provided the faid grounds had lain 20 years in an uncultivated ftate. In 1761 there

there were 13 societies existing in France, established under the patronage of government, for promoting agriculture; and these 13 societies had 19 co-operating societies belonging to them, whenever it happened that a district was too large to be effectually taken care of by one society. All packets and letters of correspondence to and from these societies were exempted from postage.

Paris, June 22, 1798.

CITIZEN BAUDIN, commander of *la Belle Angélique*, who, with several botanists and naturalists, was some time ago sent on a voyage of discovery by government, has just returned from America, and has brought with him the richest collection of living plants ever seen in Europe. He has brought home in all 3500 exotics, among which are several cabbage trees, cocoa-nut trees, and alligator pear trees (*laurus Persea*). Some of the trees are 25 feet in height, and from 12 to 15 inches in diameter. Besides the collection of living and dried plants, he has brought with him various specimens of wood, birds, insects, and many other objects of natural history.

Captain Baudin on his arrival attempted to enter the port of Havre, as being the most convenient for transmitting his collection to Paris, but was prevented by the English squadron which blockades that port. The English commander told him his orders were such, that he could suffer no vessel to entre Havre; but, in a very handsome manner, directed him to proceed to the east of Fecamp, the only place in the channel not blockaded by the division under his command.

MINERALOGY.

A VEIN of cobalt was some time ago discovered in the Wherry mine near Penzance in Cornwall, which, we are happy to announce, has turned out very rich; but as they have no person there perfectly acquainted with the process of smelting it, it is to be feared that its true value will never be fully known. It is to be lamented that there are few or no skilful

ſkilful mineralogiſts in Cornwall; and that we have no good *practical* work in the Engliſh language to enable them to apply to further uſe, what little knowledge they have acquired from working the rich tin and copper mines in that county. Kirwan's Mineralogy is an able ſcientific claſſification and brief analyſis of the ſubjects of which he treats; but we want ſome popular works like thoſe of Profeſſor Klaproth. For want of proper books of this kind in the Engliſh language, there is reaſon to believe that many valuable mineral products are every day loſt in Cornwall; for every ſubſtance that appears not to poſſeſs the characteriſtics of the tin or copper, of which they are in ſearch, is thrown away among the rubbiſh. This was the caſe with the cobalt vein, when a gentleman of more knowledge than the proprietors happened to obſerve it.

WEIGHTS AND MEASURES.

IN the month of March laſt, Citizen Aubry preſented to the Council of Five Hundred a work containing the proportions between all the meaſures poſſible, and a ſimple method to diſcover theſe proportions. This work is conſidered in France as a certain ſtep towards an univerſal ſtandard ſo much deſired.

Sir George Evelyn Shuckburgh has lately laid before the Royal Society the reſult of many years application and ſtudy, upon the ſubject of a univerſal ſtandard for weights and meaſures. He proceeds upon the principles of the late ingenious Mr. Whitehurſt, and uſes the identical inſtruments he employed. The mean meaſure is derived from the difference in length of two pendulums performing a different number of vibrations in a minute.

THE

PHILOSOPHICAL MAGAZINE.

JULY 1798.

I. *Description of the Mechanism of a reflecting Telescope twenty-six Feet in Length, constructed near Kiel in Holstein, by Professor* SCHRADER. *From the Account, published in German, by the Professor.*

AN hexagonal frame ABCD, (Plate V.) formed of ten inch square beams, joined together, rests upon twelve strong posts driven into the ground. On the smaller hexagon of this frame stands the under part of the building *aaaa*, which rises to the height of fourteen feet, and is supported by braces or spurs. On the beams which compose the upper frame of this part of the building lies a horizontal wheel, 12 feet in diameter, which is made fast by means of iron screws. A small hexagonal cabin of the like diameter, and $7\frac{1}{2}$ feet in height, forms the moveable upper part of the whole building, to which is affixed the mechanism that serves for the motion of the telescope.

Through the middle of the small cabin arises a very strong axle *b b*, the upper part of which *b* may be seen projecting above the flat top of the cabin. At *c* the axle turns on a steel gudgeon which moves in a socket, fitted into a strong beam *d d*, moveable in a horizontal direction. This beam, by means of iron wedges used as in the Dutch windmills, can be so elevated that the whole upper part of the building may be moved upon eight rollers placed above the horizontal wheel. A small vertical cylinder *ff* proceeds along the side of the cabin down to the horizontal wheel, and at the lower end has an eighteen inch wheel *g* with twelve teeth, which fit into those of the large wheel. The small wheel, to defend it from the injuries of the weather, is inclosed in a box. To the top of this small cylinder, which rises three feet above the platform, is affixed a cross-bar lever *x x*, and the cylinder has its point of motion in a collar at *h*, in which small rollers are applied to lessen the effects of friction. By turning the cross the whole cabin moves round its axis, and the tube of the telescope I I, connected with it, is thus made to move also horizontally. The vertical movement of the tube, which was attended with considerable difficulty, is effected in the following manner: At the end of the beams *k k*, which project parallel to each other, on a level with the upper frame of the building, arise the inclined beams *m m n*, joined to the former by mortices at *o*, and morticed also at bottom into the uprights of the cabin. They are supported by strong braces, and, where necessary, are bound fast with iron screws. To prevent all lateral agitation, Professor Schrader placed at right angles on the two horizontal beams *k k*, and fastened to the cabin, another beam H of sufficient strength, each end of which projects five feet over the beams *k k*. From these ends arise two oblique beams *r z* and *s i*, each of which is morticed as at *i*, a foot and a half below the bridle *l l*, and bound also with iron.

The mechanism of the movement of the tube between this hanging frame-work is similar to that of Herschel's telescope. Along the interior part of each side of the frame-work, from *n* to *l*, is a groove (represented in the plate by pricked lines), and a strong oblong rectangular frame moves in this groove by means of four small iron rollers fixed to the corners with screws. By the cross lines *v v* the place

place of the frame only is marked. In this frame the tube is made to move on a ſtrong roller. At the upper end of the frame is ſuſpended one box of a tackle of ſix pulleys, the ſecond box of which is faſtened to the croſs beam *l l* of the hanging frame-work, and the rope *l p*, proceeding from the tackle, is wound round the cylinder of a horizontal windlaſs, the handle of which is in part viſible at *t t*. The ſecond reſting-place of the tube is in a fork on the top of an iron rack *q*, by which the more accurate movement both vertical and horizontal is effected with the greateſt eaſe. When the handle *t t* is turned round, the ſliding frame together with the tube riſes or falls, and a common ſpring catch applied to the windlaſs keeps the tube in that poſition to which it has been brought. To counteract the weight of the tube, which increaſes according to the perpendicularity of its poſition, the Profeſſor faſtened to the end of it a ſmall tackle, the rope of which, carried over a pulley fixed to the croſs beam *l l*, ſuſtains a re-acting weight of 120 pounds. This weight acts only from the perpendicular ſituation of the tube to about that in which it is repreſented in the plate. The quick horizontal movement, which is effected by means of the croſs-bar lever with the cylinder and horizontal wheel, requires a power of about forty pounds; ſo that the obſerver can, with great eaſe, turn the tube round the whole horizon, though the weight of the conſtruction taken together amounts to about 12,000 pounds.

From comparing this deſcription with the figure in the annexed plate, it will be ſeen that the gravity, both on account of the weight of the hanging frame-work and that of the tube, muſt incline too much to one ſide: it was found neceſſary, therefore, immediately after it was conſtructed, to deviſe the following counterpoiſe: The two horizontal beams G G, a foot ſquare, which ſupport the gallery F F, with the ladder that conducts to the platform, were made to project on a level with the bottom part of the cabin. The weight of the gallery and ladder cauſed a leſſening of the weight towards the oppoſite ſide; but, as this was not ſufficient, the Profeſſor made the horizontal beams to be covered with boards, by which means it acquired ſo much ballaſt that the centre of gravity of the whole top reſted on the ſteel gudgeon *c*. The ſmall balcony contains a ſeven-feet teleſcope ten inches in diameter, which the Profeſſor ſuffers always to remain in the open air, and uſes as a hand teleſcope. For the greater ſecurity, a ſtrong iron rod, concealed by the wainſcoting in the inſide, is conveyed along the floor and to the top of the cabin. The lower extremity of this rod ends in two branches ſcrewed to the floor, and the upper part riſes one foot above the platform. On the top of it is ſtuck the key which ſerves for moving it; and by leſs than half a turn of this ſcrew, the obſerver is enabled to prevent all agitation of the building, becauſe the rod then preſſes with force againſt the ſurface of the horizontal wheel. Properly, however, there are three ſcrews, forming an equilateral triangle, which effect this faſtening, two of which in the cabin are very ſhort, and the whole are ſo arranged, that it is neceſſary to move the long ſcrew only on the platform. Thus, by its force, it as it were moves the upper platform from its level, and preſſes it a little, imperceptibly inclined, towards the two ſcrews, which by their preſſure on the horizontal wheel prevent all agitation.

The twenty-ſix feet octangular tube, conſtructed of boards which are prevented from bending by a number of knees applied in the inſide, and which are made impenetrable to rain, is fitted to receive a ſpeculum of from 19 to 20 Engliſh inches diameter. At preſent, however, it is furniſhed with one of only 14 Hamburgh inches in diameter, having a focus of 26 feet, and which without the frame weighs 80 pounds. It is almoſt two inches in thickneſs, and towards the edge caſt conical, ſo that the diameter of the poliſhed ſurface is almoſt a quarter of an inch leſs than that at the back. This in the finiſhing and poliſhing is of the greateſt utility.

utility. The great weight of the ſpeculum requires that it ſhould be always kept in the tube, and this renders neceſſary a peculiar apparatus not requiſite in ſmaller teleſcopes. It is well known that large metalline maſſes acquire very ſlowly the temperature of the atmoſphere. The conſequence is, that ſpecula are very frequently covered with the evaporation from the atmoſphere, which condenſes on them. If the compoſition of the metal be not good, the ſpeculum ſoon becomes tarniſhed. The cauſe of this lies in too large a quantity of copper, which forms a component part of the maſs, and therefore it muſt be combined with a ſufficient quantity of tin. Edwards's compoſition in this reſpect is much preferable to all other mixtures. By more than forty experiments Profeſſor Schrader diſcovered a very good mixture; and ſpecula made of it were ſo excellent, that they might be expoſed to conſiderable evaporation without loſing much of their ſplendour. As in a cloſe apartment no body can be tarniſhed, if a ſpeculum be ſhut up during hot and moiſt weather the above inconvenience can be avoided. Profeſſor Schrader has ſecured his ſpeculum by a cover made of braſs rings, eight inches broad, ſoldered together. The centre ſcrews, as well as the iron circle which keeps the ſpeculum in its poſition, are properly fixed in theſe rings, and, by means of two capes with handles, which internally are lined with leather, or, what is better, with the ſkins of moles, the ſpeculum is kept perfectly free from air.

The period of the day at which the ſpeculum can be uncovered for uſe, depends on the length of time which it requires to aſſume the temperature of the atmoſphere. A few experiments will here conduct to the proper regulation. A good rule for guarding againſt tarniſhing is, to endeavour as much as poſſible to keep a continual draught of air in the tube. For this purpoſe, ſeveral ſmall openings may be employed in ſuch poſitions that the rain may not penetrate through them. A ſmall ſtage for the purpoſe of getting at the ſpeculum with more conveniency, is conſtructed near the loweft ftep, to which the tube muft be previoufly turned. A pole with a knee and a pulley ftands by it, in order to take out the fpeculum occafionally. The reafon why the under part of the building was conftructed higher than neceffary, was merely that a tube of 30 or 35 feet might be ufed.

II. *Defcription of the Javanefe Swallow, which conftructs eatable Nefts; with an Account of the Manner in which the Nefts are collected. From the* Tranfactions of the Batavian Society in the Ifland of Java for promoting the Arts and Sciences, *Vol. III.*

THESE fmall birds are of a blackifh grey colour, inclining a little to green; but on the back to the tail, as well as on the belly, this blackifh colour gradually changes into a moufe colour. The whole length of the bird from the bill to the tail is about four inches and a half, and its height from the bill to the extremity of the middle toe three inches and a quarter. The diftance from the tip of the one wing to that of the other, when extended, is ten inches and a quarter. The largeft feathers of the wings are about four inches in length. The head is flat; but, on account of the thicknefs of the feathers, appears round, and to be of a large fize in proportion to the reft of the body. The bill is broad, and ends in a fharp extremity, bent downwards in the form of an awl. The width of it is increafed by a naked piece of fkin fomewhat like parchment, which, when the bill is fhut, lies folded together, but which, when the bill opens, is confiderably extended, and enables the bird to catch with greater eafe, while on wing, the infects that ferve it for food. The eyes are black, and of a confiderable fize. The tongue, which is not forked, is fhaped like an arrow. The ears are flat, round, naked fpots, with fmall oblong openings, and are entirely concealed under the feathers of the

the head, The neck is very short, as well as the legs and the bones of the wings. The thighs are wholly covered with feathers; and the very tender lower parts of the legs, and the feet themselves, are covered with a skin like black parchment. Each foot has four toes, three of which are before and one turned backwards. They are all detached from each other to the roots; and the middle one, together with the claw, is fully as long as the lower part of the leg. Each toe is furnished with a black, sharp, crooked claw of a considerable length, by which the animal can with great facility attach itself to crags and rocks. The tail is fully as long as the body together with the neck and the head. When expanded it has the form of a wedge, and consists of ten large feathers. The four first on each side are long, and, when the tail is closed, extend almost an inch beyond the rest. The other feathers decrease towards the middle of the tail, and are equal to about the length of the body.

The whole bird is exceedingly light and tender. Ten of them together weighed little more than two ounces and a half. The Javanese call it *lawit*; but those who live in the mountains, *berongdagæ* or *waled**.

There are two places in particular near Batavia where these birds are found in great numbers. The first, Calappa Nongal, lies about ten miles southwards from the city; the other, Sampia, is a little more distant towards the south-west; but they are both in that range of high land extending towards the sea, which is apparently different from the large ridge that extends over the whole island. Besides these there are also several other places in the same district, or at a greater distance from the coast, which either produce a few, or are carefully concealed by the Javanese to whom they are known.

The two bird mountains before mentioned, called by the Javanese caverns (*goa*), are insulated rocks, hollow within

* Vocrong in the Malay language signifies in general a bird.

and pierced with a great number of openings. Many of these openings are so wide, that a person can enter them with ease; others are attended with more difficulty; and some of them are so small, that nature evidently seems to have been desirous of providing for the security of these little animals. On the outside these rocks are covered with a multitude of strong tall trees of various kinds. The inside consists of grey calcareous stone and white marble. To the walls of these caverns the birds affix their small nests in horizontal rows, and so close that they for the most part adhere together. They construct them at different heights from 50 to 300 feet; sometimes higher or lower, according as they find room; and no hole or convenient place, if dry and clean, is left unoccupied; but if the walls be in the least wet or moist they immediately desert them.

At day-break these birds fly abroad from their holes with a loud fluttering noise, and in the dry seasons rise so high into the atmosphere in a moment, as they must seek their food in distant parts, that they are soon out of sight. In the rainy season, on the other hand, they never remove to a great distance from their holes, as has been often remarked, particularly in the government of Java, where there are some rocks situated very close to the shore. About four in the afternoon they again return, and confine themselves so closely to their holes, that none of them are seen any more flying either out or in, but those which are hatching.

They feed upon all sorts of insects which hover over the stagnated water; and these they easily catch, as they can extend their bills to a great width. Their most destructive enemy is a kind of hawk (*knikendief*), which seizes many of them as they issue from their holes; and which people, on that account, take great care to frighten away by shooting at them.

They prepare their nests from the strongest remains of the food which they use, and not of the scum of the sea or

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of ſea plants *, as has been aſſerted. This ſeems the more probable, as it is known, from experience, that thoſe birds which build their neſts in the two rocks before mentioned have never been found on the ſea-coaſt, and could not poſſibly fly thither and return again in ſo few hours, on account of the high intervening mountains, and the ſtormy winds that often prevail among them. The great difference in the colour and value of theſe neſts proves that their goodneſs depends merely on the ſuperabundance and quality of the inſects on which they feed, and perhaps on the greater or leſs ſolitude of the place where they ſeek for nouriſhment. Thoſe found on the territory of Calappa Nongal and Goagadja are exceedingly grey, and worth one third leſs than thoſe produced in the territory of Sampia; and the latter again are not to be compared with an excellent ſort which are every year imported from Ternate and Paſſier, or which are to be found on the ſurrounding iſlands, particularly to the eaſt of Borneo.

Theſe birds employ two months in preparing their neſts; they then lay their eggs, on which they ſit for fifteen or ſixteen days. As ſoon as the young are fledged, people begin to collect the neſts, which is done regularly every four months; and this forms the harveſt of the proprietors of theſe rocks.

The buſineſs of taking down the neſts is performed by men accuſtomed from their youth to climb theſe rocks. They conſtruct ladders of reeds (*boſchrotting*) and bamboos, by which they are enabled to aſcend to the holes; but, if the caverns are too deep, they employ ſhip-ropes. When they have got to the bottom of the caverns, they place bamboos with notches in them againſt the wall, if theſe be ſufficient

* This has been hitherto generally believed, and copied from one naturaliſt by another. Houttyn himſelf in his *Natuurlyke Hiſtorie*, vol. i. part v. p. 607, gives a deſcription of the bird as well as of its manner of feeding, which is conſiderably different from the above.

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in order to get up to the neſts; but if they cannot reach them in this manner, they ſtand on the ladders and pull the neſts down with poles of bamboo made for that purpoſe. There are alſo certain holes to which people can aſcend by means of ſtages made of bamboos; but theſe are exceedingly few.

This employment, which is attended with great danger, coſts the lives of a great many men, and particularly of thieves, while attempting to rob theſe caverns at improper ſeaſons. For this reaſon, ſmall watch-houſes are everywhere built in the neighbourhood.

The mountaineers, who are thoſe chiefly accuſtomed to this employment, never undertake their labour till they have ſlaughtered a buffalo, which is the uſual preparation made by the Javaneſe for all their undertakings. On ſuch occaſions they mutter over a few prayers, anoint themſelves with aromatic oils, and fumigate the holes with ſweet-ſmelling ſubſtances, which, according to their ideas, are things all highly neceſſary. At the chief of theſe caverns in the iſland of Java, a particular protecting female deity is worſhipped under the name of *Raton Laut Ridul*, or princeſs of the ſouth ſea. A ſmall hut with a covered ſleeping-place is there appropriated for her, together with various elegant articles of dreſs, which no one but a princeſs muſt approach; and every Friday when the neſts are taken down incenſe is continually burnt, and the body and clothes of every one who intends to aſcend the rocks muſt be expoſed to it. The other Javaneſe are not ſo ſuperſtitious, and content themſelves with much fewer ceremonies. To afford them light in the cavern, they employ torches made of the reſinous gum of a large tree called *caret*, and the inner bark of the arek-tree.

The collecting of the neſts continues no longer than a month, and, as already mentioned, may be repeated three times in the year. Some believe that it may be done a fourth

fourth time; but this is not probable, as all experienced people brought up to this employment confidently assert, that a nest as long as it remains entire is continually enlarged by the bird, or made thicker, until it is entirely deserted by her when it has become dry or hairy in the inside.

When the nests have been collected, no farther trouble is necessary than to dry them and clean them, after which they are put in baskets and sold to the Chinese. The price of them is variable, and depends on their whiteness and fineness. Some of them have a grey, and others a reddish appearance. Those of the best sort are exceedingly scarce. They are sold at the rate of from 800 to 1400 rix-dollars per 125 pounds. This high price, and the insatiable avarice of the Chinese, give rise to much dishonesty and thieving; especially as the Chinese make no ceremony of bribing the watchmen with money, opium and cloth; and this, even with the utmost vigilance, cannot be entirely prevented.

The two places above mentioned, Calappa Nongal and Sampia, belonged formerly to the Dutch East India company; but as the advantages arising from them were in part much lessened by the Javanese, and in part not well understood, government resolved, in the year 1778, to sell them by auction to the highest bidder, and received for them almost a hundred thousand rix-dollars, a sum far exceeding what was generally expected. Besides these, there are several other places of the like kind, in the above range of mountains, though of less importance. There are two or three also in the high land in the interior parts of the country, and several small ones which are kept concealed with great care. Three considerable bird mountains, Goa Daher, Gede, and Nangasari, are situated in the government of Samarang in Java; and these are washed by the sea, which forces its way so deep into the latter, that fish may be caught in it. In these places the nests are of an excellent quality; but it is exceedingly dangerous to collect them on account of the steepness of the rocks and the violence of the surf, and therefore a suspended apparatus made of bamboos must be employed.

About 2500 pounds weight of these nests are collected every year in the island of Java.

There are bird caverns also in Bantam and the island of Sumatra; but the inhabitants of the former are so indolent, and the government so bad, that rice even is not sown, nor is any other article necessary for the support of life cultivated. The Chinese have never ventured to penetrate into the interior part of that kingdom, and have no intercourse with the mountaineers; so that little can be expected from that quarter.

The young birds are eaten both by the Javanese and the Europeans in India, but it is difficult to procure them. They are considered to be very heating. The nests, on the other hand, when they have been boiled to a slimy kind of soup, exposed in the night-time to the dew, and been mixed with sugar, are exceedingly cooling. The Javanese employ them therefore, with much advantage, in violent fevers. The author of this paper saw also that, when prepared as above, they were prescribed with good success for sore throats and hoarseness. This remedy, in all probability, has been borrowed from the Chinese, who, as a rich merchant of that nation who carried on a great trade with these nests assured the author, eat abundance of them during the winter, because sore throats are then very common in the northern part of that extensive kingdom, on account of people sitting so much over the fire.

But this nourishing and strengthening quality, so much extolled, the author was not able to discover, though he used a considerable number of these nests, prepared different ways, in order to be convinced of the truth. He caused them to be examined by able chemists; but nothing more could be observed, than that the solution presented a weak gum

gum with a diſagreeable taſte, which perhaps might be of ſome uſe in ſlight indiſpoſitions of the breaſt.

Theſe neſts, therefore, are merely an article of luxury to ornament the tables of the rich. The Chineſe are remarkably fond of them. After being ſoaked and well cleaned, they put them, along with a fat capon or a duck, into an earthen pot cloſely covered, and ſuffer them to boil for twenty-four hours over a ſlow fire, which they call *timmen*; and on account of this addition the whole diſh acquires a more luſcious taſte.

The trade carried on with theſe neſts was ſome years ago not ſo conſiderable, but of late it has much increaſed. The high price of them in China, which is ſtill advancing, makes Batavia the principal mart of this commodity, which, as the company have now given it up, is employed very advantageouſly by the inhabitants to leſſen the prejudicial exportation of ſpecie.

That this ſpecies of ſwallow is not to be found in China is now ſufficiently known.

Linnæus in his *Syſt. Nat.* gives, as a diſtinguiſhing mark of the *Hirundo eſculenta*, that it has white ſpots only on the feathers of the tail. The ſmall birds in Java, however, which conſtruct theſe neſts, have ſpots neither on the tail nor on any other place. The tail feathers are entirely of one colour, blackiſh grey above, and a little brighter below.

Rumph ſays of his *capodes marinæ*, that the feathers of the tail were ſpotted, and that the breaſt alſo was ſpeckled black and white.

Valentin, in his deſcription of the ſmall ſwallow which conſtructs eatable neſts, mentions neither ſpots nor ſpeckles, and ſays only that the belly was undulated white and black. If theſe are to be conſidered as eſſential differences, it will follow that there are two kinds of theſe ſwallows: one with a ſpeckled breaſt and white ſpots on the tail feathers, and the other without ſpots or ſpeckles. A third kind of theſe ſwallows would be thoſe called *momos* or *boerongitams*. Theſe

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alſo prepare their neſts of eatable ſubſtances, but, on account of the number of ſmall feathers and other impurities mixed with them, are not fit to be uſed. People therefore endeavour, as much as poſſible, to exterminate them, as they ſpoil the habitations of the better kinds. They are diſtinguiſhed from the latter merely by being larger, and having the legs down to the feet covered by ſmall feathers.

III. *The Proceſs followed at Aſtracan to give to Cotton Yarn a Blue, Yellow, or Green Dye. From* Neue Nordiſche Beyträge, *by Profeſſor* Pallas.

THE manufacturers at Aſtracan, beſides red cotton yarn, the proceſs for dyeing of which has been given in the preceding number of this Journal, prepare alſo blue, yellow, and green, which they give out to be dyed by regular dyers. The proceſs which they employ is briefly as follows:

The principal dye is the blue, which is employed both for cotton and ſilk. To prepare it, the indigo or blue dye-ſtuff is finely pounded, and diſſolved in water by a gentle heat in large earthen jars, ſeven of which ſtand in brick-work over the fire-place, at the diſtance of about an ell and a half from each other. About two pounds are put into each veſſel. Five pounds of the ſoda or *kalakar*, mentioned in the proceſs for the Turkey red, finely pounded, together with two pounds of pure lime and one pound of clarified honey, are added to each: when theſe ingredients have been well mixed the fire is ſtrengthened; and when the whole begins to boil the dye is ſtirred carefully round in all the veſſels, that every thing may be completely diſſolved and mixed. After the firſt boiling the fire is ſlackened, and the dye is ſuffered to ſtand over a gentle heat, while it is continually ſtirred round: this is continued even after the furnace is cooled, till a thick ſcum ariſes in the neck of each jar, and ſoon after diſappears.

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The dye is then allowed to ſtand two days, until the whole is incorporated, and the dye thickens.

The dyers aſſert that with this dye they can produce three ſhades of blue, and that, as the dyeing particles gradually diminiſh, they can dye alſo a green colour by the addition of yellow.

When a manufacturer gives cotton yarn to a blue dyer, he firſt boils it at home in a ley of ſoda (*kalakar*), then dries it, waſhes it, and dries it again. The blue dyer lays this yarn to ſteep in pure water, preſſes out the ſuperfluous water with the hands, and then immediately begins to dip it in the blue jar, often wringing it till it is completely penetrated by the dye. This firſt tint is generally given to yarn in ſuch jars as have had their colouring matter partly exhauſted. It is then dried, rinſed, and again dried; after which, it is put into the freſh blue dye, properly ſaturated; and, after the colour has been ſufficiently heightened, it is dried for the laſt time.

For a yellow dye, the dyers of Aſtracan employ partly ſaw-wort, brought from Ruſſia, and partly the leaves of the *kiſlar belge* or *ſumach*. The proceſs is as follows: The yarn is firſt boiled for an hour in a ſtrong ley of *ſoda*; it is then dried, afterwards rinſed and laid wet to ſteep for twelve hours in a ſolution of alum with warm water. When it has been dried in the air, it is laid to ſoak ſeveral times in troughs with the dye which has been boiled thick in kettles from the above-mentioned plants, till it has acquired the wiſhed-for colour, care being taken to dry it each time it is ſoaked. It is then rinſed in running water, and dried for the laſt time.

On this yellow colour a green is often dyed. After the yarn has been dyed yellow, it is given out to the blue dyer, who immediately dips it in the blue jars, the dye of which has been already partly exhauſted; and if the green colour is not then ſufficiently high, the operation is repeated, the yarn being dried each time.

IV. *Ob-*

IV. *Obſervations on a Junction of the Red Sea to the Mediterranean. From the* Journal de Phyſique *for* 1798.

IT is needleſs to attempt to prove of how much importance it would be to form a junction between the Red Sea and the Mediterranean. Every one is ſenſible that it might produce invaluable advantages in regard to the civiliſation of Aſia and Africa; the reciprocal commerce both between theſe two parts of the world, and between them and the whole of Europe; and particularly in regard to France; eſpecially when it ſhall have joined the Mediterranean to the German ſea, as I propoſed in 1786, when I publiſhed The Junction of the Rhone with the Rhine.

It would be uſeleſs alſo to examine every thing that has been ſaid by ancient hiſtorians, reſpecting the great works that may have been executed, or only undertaken, for that purpoſe, by the kings and other ſovereigns or governors of Egypt, from Seſoſtris or Pſammeticus down to Trajan or Adrian, ſince no traces or certain deſcriptions of them are remaining; and ſince ſo many efforts made ſo often, and in ſuch various ways, from time immemorial, only ſerve to prove the great importance that has always been attached to this enterpriſe, even when it could have been attended only with a local or very limited utility in compariſon of what it holds out at preſent.

It is however certain, that an able engineer, by examining the country with attention, would there diſcover remains ſufficient to convey juſt ideas reſpecting the vague and contradictory accounts of the ſituation, the direction, entrance, and exit of theſe ſeveral canals. But all this would be of little benefit. He would doubtleſs perceive, that if ſome or a part of theſe works have been effaced or deſtroyed by the hand of time, or abandoned on account of wars, or through the policy or inſtability of governments, none of them were planned or executed in ſuch a manner as to anſwer fully the end

end that ought to be propofed at prefent. They cannot, therefore, be affumed as models or helps for any new work of the fame kind; which, however, as will here be feen, could be executed with much eafe and fimplicity, fuppofing the undertakers had entire and peaceable poffeffion of the ifthmus and weftern coaft of the Arabic gulph, as well as of the courfe of the Nile, and all the intermediate country advancing a great way towards the fouth.

Without giving credit to a pretended higher level of the Red Sea than of the Mediterranean, which is not probable, we muft, according to the account of all travellers, admit there periodical tides and accidental elevations, amounting from five to fifteen feet; and this is fufficient to prevent every plan of a communication between thefe two feas, conftructed on a perfect level, and always navigable for the largeft veffels, fince an influx of waves fo great would ravage it from the one end to the other, and certainly be followed by an ebbing fo low as to render the Mediterranean higher and deftructive in its turn. But what would oblige the undertakers to renounce this tafk is the impoffibility of digging a long and continued bed, to the depth of twenty feet below the level of the two adjacent feas, in a diftrict which no doubt rifes much more above that level, and which is faid to confift entirely of hills and downs of exceedingly moveable fand, where the conftruction and prefervation of a canal would be like the labour of Penelope.

We muft not, therefore, think of joining thefe two feas but by a river navigation for barks or boats drawing fix or eight feet of water at moft, and between two ports, fuch as Suez on the one fide and Grand Cairo, Foftat or Boulac on the other, which feem to have been deftined for that purpofe, fince their direct diftance is only twenty-five leagues, and fince the eaftern branch of the Nile below Cairo is as deep as the fea itfelf at Damietta, Zan, &c.

But it is neceffary not only to give the new canal the leaft length, but alfo the fmalleft elevation poffible. But according to every account, the nature of the ground will oppofe the full execution of thefe two objects, and feems to fhow that they might thwart each other. The only method then is to weigh them both together, taking matters even in the worft light; and to determine the queftion I propofe the following preliminary confiderations:

1. The leaft elevation which the canal ought to have from one end to another, fhould be equal to that of the greateft tides or fwellings of which the Red Sea is fufceptible. The level of the canal would be thus fixed, and all the differences from the higheft to the loweft rifing of the fea would be counteracted by one or two locks, as it might be poffible to counteract at the other end all the overflowings of the Nile, which probably rife higher, and which in that cafe would require flood-gates.

2. There are two other methods which might be adopted in the like cafe, but which would be far lefs advantageous. One of thefe, which would fave the neceffity of locks both towards the fea and towards the Nile, is, not to allow boats or other veffels to come from or enter the fea but twice a day at the times of the tides, and not to come from or enter the Nile but when it is at its greateft heights. But this would lay too great a reftraint on commerce, particularly at Cairo, where the tranfportation of goods would not be poffible but during two or three months: but ftill the level would become doubtful and variable, like all tides and inundations; and there would neceffarily be alternate currents, which would render the water brackifh and unhealthful, not only in the canal, but alfo in the Lower Nile.

3. The other method, in order to exclude locks altogether, or at leaft in part, would be, to deprefs more the bed and level of the canal, taking care to guard it at each end by the flood-gates, which would permit veffels to enter the fea or the river at the times of their greateft elevation. But, though this method might render the courfe of the navigation freer and lefs interrupted, it would not prevent the mixture of the

fresh

freſh and ſalt waters. It would ſave nothing either in conſtructing or the labour of managing the locks: in ſhort, it would increaſe in a prodigious degree the ſolid content of the excavations and the general expence of the works.

4. The ſmalleſt elevation which the canal ought to have would be fixed then by the greateſt height of the waters either of the ſea or the river. But in ſuch an extent it is probable that ſeveral eminences might oppoſe this general level, and even in carrying the canal round theſe the labour would undoubtedly be increaſed. In ſhort, it would be impoſſible to avoid the neceſſity of making the canal begin on a ridge or eminence; by which means it would deſcend by two inclined planes, one on the eaſt towards the ſea, and the other on the weſt towards the Nile.

5. In that caſe the queſtion would be, to determine the *maximum* and the place of the elevation, which could be done only after a long examination of the ſpot, and an exact ſurvey of the higheſt part of the ground, by means of levelling. The eſſential object of this examination will be, 1. To avoid both the ſands which are to the north, and the rocks or mountains that abound in the ſouth. 2. To find on the ridge of the latter that ſpot which would correſpond beſt with the following conditions, viz. that the canal might be rendered as ſhort and as little expoſed to windings as poſſible; and that its point of departure ſhould be ſo low that veſſels might aſcend to it by the feweſt poſſible number of locks, and yet give occaſion to as little digging as poſſible. 3. And as theſe three conditions will often be unattainable at the ſame time, to balance them, and to make them reciprocally give way and prevail in ſuch a manner that the *medium* may enſure the moſt advantageous reſult in the greateſt number of reſpects.

6. Having thus determined the ſummit or higheſt point of departure, with the length and depth of the canal, we may eaſily find, and without any doubt, the means of filling it,

and of feeding it abundantly by the waters of the Nile, by going up the river beyond Cairo as far as the ſpot where its general height is greater than the level already fixed, and from which it will be neceſſary to draw off on the right bank a large ſtream or branch of water, defended by ſtrong gates againſt muddy water or extraordinary inundations, and to conduct it gradually in an inclination of fifteen or eighteen lines in a hundred fathoms, and to make it end by the ſhorteſt paſſage towards the weſtern extremity of the point of departure. This, however, ſuppoſes that the mountains ſituated to the eaſt cannot ſupply water in ſufficient abundance and by a ſhorter paſſage, which would be extremely deſirable, and which ought to be carefully examined; for it appears certain that the Nile has very little inclination below its cataracts, which are nearly two hundred leagues from Cairo; and conſequently the place where the water is drawn off ought to be taken at a ſufficient diſtance to be higher than the point of departure of the canal, however little it may have been eſtabliſhed above the level of the higheſt tides and inundations.

7. According to the beſt and lateſt deſcriptions of that country, we may however believe that this point of departure will neither require deep excavation below the ſurface of the ground, nor a great elevation above the mouths of the canal, either at the Nile or the Red Sea; for it appears certain on the one hand, that the laſt of all the ancient canals, that aſcribed to Amron the Arabian, was dug in a perfect level, and even open from one end to the other, proceeding from the Nile to Foſtat; and on the other, that an ordinary riſe of 16 cubits will be ſufficient that the river may enter there at preſent, for a length of four leagues, traverſing Grand Cairo. There is no reaſon then to doubt that this riſe would proceed to the Red Sea, and would there make ſome fall, if the remains of the canal had not been filled up either by the hand of time, or by wars between thoſe nations ſeparated by the Adriatic.

8. It

8. It is probable then that this grand communication might be re-eſtabliſhed by ſimple cleanſing or by ſome amendment, but with ſluices and other neceſſary works at both the mouths, that navigation might at all times be there poſſible, whatever might be the variable height of the waters in the river and the ſea; the latter of which, notwithſtanding what has been ſaid on the ſubject, will be found conſtantly lower than the former even at the time of the higheſt tides. The higheſt riſings of the Nile, therefore, which at Foſtat are ſaid to be from 20 to 22 cubits, muſt determine the general level of the canal, that is to ſay, the height of the locks neceſſary to deſcend towards each of its extremities when the waters are at their loweſt, and alſo the diſtance and height of the place from which the water of the Upper Nile muſt be drawn off to feed this canal, coaſting along the ſlope of the mountain as far as the northern cape or promontory of Mokattan, or from a baſon raiſed about thirty feet above Grand Cairo. It would alſo be attended with the valuable advantage of fountains and great embelliſhments to that city, become the central mart or repoſitory of the ancient world. Beſides, it would be a powerful preſervative againſt inſalubrity and that contagion which ſo frequently afflict that immenſe city, on account of the drought and exceſſive filthineſs which prevail there.

It may be readily ſeen, then, that this plan does not preſent nearly ſo many phyſical difficulties, and is not ſuch an immenſe enterpriſe as ſome have imagined; ſince the diſtance either from Cairo to Suez, or to Colzoum, or to any other port more to the ſouth or more convenient, does not exceed 25 leagues; for that of Suez ſeems difficult, and to be threatened with being ſpeedily choked up at the point of the gulph which is the narroweſt, and which becomes narrower every day—a new reaſon for abandoning a canal, though perhaps the ſhorteſt, which ſhould proceed directly from Suez to the Mediterranean, particularly when we conſider the impoſſibility of conducting ſo far, and amidſt ſuch a ſoil, a ſtream from the Nile, which however would be indiſpenſibly neceſſary to feed it, ſince it ought not, and even could not be dug to the bottom, or to the level of the two ſeas.

There is however one important remark ſtill to be made, which is, that the preſent trade of Egypt with Aſia is carried on merely by caravans, and by two different ways; one entirely over land acroſs the iſthmus and ſands for 50 or 60 leagues, even to Syria; and another by a defile among the mountains of Upper Egypt, for 25 or 30 leagues only, from Cophtos to Coſeir, which is a port of the Red Sea much eaſier of acceſs than Suez, becauſe the ſea there is broader and much leſs dangerous. But as this defile ſeems to be favourable to a canal, which might be fed equally well and with more eaſe from the Upper Nile, and as that river is navigable to Cophtos as well as to Grand Cairo, there is every appearance that a canal in the latter ſituation, planned with the ſame care, would be more ſure as well as more advantageous to the nation that might have the ſovereign poſſeſſion of Upper as well as Lower Egypt, eſpecially as it is abſolutely neceſſary that it ſhould be ſufficiently powerful to ſubdue the Bedouins, who infeſt the whole country, and who would ſoon render the canal of Cairo as impracticable as that of Cophtos.

V. *Obſervations on the Organs of Viſion in Bats.*

By M. SPALLANZANI

THESE obſervations are extracted from a ſmall work publiſhed by M. Spallanzani a few years ago, under the following title: "An account of ſome ſpecies of bats, which, when deprived of ſight, perform their movements in the air as if they ſtill ſaw: a faculty not poſſeſſed by other birds under the like circumſtances." And the author ſays that he was led to them by ſome experiments which he made on night

night birds. He let loofe feveral birds in a chamber perfectly dark, and perceived that the bats flew about in it without any impediment, and neither rufhed againft any thing in the apartment, nor touched the walls with their wings. He at firft imagined that they were conducted by fome glimpfe of light which he did not perceive, and on that account he blindfolded them with a fmall and very clofe hood. They then ceafed to fly; but he obferved at the fame time, that this did not proceed from any deprivation of light, but rather from the conftraint thence occafioned, efpecially when a hood of a very light texture was attended with the fame effect.

He then conceived the idea of pafting up the eyes of the bats with a few drops of fize or gum; but they ftill flew about in the fame manner as if their eyes had been open. As this however was not fufficient, he pafted up the eyes of thefe animals with round bits of leather, and this even did not impede them in their flight.

That he might at length be certain of his object, he blinded them entirely, either by burning the cornea with a red hot wire, or by pulling out the pupil with a pair of fmall pincers, and fcooping out the eye entirely. Not contented even with this precaution, he covered the wounds with pieces of leather, that the light might have no influence whatever on the remains of the organs which had been deftroyed. The animals feemed to fuffer very much by this cruel operation; but when they were compelled to ufe their wings, either by day or by night, and even in an apartment totally dark, they flew perfectly well, and with great caution, towards the walls, in order to fufpend themfelves when they wifhed to reft. They avoided every impediment great or fmall, and flew from one apartment to another, backwards and forwards, through the door by which they were connected, without touching the frame with their wings. In a word, they fhewed themfelves as bold and lively in their flight as any other animals of the ſame ſpecies which enjoy the uſe of their eye-ſight.

M. Spallanzani tried the ſame experiments with the ſame reſult on the eyes of the horſe-ſhoe bat *(veſpert. ferrum equinum)*, the dwarf-bat, the great bat (*noctula*), and the bat of Buffon. M. Spallanzani is convinced that the other four ſenſes ſtill remaining to theſe animals cannot ſupply the want of ſight; and he is therefore of opinion that a *new organ*, perhaps a *new ſenſe*, which is wanting in the human ſpecies, may in them be put in activity by their being blinded. Profeſſor Vaſalli at Turin, Profeſſor Roſſi at Piſa, M. Spadone at Bologna, and M. Jurine at Geneva, repeated theſe experiments, and obſerved the ſame phenomena as thoſe mentioned by Spallanzani.

VI. *Experiments on Bats deprived of Sight by M.* DE JURINE.

From the Journal de Phyſique *for* 1798.

THE experiments of M. Jurine were made only on the long-eared bat (*veſpertilio aurilus*), and the horſe-ſhoe bat *(veſpert. ferrum equinum)*. The bats were procured from the vaults under the fortifications of Geneva in the months of December and January. The author firſt obviates ſome doubts reſpecting the places where theſe animals reſide in winter, as ſome of them have been found in a torpid ſtate in the trunks of old trees during that ſeaſon.

The author obſerves, that he found at the above ſeaſon, and in the ſame vaults, abundance of moths (*phalænæ*) and crane-flies (*tipulæ*), and thinks he here diſcovers one of thoſe wiſe diſpenſations of nature, by which other animals of more utility find a ſource of aliment when they could procure nothing in the atmoſphere at that rigorous ſeaſon.

The long-eared bat has ſix inciſive teeth in the under jaw, three-lobed, and cut into the form of a heart. The upper has four,

four, and unequal. The horſe-ſhoe bat has none in the upper jaw, except two ſmall ones in the membrane of the palate: the lower jaw is furniſhed with four. When the horſe-ſhoe bat attaches itſelf to a wall, it contracts its body, and wraps itſelf up in its fur in ſuch a manner that it might be taken for a black chryſalide. The long-eared bat appears leſs careful of itſelf, and firſt makes uſe of its hind feet, and then of thoſe before, in order to affix itſelf to a wall.

The temperature of the vaults which ſerved them for a habitation was between 50° and 57° Fahr. that of the external air between 27° and 30°. M. Jurine having expoſed ſome of theſe animals to a temperature between 36° and 39°, ſeveral of them periſhed, and others fell into a ſtate of torpidity; from which he was not able to rouſe them by any touching, though a gentle current of air directed againſt them cauſed them to make a movement, by drawing back the whole body on the hind legs, and this they repeated as often as the inſufflation was renewed. M. Jurine had before obſerved the ſame effect on mice. He remarked, however, that the approach of a candle agitated and awakened them, probably on account of the rarefaction of the ambient air. A violent agitation of the air by which they are ſurrounded makes them ſpeedily take wing.

During the torpid ſtate of theſe animals no movement is obſerved which can indicate that they breathe. A ſmall horſe-ſhoe bat, a large bat of the ſame ſpecies, and a long-eared bat were placed on a ſtove, and exhibited ſigns of life at different periods; but their inſpiration and expiration were extremely irregular, particularly thoſe of the long-eared bat. There is a ſtriking difference between the poſition of theſe two ſpecies of bats when they fix themſelves againſt any object. The horſe-ſhoe bat hooks itſelf all at once, with its head down and its legs upwards; while the long-eared bat turns itſelf round quietly, in order to aſſume very often an oblique poſition.

The

The author then proceeds to the experiments which the illuftrious Spallanzani undertook before, but in which great fcope was ftill left for the imagination. The author feems to have found the defideratum which his predeceffor left for thofe who might follow him in the fame path.

He extended in an apartment feveral willow twigs three feet in length, at the diftance of fix inches from each other, and let loofe two bats, which paffed and repaffed between them, without touching them at all with their wings, and which, when their flight was ended, always attached themfelves to the fame cornice. The author then cut out their eyes; during which operation, the long-eared bat fuffered a confiderable hemorrhage from the ocular orbits. Being let loofe in that ftate, they ftill flew to the fame interftices. Thefe being barred up, they made choice of others, through which they paffed feveral times, always avoiding to touch the twigs with their wings, and for that purpofe they paffed obliquely.

The long-eared bat fometimes ftretched out its neck, and as it were made choice of that object to which it wifhed to attach itfelf; a cuftom which it had before it was blinded. It often applied one of its hind paws to its eye; collected the liquid which exuded from it, and then applied it with avidity to its mouth. Thefe two bats lived a long time after they were deprived of fight. Two long-eared bats, the one blind, and the other having the perfect ufe of its fight, were let loofe together. The blind one always followed its companion, even obferving the fmalleft finuofities of its courfe. The bat which faw, paffed between the twigs with lefs delicacy than the blind one.

M. Jurine then extended a net with large mefhes, after making a breach in it. The long-eared bat which faw, paffed through it immediately; but the blind one ftopped fhort, went all over the net, and, having found the breach, paffed through without touching it, and then foon joined its com-

companion, which it afterwards followed wherever it flew. Of what ufe then is fight to the bat, and what is the organ that fupplies its place?

The author then imagined that the folution of this problem could be found only by anatomical refearches. During the courfe of thefe, he found the organ of hearing very great in proportion to that of other animals, and a confiderable nervous apparatus affigned to that part. The upper jaw alfo is furnifhed with very large nerves, which are expanded in a tiffue on the muzzle.

M. Jurine then extended his experiments to the organ of hearing and that of fmell. Having put a fmall hood on a long-eared bat, it immediately pulled it off, and flew. He ftopped up its ears with cotton, but it freed itfelf in the like manner from that inconvenience. He then put into its ears a maftic of turpentine and wax. During the operation the animal fhewed a great deal of impatience, and flew afterwards very imperfectly.

A long-eared bat, the ears of which had been bound up, flew very badly: but this did not arife from any pain occafioned by the ligature; for, when its ears were fewed up, it flew exceeding well. In all probability the animal would have preferred having its ears bound up to having them fewed. Sometimes it flew towards the ceiling, extending its muzzle before it fettled.

M. Jurine poured liquid pomatum into the ears of a bat which enjoyed the ufe of its fight. It appeared to be much affected by this operation; but when the fubftance was removed, it took flight. Its ears were again filled, and its eyes were taken out; but it flew then only in an irregular manner, without any certain or fixed direction.

The ears of a horfe-fhoe bat, which had the ufe of its fight, were filled with tinder mixed with water. It was uneafy under the operation, and appeared afterwards reftlefs and ftunned; but it conducted itfelf tolerably well. On being blinded, it rufhed with its head againft the ceiling, beat the ozier

ozier twigs with its wings, and made the air refound with ftrokes which it gave itfelf on the muzzle. This experiment was repeated on other bats with the like effects.

The tympanum of a large horfe-fhoe bat was pierced with a pin (*trois-quart*). The animal appeared to fuffer much from the operation, and fell down in a perpendicular direction when thrown into the air. It died next morning. The fame effect was produced on piercing the tympanum of a long-eared bat with a needle.

The author then made very accurate refearches on the difference between the organifation of the brain of thefe two kinds of bats, and, after a careful diffection, found that the eye of the long-eared bat is much larger than that of the horfe-fhoe bat, but that the optic nerve is proportioned to it. The outer part of the ear of the former is much larger than that of the latter, but the interior part is fmaller.

The horfe-fhoe bat is indemnified for this difference by a greater extenfion of the organ of fmell, as evidently appears when the external elevations and irregularities of its muzzle are examined. When it is about to take flight, it agitates its nofe much more than the long-eared bat.

From thefe experiments the author concludes, firft, that the eyes of the bat are not indifpenfibly neceffary to it for finding its way; fecondly, that the organ of hearing appears to fupply that of fight in the difcovery of bodies, and to furnifh thefe animals with different fenfations to direct their flight, and enable them to avoid thofe obftacles which may prefent themfelves. The author alfo found on thefe animals a particular kind of fleas.

VII. On

VII. *On the Antiquity and Advantages of Encaustic Painting, with an Examination of the Process employed in that Art by the Ancients. From a Treatise entitled* Antichita, Vantaggi e Metodo della Pittura Encausta; Memoria del Ch. Sig. Giov. Fabbroni, &c. Roma, 1797. Quarto.

[Concluded from page 31.]

FROM what has been already said, it appears that encaustic painting is much better calculated than oil painting to withstand the power of time and the influence of those circumstances which destroy sooner any other kind. It affords this advantage also to the painter, that he can lay on an unchangeable white, which cannot be used in oil painting, as is proved by the fragment of a mummy above mentioned.

We are indebted in particular to Nardi, Borrichius, and Jablonski, for hints how to employ with advantage the Egyptian remains of antiquity; but one cannot help wondering, notwithstanding all the illustrations of these learned men, that they seem to be so little valued, and that mummies are now almost banished to apothecaries' shops, though they are often monuments of sculpture on account of the exterior cases in which they are preserved; of painting, on account of their clothing and bandages; and perhaps also of history, on account of the hieroglyphics which serve on them as inscriptions. In regard to the two first circumstances, mummies have not hitherto been sufficiently valued by those who neither trace out the progress of the human mind, nor are interested in enquiries respecting the infancy of the arts. With regard to the last point of so much importance, we often hear people say: Of what use is it to collect things of which we understand nothing? It may, however, be easily perceived that this is not the language of philosophy, whose penetrating eye sees farther, and which values every thing. Leibnitz considered it impossible to read and explain the Etruscan inscriptions; he even doubted whether they were characters. Without studying good collections and Etruscan monuments, could it have been possible to discover the alphabet of these ancient people? Without the repeated researches of travellers, could it have been hoped that Barthelemi would explain the Palmyrean inscriptions? Without possessing and examining the present fragment, or something of the like kind, could any one with certainty determine the remote period when the art of encaustic was practised, or discover the true method in which it was employed? But we shall allow every one to think on this subject as he pleases. Our academy requires facts and observations: any thing else does not merit its attention.

The first fact, which I think I have proved, is, that the Egyptians were acquainted with and practised wax painting.

The second is the better preservation of colours, and in particular of the white, by means of encaustic, notwithstanding the revolutions of many centuries.

The third is, that the matter of the Egyptian white colours is not metallic calces or oxydes, which at present are used in oil painting.

And the fourth, a deduction from the experiments made of the component parts of the ancient encaustic, which differ very much from those already made known.

Those who are acquainted with the accuracy and certainty of the method not long since introduced into chemical operations, will be convinced that in 24 grains of the encaustic painting, which I ventured to detach from the above-mentioned Egyptian fragment, in order to subject it to examination, the mixture of an hundredth part of a foreign substance would have been discovered with the greatest certainty; that the resin of Requeno must undoubtedly have been perceptible to me, and that the alcali of Bachelier and Lorgna could not have escaped the counteracting medium. But in this Egyptian encaustic I found nothing except very pure wax, though I varied my analysis in every known method. I must therefore conclude that modern learned writers, at least in

respect

respect to this Egyptian mode of painting, were as far from the truth as the accounts of ancient authors appear to me precise and satisfactory; and that the encaustum with which formerly the fore part of ships and the walls of houses and temples were painted, was something different from soap or resinous crayons (*pastello di mastice*).

The basis however of the ancient pigments for the skin was perhaps formed of a waxy soap, with which they combined lake (*fuco*) and white lead; and hence perhaps arose the well-known common expression, which is still figuratively used, when people say that a face has *buona* or *cattiva cera*, according as the complexion appears healthful or sickly. But as those who at present prepare paints for the skin do not use that oil which the portrait-painters employ, it is not improbable that the ancients made use of one composition for paintings, and another for improving the natural complexion of the female skin.

I am well aware that it will be asked: In what manner can wax at present be rendered sufficiently liquid for the strokes of the pencil, if it be not converted into powder or soap? This question, in my opinion, can be fully answered from the words of an ancient author, and in the next place by experience.

Vitruvius in particular, book vii. chap. ix. expresses himself in the following clear manner:

"Those," says he, "who wish to retain cinnabar on walls, cover it, when it has been well laid on and dried, with Punic wax diluted in a little oil (let this be well remarked); and after they have spread out the wax with a hair brush, they heat the wall by means of a brazier filled with burning coals (hence it is called encaustic painting), and then make it smooth and level by rubbing it with wax tapers and clean cloths, as is done when marble statues are covered with wax. The effect of this wax crust is, that the colour is not destroyed by the light of the sun or the moon."

It here appears by these words of Vitruvius that the Romans, who copied the Grecian process, which the latter borrowed from the Egyptians, mixed the wax with an oil to make it pliable under the brush; but no mastic, alkali or honey, as has been ingeniously imagined, and which some have thought might be employed with success. The difficulty now will be confined to point out in what manner this oil was employed. It does not appear that they used those fat oils which are commonly called drying oils; because they could have employed these as we do, without the addition of wax, which in such a case would have been entirely superfluous. Fat oils which do not dry would not have been proper for that purpose, as they would have kept the wax continually in the state of a soft pomade or salve. Besides, my experiments would without doubt have shewn me the existence of any oily matter.

With regard to essential or volatile oils, a knowledge of them is not allowed to the ancients, as the invention of distilling is not older than the eighth or ninth century, and therefore falls in with the period of Geber or Avicenna. But Herodotus speaks in a very clear manner of the distillation of asphaltes, which was made at Susa; and I, who distinguish so much chemical knowledge among the Egyptians, cannot suppose them ignorant of so easy a process. In the temple of Vulcan at Memphis they had a school of chemistry, which flourished there for a long time, as we are told by Zosimus Panoplitanus, Eusebius, Sinesius, Albufaragius, &c. In order to use wax in their encaustic painting, it is certain that they must have combined it with an ethereal volatile oil, of which no traces should afterwards remain; because this was required for the solidity of the work, and because I actually found this to be the case in the fragment which I examined. But though they might be unacquainted with the art of separating ethereal oils from the many substances which they contain, they certainly were acquainted with a very volatile thin oil produced by nature, and which in various places issues from the earth, but probably not in Greece, as I found reason to conjecture from the following observations:

tions. Strabo and Plutarch relate that the people of Ecbatana, in order that they might exhibit a pleasing spectacle to Alexander the Great, shewed him a flaming stream, by sprinkling rock-oil in the streets of a village, and then setting fire to it. They also rubbed over with naptha a naked boy, and then setting fire to it in the like manner caused him to run about in a bath. These people then were acquainted with naptha, which issued from the earth in that district; but it was not known in Greece, at least to the common people, as it never was seen by them under the like circumstances. This ethereal oil was used, in my opinion, to render wax fit for painting; and it is natural to suppose that it would be first employed for this use where it was first known. It appears to me that the Greeks, as was the case with many other things, and as the above-quoted authors say, learned encaustic from the Egyptians, as the latter learned it perhaps from the Assyrians or Chaldeans. We know that Lysippus wrote expressly under one of his pictures: "Painted in encaustic;" which he would not have done, had not this kind of painting been new or a secret in Greece.

Naptha is an ethereal oil much lighter than sulphuric ether itself, as I found, contrary to common opinion, by my experiments. It is an exceedingly volatile oil, which entirely flies off and evaporates without leaving a single trace of it behind. On account of this property naptha is used, as is well known, to copy signatures and manuscripts, by rubbing it over the paper to which it may be requisite to transfer any writing, as it makes it perfectly transparent. The paper then becomes opake and white as before, after the naptha has evaporated. Such in all probability was the case with the oil, which Vitruvius does not specify, but which, as he says, was combined with the wax. It was for this reason that I found no oil in the Egyptian wax painting when I examined it. We have therefore discovered the real mixture used for the ancient encaustic painting.

But, to bring my assertions to greater certainty, it was necessary not only to prove the absence of every foreign matter in the above-mentioned encaustic fragment by means of an accurate analysis, and to form some conjecture what kind of oil must have been combined with the wax, but it was necessary also to search for an imitation of it synthetically; and I had the good fortune to meet with a favourable opportunity of gratifying my wishes in this respect.

In the year 1785 my worthy friend Gultenbrunn, an eminent Saxon painter, now in London, resided at Florence. I prepared for him a solution of Venetian wax in highly purified naptha, and desired him to mix up with it the colours necessary for a painting. He immediately complied with my request; and we were both astonished, as well as all our friends, at the high tone which the colours assumed, and the agreeable lustre which the painting afterwards acquired, when it had been rubbed over with a soft cloth. I observed that, in following this process, the artist can determine the effect of the colours from their appearance on the pallet. This is not the case when the wax is combined with alkali, gum, or mastic, by which the pigments have a different appearance under the pencil, from that which they ought to have on the painting; because the painting, until it has been dried, heated, and varnished, appears muddy and obscure. At this period I had only conjecture in my favour respecting the composition of encaustic; but the result of the above trial, and, still more, my examination of the Egyptian fragment, so often mentioned already, freed me from all doubt.

I made another preparation of the like kind for that celebrated painter Ademello, by combining a quantity of the common spirit of turpentine (*acqua ragia*) with wax, the good effect of which was also extolled by that artist. The purpose for which at present I would apply a preparation of this kind, is to daub over some of those beautiful paintings in fresco by Giovanni da San Giovanni, to be seen in the cou t

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of an elegant villa near this city, which in my opinion would certainly preferve them from that decay through which they are advancing with rapid fteps to deftruction; for it appears from the words of Vitruvius, that encauftum was ufed in the time of the Romans to cover parts which had been already painted either with water colours or in frefco. I judge, from the analogy of effect, that this was the fubftance with which Apelles daubed over his paintings, and which, according to Pliny, made them appear as if covered by a thin plate of talc or tranfparent felenite, and gave the colours a wonderful foftnefs. In the ancient cedar oil I can diftinguifh only the more modern *acqua ragia*, or fpirit of turpentine; confequently that, or naptha, was the oily matter which the ancient painters muft have ufed for their encauftic works.

As experiments made both by analyfis and combination were favourable to my idea, I flatter myfelf that I have approached nearer the truth than the preceding celebrated writers, whofe refearches were indeed highly ufeful and meritorious, and among which the illuftrations of the learned Requeno deferve much praife. Should this be granted, I fhall think myfelf well rewarded for my trifling labour; and nothing remains but to exprefs a fincere wifh that I may fee the above method extended to all thofe purpofes to which it was applied by the ancients, that is, to preferve paintings in water colours, or on plafter, and fculptured pieces of marble. Were our public ftatues covered with encauftum, as was the cafe formerly, according to Vitruvius and Juvenal, the dark mofs (*lichen*) would not adhere to their pores, which disfigures their whitenefs, and renders them black; and to which the attracting of oxygen by carbon may perhaps fomewhat contribute. Were paintings *a frefco* and *a tempera* covered with wax in this manner, Florence would not have loft fo many mafterpieces by Giovanni and Andrea, which it once poffeffed. Laftly, were this plaftic varnifh ufed, after the method of Apelles, to give equality to the tone of the colours, and to preserve our oil-paintings, many valuable pieces would be guarded from the destructive influence of the light and atmosphere, which change every thing; insects would be protected from being spotted with dust, which greatly injure their tints; and in particular we should prevent that damage which the common resinous varnishes occasion, though with slow steps, as these varnishes not only become black of themselves with time, but, as they contract in drying, and, becoming hard, they produce rents and cracks, and consequently bring the painting, which it is wished to preserve, sooner to destruction. Resinous varnishes are naturally stiff and unpliable, and the materials on which most new paintings are found are hygrometric substances, which contract or expand in proportion to the dryness or moisture that prevails in the atmosphere. If it be true, as Oberlin observes, that the varnish (*vernice di moriconi*) has rendered many beautiful paintings scaly, which were taken from the ruins of Herculaneum in good condition; what destruction must it not occasion in paintings on wood and canvas! Giuseppe Piazenza also makes a very pathetic remark on this circumstance. But I do not say this with a view to offend those judicious and meritorious persons who go to work with prudence and skill, as I have no other object in my observations, than to place in a proper light the antiquity and superiority of wax-painting.

VIII. *An Account of the "New Method of performing and facilitating the Business of divers manufacturing and economical Processes," for which a Patent, dated 24th June* 1795, *was granted to* "SAMUEL BENTHAM, *Esq. of Queen's-square, Westminster.*"

EVER since the days of Bacon, the philosophers of Europe have employed themselves in determining, by actual experiments, the physical properties of matter, and the laws to which

which it is subject; not merely to gratify a harmless and laudable curiosity, but with the avowed intention of reducing to a rational and solid system of principles, the various arts, manufactures, and economical processes which, before that period, depended almost wholly upon chance or caprice.

To the result of philosophical experiments we owe the present advanced state of science, and the many improvements which have been introduced into the manufactures of Britain, and have brought them to the high state of perfection they have attained. Has Mr. Bentham, in the patent under consideration, added to the number of physical facts before known? Has he discovered any new principles to entitle him, as a discoverer, to enjoy for fourteen years an exclusive monopoly of the arts to which they apply? No such thing. Mr. Bentham has discovered what all the world knew before—what may be found, in various forms, scattered through the pages of thousands of volumes; namely, that it would very much promote arts and manufactures, if means could be devised to enable us to apply, in the large way, all the facts that have been determined by philosophical experiment. Yes, reader, the learned of all countries have been indefatigable in their various pursuits for these last two centuries, only to furnish materials for the exclusive advantage and emolument of Mr. Bentham. But he shall be allowed to speak for himself.

Every one knows, that a patentee must lodge in the proper office a specification, describing his invention in so full a manner that, at the expiration of his term, the public may be able to enjoy the benefit of the discovery. The present patentee, in compliance with this requisite, says, "I the said Samuel Bentham do hereby declare, that my said invention is described in manner following; that is to say, my invention consists in the *idea* of applying to the purposes of art and manufacture, in *the large way*, the practice that has been *so long in use*, of extracting and excluding the air in *the way of philosophical experiment.*" He then proceeds to tell us, that "air is either *known* to be, or fuſpected of being, an obſtacle to art and manufacture, in a great variety of ways;" but it would be inſulting our readers to enumerate thoſe he points out, as they muſt be as well acquainted with them as Mr. Bentham himſelf. We ſhall only obſerve in paſſing, that, as he admits the fact to have been known *before*, it appears odd that he ſhould call the *idea* his invention.

He then proceeds to exemplify the uſes that may be made of *his* invention, in preſerving ſubſtances animal and vegetable from putrefaction. It was known, before Mr. Bentham was born, that ſuch ſubſtances might in ſome degree be preſerved for a long time *in vacuo:* but perhaps Mr. Bentham has found out ſome new way of producing a vacuum, and therefore is entitled to the excluſive uſe of that method?—No! He ſays the air muſt be extracted from the veſſel or chamber by "an air-pump, *or otherwiſe*;" but the other ways he has kept to himſelf. Mr. Bentham ſuppoſes that, in the practice of potting ſolid ſubſtances, the fat, which in a melted ſtate is thrown round them, acts "in good meaſure" by excluding the air. It is *partly* true; but it performs another work which his vacuum would entirely deſtroy—it prevents the eſcape of the juices.

"Many of the changes," ſays the patentee, "to which bodies are ſubject in point of colour, are known to reſult from the action of the air. An exhauſted chamber affords the means of preſerving them from all ſuch changes, for any length of time." This was known long ago; but we ſhall ſuggeſt one uſe to which thoſe may apply it, who ſhall firſt purchaſe permiſſion from the patentee. Such as wiſh to preſerve the colours of their clothes from being injured by the action of the air, may get an air tight-caſe made for themſelves to walk in—the bottom part terminating in a pair of boots. After they have incloſed themſelves, let their ſervant, "by an air-pump or otherwiſe," extract the air, "care being taken at the ſame time to exclude the light, when the preſence of that element alſo is found to influence

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the result." This process, excepting the boots, has been often tried, "in the way of philosophical experiment," upon mice and other small animals; but, having never yet been applied in "the large way," comes fairly within the right of the patent.

"Distillation;" "effectuation of contact;" "intromission into tubular or other cavities," (for instance, filling a thermometer, as if such a thing had never been performed in the same manner before Mr. B. hit upon the idea;) "impregnation;" "transmission and percolation:" "mixture, viz. of fluid masses with powders, or heaps of small-sized bodies;" "regulation of heat;" and "exsiccation;" are all enumerated and exemplified at great length, as processes in which the exclusion of air would be an advantage: but we shall not abuse the patience of our readers by detailing the particulars *.

"The vacuum chamber may be of the size of a large room:—to enable the operator to see the processes, it may have glass windows to it, but the glass must be thick." Indeed it must! "to enable it to resist the pressure of the atmosphere." "For the accomplishment of such a *variety* of purposes," says Mr. B. "a *variety* of operations may respectively require to be performed; to some of which, a *variety* of machinery, and that more or less complicated, may be necessary: as, in all or most of these instances, the source of motion will be exposed to the external atmosphere, while the subject to be operated upon will be in the vacuum chamber, the most commodious means of transmitting the motion from the one of these situations will, on this account, be an object of attention." Our readers may surely expect something new in the way of invention after all this pomposity. We are now told that "the methods *already in use* in the way of experiment, such as the collar of leathers, will in

* Those who wish to be informed more fully, may see a copy of the specification in The Repertory of Arts and Manufactures, vol. vii.

general be found fufficient, however large the fcale! A fpindle fliding in fuch a collar gives rectilinear motion;" wonderful! "A fpindle turning round on its axis gives circular motion;" wonderful!! "From one or other of thefe two, or indeed from either of them, any other motions may be produced at pleafure:"—and if you cannot, from this defcription, frame a parcel of Androides able to work in your vacuum chamber, in packing beef and butter into cafks, gilding and plating metals, cafting images, glueing boards together, filling thermometers, and performing every thing you can wifh, it is becaufe your fcull is a vacuum alfo.

Whoever can difcover the means, whether by an air-pump *or otherwife*, to make with facility fuch large vacuums, and can contrive the *jack in the box* who is to perform the various operations required, may do it without confulting with this patentee, whofe *invention confifts in an idea* that fhould others contrive fuch machinery, he could prevent them from ufing it without paying him for the privilege. It is however a miftake, founded upon another, that what becomes an art or manufacture ceafes to be philofophical; when the fact is, that an art is only perfect in proportion as it is ftrictly fo. He labours under another error, when he believes that the difference in the fcale, on which any procefs may be carried on, will furnifh grounds for a patent! *Great* and *fmall* are merely relative terms, and abfolutely mean nothing in themfelves—1000 is a great number when compared with unity, but when contrafted with 1,000,000 it becomes a fmall one.

The duty we owe to the public calls upon us to point out the faults as well as the merits of Patent Inventions; but when we fee, as in the prefent inftance, an unjuft effort made to monopolize the fruits of the accumulated fagacity of thofe who labour for the benefit of their fellow-creatures in general, it lays us under a double obligation to expofe the impudence of the attempt.

IX. *On the Theory of the Structure of Crystals, by the Abbé Haüy. From Vol. XVII. of the* Annales de Chimie.

[Continued from Page 46.]

2. *Various Examples of Decrease on the Edges.*

DODECAEDRAL Sulphure of iron or martial pyrites (*fig.* 19, Plate VI.) *Pyrites ferrugineuses dodécaèdres.* Daubenton. *Tab. Miner.* edit. 1792, p. 29. De l'Isle, *Crystallographie*, t. ii. p. 224. var. 16.

Geomet. Charact. Inclination of any one of the pentagons, such as D P R F S to the pentagon C P R G L, having the same base P R 126° 56′ 8″. Angles of the pentagon C P R G L, L=121° 35′ 17″; C or G=106° 35′ 57″ 30‴; P or R = 102° 36′ 19″.

Let us again conceive a cubic nucleus, the different edges of which are so many lines of departure to the same number of decrements, taking place at the same time in two different ways, that is to say, by the subtraction of two ranges parallel to the edges A B, C D (*fig.* 7, Plate II.*), and of one range parallel to the edges A D, B C. Let us suppose also that each lamina, being in thickness equal only to a small cube of the side A B and C D, is equal to double the side of A D and B C. This disposition, in regard to the decrements proceeding from the lines D C, B C (*fig.* 7), is represented by *fig.* 14. In this hypothesis it is evident that on account of the more rapid decrease in departing from D C or A B, than in departing from B C or A D, the faces produced in the former case will be more inclined to the plane A B C D, while the faces produced in the latter will remain as it were behind; so that the pyramid will no longer be terminated by a single cube E (*fig.* 12), which, on

* All the *figures* below 14 referred to in this article will be found in plate II of the preceding number, and all above it in plates VI and VII of the present number.

account

account of its extreme minuteneſs, appears to be only a point, but by the range of cubes M N S T (*fig.* 14, Plate VI.) which, ſuppoſing theſe cubes to be almoſt infinitely ſmall, will preſent the appearance of a ſimple ridge. By a neceſſary conſequence the pyramid will have for faces two trapeziums, ſuch as D M N C, reſulting from the firſt decrement; and two iſoſceles triangles, ſuch as C N B, which will be produced by the ſecond decrement*.

Let us ſuppoſe, moreover, that, in regard to the laminæ of ſuperpoſition which ariſe on the face B C G H (*fig.* 7, Plate II), the decrements follow the ſame laws, but by croſs directions; ſo that the more rapid of the two may take place in proceeding from B C or G H towards the ſummit of the pyramid, and the ſlower in proceeding from C G or B H towards the ſame ſummit. The pyramid reſulting from theſe decrements will be placed in a direction oppoſite to that reſting on A B C D, and will have the poſition exhibited *fig.* 17, where it is ſeen that the edge K L, which terminates the pyramid, inſtead of being parallel to C D like the edge M N (*fig.* 14 and 15), is, on the contrary, parallel to B C. We ſhall then conceive what ought to be done in order that the pyramid which will reſt on D C G F (*fig.* 7) may be turned as repreſented *fig.* 16, and may have its terminating edge P R parallel to C G (*fig.* 7). I ſhall ſay nothing of the pyramids that will reſt on the three other faces of the cube, becauſe it is evident that each of theſe pyramids ought to ſtand like that which ariſes on the oppoſite face.

But as the decrements which produce the triangle C N B (*fig.* 15) make a continuity with thoſe from which reſults the trapezium C B K L (*fig.* 17), theſe two figures will be in the ſame plane, and will form a pentagon CNBKL (*fig.* 18).

* Here the face which correſponds to A B C D (*fig.* 7.) has 25 ſquares on each ſide, as may be ſeen *fig.* 14. and the ſtructure of the pyramid in queſtion may be imitated artificially by obſerving the order and number of the cubes repreſented in the ſame figure.

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For the ſame reaſon the triangle D P C (*fig.* 16) will be on a level with the trapezium D M N C (*fig.* 15); and by reaſoning in the like manner in regard to the other pyramids, it will be conceived, that as the ſix pyramids have for their whole faces twelve trapeziums and twelve triangles, the ſurface of the ſecondary ſolid will be compoſed of twelve pentagons, which will correſpond with the twelve rhombuſes of fig. 5; but with this difference, that they will have other inclinations. This ſolid is repreſented alone *fig.* 19, and with its cubic nucleus *fig.* 20, where it may be ſeen in what manner it would be neceſſary to proceed in order to extract this nucleus. For example, if a ſection be made paſſing through the points D, C, G, F, you will detach the pyramid reſting on the face D C G F of the nucleus, which will by this ſection be uncovered.

Among the cryſtals belonging either to the ſulphure of iron (martial pyrites), or the arſeniate of cobalt (the arſenical cobalt ore of Tunaberg), there is found a dodecaedron, the faces of which are equal and ſimilar pentagons, and its nucleus is a cube ſituated as above deſcribed. But there are an infinite number of poſſible dodecaedra, which may have, for faces, equal and ſimilar pentagons, and will differ from each other by the reſpective inclinations of their faces. Of all theſe dodecaedra, the one, the ſtructure of which would be ſubjected to the before-mentioned laws, gives 126° 56′ 8″ as the angle made by the inclination of any two of its faces D P R F S, C P R G L (*fig.* 19), at the edge of junction P R, as may be eaſily demonſtrated by calculation*. But though we cannot flatter ourſelves with the hope of attaining to the preciſion of ſeconds, nor even to that of minutes, in meaſuring the ſame angle in dodecaedral pyrites, that meaſurement taken with every poſſible attention evidently approaches ſo near to the reſult given by calculation, that we may conſider that reſult as the real boundary of approximation, found by help of the inſtrument, and conclude that

* See *Les Mémoires de l'Academie des Sciences, année* 1785.

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theory has arrived at the utmoſt point of accuracy. What I here ſay takes place alſo in regard to all the other reſults of theory compared with thoſe of calculation; and it is obvious that if this theory were falſe, it would conduct to errors which the inſtrument would not fail to render ſenſible, by the great differences which it would give between the angles found by calculation and thoſe found by meaſurement.

M. Verner and M. Romé de l'Iſle have confounded the dodecaedron of pyrites with the regular dodecaedron of geometry, in which each pentagon has all its ſides equal, and all its angles equal alſo*. If theſe two celebrated mineralogiſts had made more uſe of geometry in conſidering cryſtals, they would have perceived a very ſtriking difference between theſe two dodecaedra, ſince the regular dodecaedron gives only 116° 33′ 54″ as the inclination of its reſpective pentagons, which makes a difference of about 11° $\frac{1}{4}$ between it and that above mentioned. Nay, there is no law of decrement whatever capable of producing the regular dodecaedron, however compound it may be imagined, as I have ſhewn elſewhere † in regard to a cubic nucleus, and as I can demonſtrate at preſent, generally, for a nucleus of any form. After theſe details it may be eaſily ſeen how important the uſe of calculation is, either to prove the truth of theory, or to trace out the boundaries by which the progreſs of cryſtalliſation is circumſcribed.

We have already then two kinds of dodecaedra; one, whoſe faces are rhombuſes; and another, whoſe faces are pentagons; produced upon a cubical nucleus, in conſequence of two ſimple and regular laws of decrement, in a direction parallel to the edges of the nucleus. A multitude of new polyedra, which will have the ſame nucleus, may be conſtructed, by varying theſe laws in divers other ways.

* *Traité des Caract. des Foſſiles*, page 184. See alſo, *La Cryſtallographie de M. de l'Iſle*, t. iii. p. 232 and 233.

† *Mém. d. l'Acad. des Sciences, année* 1785, p. 223.

Calcareous

Calcareous Metaſtatic Spar (*Fig.* 21*).

Spath. calcaire à douze triangles. Daubenton. *Tabl. Miner.* édit. 1792, p. 15. nº. 5. De l'Iſle, *Cryſtall.* t. i. p. 530, var. 1.

Geomet. Charact. Inclination of the triangle *o f d* to *o f x*, 104° 28′ 40″, and to *o b d*, 144° 20′ 26″. Angles of the triangle *o f d*; *f* = 101° 32′ 13″; *d* = 54° 27′ 30″; *o* = 24° 0′ 17″.

Geomet. Properties. The obtuſe angle *o f d* of each triangle is equal to that of the rhombus of the primitive form.

The inclination of the faces *o f d*, *o f x* is equal to that of the rhombuſes *b a f d*, *g a f x* (*fig.* 4), of the nucleus†.

That part of the axis of the dodecaedron which exceeds on each ſide the axis of the nucleus, is equal to that axis; or, what amounts to the ſame thing, the whole axis of the dodecaedron is triple that of the nucleus.

The twelve ſcalene triangles that compoſe the ſurface of this variety have their leſſer ſides, which are united two to two on the ſix edges *b d*, *d f*, *f x*, *g x*, *g c*, *b c* (*fig.* 21), exactly ſituated like thoſe marked with the ſame letters in *fig.* 4, which gives an idea of the poſition of the nucleus in regard to the ſecondary cryſtal.

It is thence ſeen that the laminæ of ſuperpoſition decreaſe in a direction parallel to the inferior edges *b d*, *d f*, *f x*, &c. or the edges of which we have been ſpeaking. The theoretic calculus demonſtrates that this decreaſing takes place in two ranges of integral moleculæ; and, as the laminæ always retain their rhomboidal figure, the ſum of all their external angles, analogous to *b*, *d*, *f*, *x*, *g*, *c*, produces ſix longitudinal ridges, which form, alternately, the large and mean ſides *o d*, *o f* (*fig.* 21), of the ſcalene triangles. It

* This variety is commonly called *dent de cochon*. The Engliſh call it dog's tooth, *dent de chien*.

† The word *metaſtatic* ſignifies tranſpoſition, or the *metaſtaſis* of the angles of the nucleus to the ſecondary cryſtal.

may readily be conceived that the laminæ, at the ſame time that they decreaſe towards their lower edges, ought, on the other hand, to increaſe towards their ſuperior edges, analogous to *a b*, *a f*, *a g*, &c. (*fig.* 4.) in ſuch a manner that the parts of the cryſtal ſituated towards theſe edges ſhould be always enveloped, and that the angles at the ſummits of the rhombuſes ſhould remain contiguous to the axis. But this is only an auxiliary variation, proper to ſecond the effect of the decreaſe, which alone is ſufficient to determine the form of the dodecaedron.

Very obtuſe Calcareous Spar (*Fig.* 22).

Spath. calcaire rhomboïdal très obtus. Daubenton. *Tab. Miner.* edit. 1792, p. 15, n°. 2. De l'Iſle, *Cryſtall.* t. i. p. 504. var. 2.

Geomet. Charact. Inclination of the rhombus *n a d b'* to the rhombus *a i f d'*, 134° 25′ 36″. Angles of the rhombus *n a d b'*; *a* or *b'* = 114° 18′ 56″; *n* or *d'* = 65° 41′ 4″.

This variety, commonly called *lenticular calcareous ſpar*, ariſes from a decrement by a ſingle range on both ſides of the edges *a b*, *a g*, *a f* (*fig.* 23), and *e c*, *e d*, *e x*, contiguous to the ſummits *a*, *e*, of the nucleus. An idea may be formed of its ſtructure by comparing it with that of the dodecaedron whoſe planes form rhombuſes (*fig.* 5 and 12) originating from the cube (*fig.* 7); and by ſuppoſing that the laminæ, inſtead of decreaſing at the ſame time on all the edges, decreaſe only towards thoſe contiguous, three by three, to the angle C, and its oppoſite. In that caſe the faces formed will be reduced to ſix, which, by prolonging themſelves according to the law of continuity, ſo as to interſect each other, will compoſe the ſurface of a rhomboid analogous to that in queſtion; except that it will have other angles on account of the cubical form of its integral moleculæ.

From what I have here ſaid it may be eaſily conceived that the diagonals drawn from *a* to *b'* (*fig.* 22), from *a* to *g'*, from *a* to *f'*, &c. on the ſecondary rhomboid, will be confounded with the edges *a b*, *a g*, *a f*, &c. (*fig.* 23.) of the nucleus, which ſerve as lines of departure for the decrements. Hence it follows, that to extract this nucleus it will be neceſſary to make the planes of the ſections paſs along the diagonals in queſtion, as has been already remarked.

The Common Topaz (Fig. 25).

Rubis et Topaze du Brezil. Daubenton. *Tab. Miner.* edit. 1792, p. 7, n°. 1 and 2.

The inclination of the trapezoid *f r t m* to the adjacent plane *r t e y* 136°; of the ſame plane to *k r y z* 124° 26′; of the plane *t m g e* to *m l i g* 93°.

The primitive form of this topaz is that of a right quadrangular priſm *h y* (*fig.* 24), the baſes of which are rhombuſes, having the angle *h* or *r* = 124° 26′. Theory ſhews that in regard to the integral molecula the height *r y* is to the ſide *r n* almoſt in the ratio of 3 to 2.

The pyramidal ſummit of the topaz reſults from a decrement by two ranges of ſmall priſms on the edges *x r*, *r n*, *n b*, *b x*, of the ſuperior baſe of the primitive form. The planes *t m g e*, *l m g e* (*fig.* 25), on one ſide, and *b k z p*, *b u d p* on the other, ariſe from a decrement by three ranges on each ſide of the edges *n v*, *x q* (*fig.* 24), which decrement remains ſuſpended at a certain term, and leaves four rectangles *t r y e*, *k r y x*, *l h c i*, *u h c d* (*fig.* 25), parallel to the planes of the primitive form. The effect of this decrement is repreſented *fig.* 26, where the rhombus *b n r x* is the ſame as *fig.* 24; and all the ſmall rhombuſes by which it is ſubdivided, or which are exterior to it, repreſent the baſes of as many moleculæ. The lines *x d*, *x z*, *n i*, *n c*, are directed according to the law of decrement already pointed out, and the lines *c d*, *c i*, *y z*, *y e*, anſwer to the planes of the priſm, which are not ſubject to this law.

3. *Decreaſe on the Angles.*

The obſervation which gave birth to the preſent theory, by by pointing out the poſition of the rhomboidal nucleus incloſed in the regular hexaedral priſm of the calcareous ſpar, was not ſufficient to conduct immediately to a determination of the laws of thoſe decrements which produce ſecondary cryſtals. It was neceſſary to paſs through intermediate ſteps more ſimple than the reſult of theſe laws in regard to the priſm in queſtion. I ſhall now proceed to give an idea of theſe laſt reſults, which depend on laws of decrements whoſe lines of departure are not parallel to the edges of the primitive form, but to the diagonals of its faces.

To aſſiſt the imagination in conceiving the method which I have followed to inveſtigate theſe new decrements, I ſhall remark, that the ſame ſubſtances which exhibit the dodecaedron with pentagonal planes originating from the cube (*fig.* 19 and 20), and which might even aſſume the form of the dodecaedron whoſe planes are rhombuſes (*fig.* 5 and 6), are found alſo under that of the regular octaedron. But it appears, on the firſt view, that it might be poſſible to bring the ſtructure of this octaedron to a decrement on the edges of a cube; for, if we confine ourſelves to make the laminæ of ſuperpoſition decreaſe only on the edges of the two oppoſite faces of this cube, for example, on thoſe of the ſuperior baſe A B C D (*fig.* 6), and of the inferior baſe, we ſhall have in general two pyramids applied on theſe baſes; and if we ſuppoſe farther that the faces of theſe pyramids are extended until they meet, which is nothing elſe than continuing the effect of the law of decrements in the ſpace ſituated between the baſes of the cube, we ſhall arrive at an octaedron, the angles of which will vary according as the law ſhall determine a greater or ſmaller number of ranges ſubtracted. But theory demonſtrates that there is no law, however complicated it may be ſuppoſed, which is capable of giving equilateral triangles as the faces of this octaedron.

On the other hand, if we divide a regular octaedron, originating from a cube, we ſhall perceive that the cubic nucleus is ſituated in this octaedron in ſuch a manner that each

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of its ſix ſolid angles correſponds to the centre of one of the faces of the octaedron, which could not be the caſe on the hypotheſis of a decrement on the edges. From this relation of poſition, added to the impoſſibility of applying here the theoretic calculus, I have concluded that the law of decrements accompliſhes its end, in ſuch caſes, by a progreſs different from that which conducts to the forms before deſcribed; and my reſearches, in regard to that point, have unfolded a new order of facts which add much to the fecundity of cryſtalliſation, and at the ſame time to that of its theory. But on this ſubject it is neceſſary to enter into a more particular inveſtigation.

Let A B C D (*fig.* 27) be the ſuperior or inferior ſurface of a lamina compoſed of ſmall cubes, the baſes of which are repreſented by the ſquares that ſub-divide the whole ſquare. If we conſider the ſeries of cubes to which the ſquares *a*, *b*, *c*, *d*, *e*, *f*, *g*, *h*, *i*, belong, it is evident that all theſe cubes will be on the diagonal drawn from A to C, and that they will form one ſtring (*fig.* 28), which will not differ from the ſtring of the cubes *a*, *n*, *q*, *r'*, *s'*, *t'*, *u'*, *z'*, *x'*, (*fig.* 27) lying in the direction of the edge A D; except in this, that in the former the cubes touch only by one of their edges, and in the latter by one of their faces. We ſhall obſerve at the ſame time, throughout the whole extent of the lamina, ſtrings of cubes parallel to the diagonal, one of which is pointed out by the ſeries of letters *q*, *v*, *k*, *u*, *x*, *y*, *z*, another by that of the letters *n*, *t*, *l*, *m*, *p*, *o*, *r*, *s*, and ſo of the reſt.

We may conceive then that the laminæ of ſuperpoſition, inſtead of projecting beyond each other one or more ranges of cubes, in a direction parallel to the edge, project beyond each other in a direction parallel to the diagonal; and we ſhall conſtruct in the like manner around the cubic nucleus ſolids of different figures, by placing, ſucceſſively, above the different faces of this nucleus, laminæ, which may ariſe in the form of pyramids, and which will experience the kind of decrement juſt deſcribed. The faces of theſe ſolids will not be ſimply furrowed by ſtriæ, as when the laminæ decreaſe towards the ridges. They will be roughened by an infinite number of ſalient angles, formed by the exterior points of the compoſing cubes, which is a neceſſary conſequence of the continually angular figure preſented by the edges of the laminæ of ſuperpoſition. But all theſe points being ſituated on a level, we may ſuppoſe the cubes ſo ſmall that the faces of the ſolid will appear to form ſo many ſmooth and continued planes.

But this will be rendered more ſtriking by an example. Let it be propoſed to conſtruct around the cube A B G F (*fig.* 29), conſidered as nucleus, a ſecondary ſolid, in which the lamina of ſuperpoſition ſhall decreaſe on all ſides by a ſingle range of cubes, but in a direction parallel to the diagonals. Let ABCD (*fig.* 30), the ſuperior baſe of the nucleus, be ſub-divided into 81 ſmall ſquares, repreſenting the exterior faces of as many moleculæ. What will be ſaid in regard to that baſe may be applied to the other five faces of the cube.

Figure 31 repreſents the ſuperior ſurface of the firſt lamina of ſuperpoſition, which ought to be placed above A B C D (*fig.* 30), in ſuch a manner that the point *a′* may anſwer to the point *a*, the point *b* to the point *b*, the point *c′* to the point *c*, and the point *d′* to the point *d*. It may be readily ſeen by this diſpoſition that the ſquares A *a*, B *b*, C *c*, D *d*, (*fig.* 30), remain uncovered, which will fulfil the law of decrement above deſcribed. It is moreover ſeen that the borders Q V, O N, I L, G F, (*fig.* 31), project by one range beyond the borders A B, A D, C D, B C, (*fig.* 29), which is neceſſary, that the nucleus may be enveloped towards theſe edges. For a little attention will ſhew, that if this were not the caſe, that is to ſay, if the edges of the lamina repreſented *fig.* 31 as well as the following, coincided with the lines S T, E Z, Y X, M U, on which ſuppoſition they would be on a level with A D, A B, C D, B C, (*fig.* 30), they would form re-entering angles towards the analogous parts

of

of the cryſtal. Thus in the laminæ applied on A B C D (*fig.* 29), all the edges anſwering to CD would be on a level with C D F G, of which they would form a prolongation; and in the laminæ applied on D C G F all the edges analogous to the ſame ridge C D would be on a level with ABCD, from which there would neceſſarily reſult a re-entering angle oppoſite to the ſalient angle formed by the two faces A B C D and C D F G. But the re-entering angles appear to be excluded by the laws which determine the formation of ſimple cryſtals. The ſolid will increaſe then in thoſe parts to which the decrement does not extend. But as this decrement is alone ſufficient to determine the form of the ſecondary cryſtal, we may ſet aſide all the other variations which intervene only in a ſubſidiary manner, except when it is wiſhed, as in the preſent caſe, to conſtruct, artificially, a ſolid repreſentation of a cryſtal, and to exhibit all the details which relate to its ſtructure.

The ſuperior face of the ſecond lamina will be like A′, G′, L′, K′, (*fig.* 32), and this lamina muſt be placed above the preceding in ſuch a manner that the points *a″*, *b″*, *c″*, *d″*, may anſwer to the points *a′*, *b′*, *c′*, *d′*, (*fig.* 31), which will leave uncovered the ſquares that have their exterior angles ſituated in Q, S, E, O, V, T, M, G, &c. and continue to effect the decrement by one range. It is here ſeen that the ſolid increaſes ſucceſſively towards the analogous edges at A B, B C, C D, A D (*fig.* 30), ſince between A′ and L′, for example, (*fig.* 32), there are thirteen ſquares, whereas there are only eleven between Q V and L I (*fig.* 31). But as the effect of the decrement contracts more and more the ſurface of the laminæ in the direction of the diagonals, nothing is neceſſary but to add towards the edges that do not decreaſe, a ſingle cube denoted by A′, G′, L′ or K′, (*fig.* 32), inſtead of the five which terminate the preceding lamina along the lines Q V, G F, L I, O N, (*fig.* 31).

The large faces of the laminæ of ſuperpoſition, which hitherto were octagons, Q V G F I L N O, (*fig.* 31), having arrived at the figure of the ſquare A′ G′ L′ K′ (*fig.* 32)*, will, when they paſs that term, decreaſe on all ſides at the ſame time, ſo that the following lamina will have for its ſuperior face the ſquare B′ M′ I′ S′ (*fig.* 33), leſs by one range in every direction than the ſquare A′ G′ L′ K′ (*fig.* 32): This ſquare muſt be diſpoſed above the preceding in ſuch a manner that the points *c′*, *f′*, *g′*, *b′*, (*fig.* 33), may correſpond with the points *c*, *f*, *g*, *b* (*fig.* 32).

Figures 34, 35, 36 and 37 repreſent the four laminæ which ought to riſe ſucceſſively above the preceding, under this condition, that the ſame letters muſt correſpond as above. The laſt lamina will be reduced to a ſingle cube, diſtinguiſhed by *z′* (*fig.* 38), and which ought to reſt upon that pointed out by the ſame letter *fig.* 37.

It follows from what has been ſaid, that the laminæ of ſuperpoſition applied on the baſe A B C D (*fig.* 29 *and* 30) produce by the total of their decreaſing edges four faces, which, in proceeding from the points A, B, C, D, incline one to another in the form of a pyramidal ſummit.

It is here to be remarked, that the edges in queſtion have lengths which begin by increaſing, as may be ſeen on inſpecting *fig.* 31 and 32, and which then proceed decreaſing, as may be ſeen by the following figures. It thence reſults that the faces produced by the ſame edges increaſe at firſt, and afterwards decreaſe in breadth, ſo that they become quadrilaterals. Figure 39 repreſents one of theſe quadrilaterals, in which the inferior angle C is confounded with the angle C (*fig.* 29) of the nucleus; and the diagonal L Q repreſents the edge L′ G′ of the lamina A′ G′ L′ K′ (*fig.* 32), which is the moſt extended in the direction of that edge. And as the number of the laminæ of ſuperpoſition which produce the triangle LCQ (*fig.* 39) is leſs than that of the laminæ which produce the triangle LZQ, ſince there is here only one

* In the preſent caſe this figure takes place from the ſecond lamina of ſuperpoſition. By aſſuming a nucleus compoſed of a greater number of moleculæ, it is evident that we ſhould have a more remote boundary.

lamina preceding the lamina A′ G′ L K′ (*fig.* 32), while there are ſix which follow it as far as the cube *z* (*fig.* 38) incluſively, the triangle **L Z Q** (*fig.* 39), compoſed of the ſum of the edges of theſe latter laminæ, will have a much greater height than the inferior triangle L C Q, as expreſſed in the figure.

The ſurface of the ſecondary ſolid will be formed then of 24 quadrilaterals, diſpoſed three and three around each ſolid angle of the nucleus. But in conſequence of the decrement by one range, the three quadrilaterals which belong to each ſolid angle, ſuch as C (*fig.* 29), will be in the ſame plane, and will form an equilateral triangle Z I N (*fig.* 40). The twenty-four quadrilaterals then will produce eight equilateral triangles, one of which is repreſented *fig.* 41, in ſuch a manner as to ſhew, on a ſimple view, the aſſortment of the cubes that concur to form it; and the ſecondary ſolid will be a regular octaedron. Figure 42 ſhews this octaedron in which the cubic nucleus is incloſed, ſo that each of its ſolid angles C, D, F, G, &c. correſponds to the centre of one of the triangles I Z N, I P N, P I S, S I Z, &c. of the octaedron. It may be readily ſeen, that to extract this nucleus, it would be neceſſary to divide the octaedron in its eight ſolid angles, by ſections parallel to the oppoſite edges. For example, the ſection made in the angle Z ought to be parallel to the edges I S, IN, T N, T S; and hence will reſult a ſquare which will itſelf be ſituated parallel to the ſuperior baſe A B C D of the nucleus, and which will be confounded with that baſe when the ſections have made the faces of the octaedron to diſappear entirely.

This ſtructure is that of the octaedral ſulphure of lead (galena), and the muriate of ſoda (common ſalt) of the ſame form.

I call decrements on the angles, thoſe which take place in a direction parallel to the diagonals, as in the example juſt mentioned. This denomination will ſupply us with the means of expreſſing in a preciſe manner the reſult of each

 decrement,

decrement, by pointing out the angle which ſerves it as a point of departure.

Other Examples of Decrements on the Angles.

Acute calcareous Spar (*fig.* 43).

Spath calcaire rhomboidal aigu. Daubenton, *Tab. Miner*, edit. 1792, p. 15. n°. 3. *Spath calcaire muriatique.* De l'Iſle *Chryſtallographie*, t. i. p. 520. var. 12.

Geomet. Charact. Inclination of *p z r y* to *p u o y* 78° 27′ 47″ and to *i r z s* 101° 32′ 13″. Angles of the rhombus *p z r y*, *p* or *r* = 75° 31′ 20″; *z* or *y* = 104° 28′ 40″. Inclination of the oblique diagonal drawn from *p* to *r* with the edge *p u*, 71° 33′ 54″.

Geomet. Propert. The angles of the rhombus are equal to the reſpective inclinations of the faces of the nucleus, and reciprocally.

The angles of the principal quadrilateral, or that which paſſes through two oppoſite oblique diagonals *pr*, *ui*, and through the intermediate edges *pu*, *ir*, are the ſame as on the nucleus.

To conceive the ſtructure of this rhomboid, let us ſuppoſe that *a b d f* (*fig.* 44) repreſents the face of the nucleus marked by the ſame letters (*fig.* 4), ſubdivided into a multitude of partial rhombuſes, which are the exterior faces of ſo many moleculæ. Let us ſuppoſe farther, that the laminæ of ſuperpoſition, applied on this face, decreaſe by one range towards the lateral angles *a b d*, *a f d* in ſuch a manner that, on the firſt the two rhombuſes *b h k l*, *f m i n* are uncovered, that on the ſecond the uncovered rhombuſes are thoſe traverſed by the diagonals *c o*, *u y*, on the third thoſe traverſed by the diagonals *s t*, *q z*, &c. in which caſe the decreaſing edges will ſucceſſively correſpond with theſe diagonals. This law of decrement will produce two faces, which proceeding from the angles *b*, *f* will riſe in the form of a roof above the rhombus *a b d f*, and will meet on a common edge ſituated immediately above the diagonal *a d*, and which will

be

be parallel to it; and as there are ſix rhombuſes that undergo like decrements on the primitive form, the faces produced will be twelve in number. But in virtue of the law of decreaſe by one range, the two faces which have the ſame angle, *b*, *f*, *g*, &c. (*fig.* 4), for the point of departure, will be in the ſame plane, which reduces the twelve faces to ſix, and transforms the ſecondary cryſtal into an acute rhomboid *p i* (*fig.* 43).

This rhomboid, from what has been ſaid, has its edges, *p z*, *p y*, *p u*, ſituated each as the oblique diagonals of the nucleus, or thoſe which would be drawn from *a* to *d*, from *a* to *x*, from *a* to *c*, &c. (*fig.* 4).

The edges of the laminæ of ſuperpoſition experience, in the parts to which the decrement does not extend, auxiliary variations, in virtue of which they are prolonged to envelop the nucleus towards theſe parts, as in the regular octaedron, the ſtructure of which has been already explained. Moreover, while the laminæ decreaſe, for example on the angles *a f d*, *a f x*, (*fig.* 4), they undergo alſo towards the adjacent angle *d f x*, variations which intervene in a ſubſidiary manner to aid the effect of the principal decrement. The variations here are alſo decrements by a ſimple range on the inferior angles. But in caſe the principal decrement ſhould proceed by two ranges, three ranges, or a much greater number, theſe variations would become decrements of a particular nature, and which would not be parallel to the diagonals.

In ſhort, we might apply here what we have already ſaid in regard to the firſt variations conſidered on the regular octaedron, and obſerve, that the principal decrement alone determines the form of the ſecondary cryſtal; ſo that this decrement being well comprehended, nothing is then neceſſary but to ſuppoſe its effect prolonged, in order that the faces to which it gives birth may interſect each other in ſuch a manner as to circumſcribe entirely the ſpace to which they correſpond.

M. Bournon has diſcovered beautiful cryſtals of this variety at Couſon near Lyons. It is obſerved alſo in ſmall yellowiſh cryſtals, often thrown together in confuſed groups in the calcareous banks near Paris. The freeſtone (lapis arenarius) of Fontainbleau, which is nothing elſe than calcareous ſpar accidentally mixed with quartzy particles, exhibits the ſame form. The cryſtals of this ſtone yield to the mechanical diviſion, and have their natural joinings, like thoſe of the cryſtals of pure ſpar, ſituated in the planes parallel to the edges *p z*, *p y*, *p u*, &c. (*fig.* 43), and which would paſs at an equal diſtance from theſe edges.

Rhomboidal Iron Ore (*fig.* 45).

Mine de fer lenticulaire. Daubenton, *Tab. Miner.* edit. 1792. p. 30, n°. 3.

Geomet. Charact. Inclination of B C R P to B C O A or O C R S, 146° 26′ 33″; Angles of the rhombus B C R P, C or P = 117° 2′ 9″; B or R = 62° 57′ 51″.

The laminæ which compoſe this rhomboid decreaſe by two ranges on the angles *b c r*, *o c r*, *b c o*, &c. (*fig.* 46), which concur to the formation of the two ſolid angles *c*, *n*, of a cubic nucleus. The faces produced, inſtead of being on a level, three and three, around theſe angles, as in the caſe of a decrement by a ſingle range, incline one to the other, and extend above the faces of the nucleus in ſuch a manner that their diagonals are parallel to the horizontal diagonals of the ſame faces.

By this it is ſeen that the cube here anſwers the purpoſe of a rhomboid, which ſhould have its ſummits in *c* and *n*, in which caſe there would be only one axis paſſing through the ſummits in queſtion. In the dodecaedron, on the other hand, with pentagonal planes (*fig.* 19), the cube performs the functions of a rectangular parallelopipedon, and then we may conceive three different axes, each of which paſſes through the middle of the two oppoſite faces. I have obſerved that when the cube began to perform the one or other

other function, in regard to one species of mineral, it continued that function in all the varieties of that species.

The crystals of rhomboidal iron are found among those of the iron ore of the island of Elba. But it is very uncommon for the law of decrement to attain to its boundary, and for the rhomboid not to be modified by facets parallel to the faces of the nucleus.

If the decrement which produces the rhomboid took place at the same time on the eight solid angles of the cube, there would result from it a polyedron of 24 facets, all like the trapezoidal granite, of which I shall speak hereafter, but with a very different structure. This result is realised by nature in the crystals found at the Calton-hill near Edinburgh, which are considered as zeolites.

[*To be continued.*]

X. *Method to destroy or drive away Earth-worms and various other Insects hurtful to Fields and Gardens, by* M. SOCOLOFF. *From the* New Transactions of the Imperial Academy of Sciences at Petersburgh, *Vol. V.*

THOUGH it is certain that earth-worms occasion great destruction by gnawing the tender roots of shrubs and plants, and that other insects, such as caterpillars and locusts, are exceedingly hurtful both to fields and gardens, few have given themselves the trouble to devise any remedy for this evil. I flatter myself, therefore, that I shall do a service to the public if I point out an easy and sure method, certified by experience, of either killing or driving away from fields and gardens all noxious vermin.

As the destructive power of quick-lime, heightened by a fixed alkali, which corrodes, dissolves and destroys all the tender parts of animals, has been long known, I thought this mixture would be the best means for accomplishing the object I had in view. I took three parts, therefore, of quick-

lime

lime, newly made, and two parts of a saturated solution of fixed alkali in water, and thence obtained a somewhat milky liquor sufficiently caustic, highly hostile and poisonous to earth-worms and other small animals; for, as soon as it touched any part of their bodies, it occasioned in them violent symptoms of great uneasiness. If this liquor be poured into those holes in which the earth-worms reside under ground, they immediately throw themselves out as if driven by some force; and, after various contortions, either languish or die. If the leaves of plants or fruit-trees, frequented by the voracious caterpillars, which are so destructive to them, be sprinkled over with this liquor, these insects suddenly contract their bodies and drop to the ground. For though nature has defended them tolerably well by their hairy skins from any thing that might injure their delicate bodies, yet, as soon as they touch with their feet or mouths leaves which have been moistened by this liquor, they become as it were stupefied, instantly contract themselves, and fall down.

I had not an opportunity of trying a like experiment on locusts: yet we may conclude, and not without probability, from their nature, and the general destructive qualities of the above liquor, that they, in the like manner, may be driven from corn-fields, if it be possible to sprinkle the corn with the liquor by means of a machine.

With regard to plants or corn, these sustain no injury from the liquor, because it has no power over the productions of the vegetable kingdom, as I have fully learned from experience; or, if any hurt is to be suspected, all the danger will be removed by the first shower that falls. This liquor may be procured in abundance in every place where lime is burnt. If the lime be fresh, one part of it infused in about seventy parts of common water will produce real lime-water. The want of the fixed alkali may be supplied by boiling wood-ashes in water, and thickening the lye by evaporation.

This liquor might be employed also to kill bugs and other

domestic

domestic insects which are noxious and troublesome; but, on account of its strong lixivious smell, which disposes the human body to putridity, I dare not recommend the use of it in houses that are inhabited. Besides, bugs may be easily got rid of, as I have repeatedly found from experience, by the oily pickle that remains in casks in which salted herrings have been packed. To this liquor they have a strong aversion; and, if they are moistened with it, they die in a very short time.

XI. *On the Revivification of some Kinds of Insects killed in Spirit of Wine. By* M. SOCOLOFF. *From the* New Transactions of the Imperial Academy of Sciences at Petersburgh, *Vol. V.*

IT is very singular, and worthy of great attention, that a small insect intoxicated with spirit of wine and then immersed in it, or killed on purpose in that manner, may, by certain means, be revivified, after having been deprived of all signs of life for about a quarter of an hour. I had occasion to observe this circumstance, for the first time, in common flies; for it is well known that these insects are strongly attracted by the smell of spirit of wine; and that, becoming intoxicated by it, they fall into the liquor, and are drowned. Having thrown a great number of flies which had perished in this manner in a glass, into a stove among wood ashes scarcely warm, and looking into the stove a little while after, on account of some experiments I was making, I observed, not without astonishment, the flies start up from the ashes, and, after wiping themselves clean from the dust adhering to their wings, fly away as if nothing had happened to them*.

My

* A circumstance of a similar kind occurred to the late Dr. Franklin. While he resided in France he received from America a quantity of Madeira

My curiosity being excited by this circumstance, I left a wide-mouthed glass, into which I had put some spirit of wine, uncovered, on purpose, and, having collected the flies which I afterwards found dead in it, I buried them carefully among the before-mentioned wood-ashes; and in a little time, when the moisture of the spirit had been completely absorbed by the ashes, I observed them all revivified. Being convinced in this manner that the experiment would succeed with common flies, I resolved to make a like trial with other kinds of insects. I therefore took some small beetles, which were those nearest at hand, put them into a glass filled with spirit of wine, and, when they were perfectly dead, covered them with ashes. These, to my great satisfaction, were restored to life in the like manner.

I made an experiment also with a small spider and a young moth, by depriving them of life five different times within the course of three hours, and always with the wished-for success, except that the spider, after the last experiment, was become so languid and weak that it could scarcely crawl. I found the like effect to be produced on bugs, only that it was necessary to keep them longer in the ashes before they were brought to life.

In regard to butterflies I cannot speak with certainty, as those on which I made experiments were feeble and sickly. Common wood-lice on the other hand, after being killed in spirit of wine, I could not bring to life by the same means. Further experiments on this subject I shall leave to naturalists and physicians, who, perhaps, may infer from the above observations, that warm wood-ashes might be employed, not

deira wine which had been bottled in Virginia. In some of the bottles he found a few dead flies, which he exposed to the warm sun, it being then the month of July, and in less than three hours these apparently dead animals recovered life which had been so long suspended. At first they appeared as if convulsed; they then raised themselves on their legs, washed their eyes with their fore feet, dressed their wings with those behind, and began in a little time to fly about. EDIT.

without advantage, by way of fomentation, to gouty and paralytic limbs, and for thoſe afflicted with rheumatic complaints.

XII. *Chemical Experiments reſpecting different Methods of rendering Paper and the Writing on it indeſtructible by Fire. By* Mr. L. BRUGNATELLI. *From* Crell's Chemical Annals *for* 1797.

Various Methods of rendering Writing indeſtructible.

[Concluded from Page 92.]

WHEN I had diſcovered the means by liquor of flint to render paper ſo much leſs combuſtible, and alſo in particular to prevent its being converted into aſhes, I reſolved to examine how common ink would ſtand on paper prepared in that manner. I imagined that ink, on account of the oxydated metal contained in its mixture, would not be ſo eaſily deſtroyed by the fire; for, though it is not naturally black when freed from the acid of galls, it muſt however be ſomewhat viſible as ſoon as the ſubſtance on which it is put is rendered indeſtructible. And this I actually found to be the caſe, after writing a few lines with good common ink upon a leaf of paper which had been carefully prepared with liquor of flint, and putting it into the fire till it was burnt to a coal. I examined the writing with attention, and found that ſeveral words which I had written upon it could be read, though the paper was reduced to a coal. All the words could not indeed be diſtinguiſhed with the ſame clearneſs, and therefore they could not be all properly read. Some of them had a red ochrey colour, and theſe were the cleareſt; others were blackiſh, and ſome were of ſo dark a tint that they were almoſt entirely blended with the colour of the charred paper: the laſt were totally illegible. Theſe phenomena are perfectly agreeable to the nature of oxydated iron,

iron, which, as is well known, aſſumes the above-mentioned tints, according as it contains more or leſs oxygene or carbon.

On account of the oxydated iron, as I could not employ common ink for my propoſed object, I ſought among the oxydated metals for one that was capable of ſtriking the eye on a black ground, and which at the ſame time would combine with common ink *.

To common ink I added a portion of oxydated biſmuth, which, according to its own nature, is exceedingly white, and which on a black ground would produce viſible characters that muſt then be legible. I prepared the mixture, and obtained a ſomewhat thick ink, which did not flow readily, and with which I could write a few lines, but not without difficulty. Paper written upon with this ink I burnt in a wood fire, and examined it as ſoon as it was reduced to coal. I however found that the words were not more legible than thoſe written with common ink; for the oxydated biſmuth communicated its oxygene to the inflammable parts of the mixture, and the whole was revived into a metallic regulus: ſeveral ſmall grains of regulus of biſmuth could therefore be diſtinguiſhed in it with the naked eye. I mixed common ink with ſeveral other oxydated metals, and with ſeveral kinds of earths; but the ink by theſe was ſo much changed in its colour and conſiſtence, that I thought it unneceſſary to pay any farther attention to it. I had recourſe, therefore, to diſſolved metals, becauſe ink by theſe is not changed in its conſiſtence, as by oxydated metals, and particularly earthy bodies.

But before I made any mixture with common ink, I wiſhed to try what colour characters made with diſſolved metals only would aſſume, on paper prepared as before, when reduced to coal.

I wrote, therefore, on different leaves of paper, which had been ſoaked in liquor of flint, with a common ſolution of

* For common ink any other black dye may be ſubſtituted.

gold,

gold; nitrite of ſilver, copper, tin, lead, biſmuth, cobalt, antimony, and manganeſe. None of the characters written with the above ſolutions could be read by the naked eye, except that written with nitrite of copper, which appeared of a beautiful green colour. I burnt all theſe leaves in a flame, and the reſults were as follows:

The characters made with ſolutions of gold and ſilver were not viſible on the charred paper, on account of the dark tint which they aſſumed in the fire. The caſe was the ſame with thoſe characters made by ſolutions of cobalt, antimony, and lead.

I have found that diſſolved nitrite of cobalt may be employed with great advantage for making ſympathetic ink, not inferior to the celebrated ink prepared from the ſame metal diſſolved in the nitro-muriatic acid, or aqua-regia; which, as is well known, becomes viſible of a beautiful green colour by heat, and diſappears in the cold. Characters written with diſſolved nitrite of cobalt became viſible, of a beautiful violet colour, on paper prepared as above. I held the leaf of paper, on which I had written with the before-mentioned ſolution, a few ſeconds over the fire; and when I took back the leaf I could read the characters, before inviſible, as they now appeared of a violet colour; but the colour gradually diſappeared, and the writing again became inviſible. When I held the paper ſo near the fire that it was a little ſinged, the characters appeared white, and diſappeared again in the cold.

Characters made with nitrite of antimony were not viſible, becauſe they were as black as the charred paper. But when the paper was held to the light they could be read a little, becauſe the oxydated metal made the characters exceedingly opaque, and therefore eaſily to be diſtinguiſhed from the reſt of the paper, which was more or leſs tranſparent.

Characters made with diſſolved nitrite of tin gave the ſame reſult as the preceding. Thoſe alſo made with a ſolution of biſmuth were ſcarcely viſible after being in the fire; and when the fire was briſk it deſtroyed the charred paper; while

while the oxydated bismuth was converted into metal *. The invisible letters made with a solution of this metal can be read also, if the paper be dipped into pure water. By this simple process the characters appear of a white colour, as the paper becomes somewhat darker. The writing, however, may be read better if the paper be then held to the light, because the paper, which becomes somewhat transparent, suffers the characters, which are altogether dark, to be seen.

I thought it unnecessary to make any experiments with dissolved arsenic and quicksilver, because their oxydes easily suffer the oxygene to escape; sublime in the fire, and then entirely fly off from the burning body.

Of all the metallic salts, I found only nitrite of copper and zinc fit for my proposed object; for the calces of these metals continue fixed in the fire, and shew themselves afterwards in durable and bright colours.

The characters which I wrote with dissolved nitrite of copper were exceedingly visible, of a copper colour on the charred paper, and this colour can be well distinguished on a dark ground. When I wrote with dissolved ammoniacal copper, instead of nitrite of copper, the characters assumed in the fire a dark red colour, which approached that of cinnabar. Dissolved nitrite of zinc, however, is the best of all the substances with which I made experiments, because characters written with it on paper prepared by liquor of flint were legible; and it is therefore preferable to solutions of copper, or of any other substance.

When I wrote with dissolved nitrite of zinc, the characters were not visible; but when the paper was burnt they were

* To observe this phenomenon better, it will be sufficient to write on a leaf of paper which has been impregnated with sal-ammoniac, and then to burn it over the flame of a candle. The charred paper remains smooth: but at the places where the characters were written a beautiful small border of regulus of bismuth is seen, so that when the paper is held to the light many of the words written upon it may be read.

so

ſo viſible, in a clear white colour on a dark ground, that they could be read with as much eaſe as characters written with the beſt ink on white paper.

I ſhall now examine whether diſſolved nitrite of zinc, which produces ſo beautiful a ſympathetic ink, can be combined with common ink, without the latter being ſo changed in its colour as to be rendered unfit for uſe as before. I made this mixture, and found that the ink became ſomewhat pale by the nitrite of zinc, on account perhaps of the nitrous acid, which probably leſſened the combination of the acid of galls with the iron: but I could write with it very well on paper prepared by my liquor of flint; for the colour of common ink mixed with nitrite of zinc, which appeared on common paper to be ſomewhat weakened, became ſo dark on prepared paper, that words written with it appeared more conſpicuous than thoſe written with common ink. The white colour of which the characters appeared, on the charred paper, was not changed by the mixture of ink, as I was fully convinced by repeated experiments.

One part of my curioſity was ſtill not gratified, as I wiſhed to know of what colour the diſſolved metals would appear on paper impregnated with different ſalts. For that purpoſe I made the following experiments:

I wrote on paper, which had been impregnated with acetite of barytes, with a ſolution of gold, nitrite of ſilver, copper, biſmuth, tin, lead, antimony and zinc. The characters written with a ſolution of gold appeared on the charred paper of a beautiful poppy red, and thoſe with a ſolution of copper of a dark yellow. Thoſe written with a ſolution of antimony, zinc, biſmuth, tin and lead, could not be ſeen.

I wrote alſo with ſolutions of the above metals on paper which had been ſoaked in muriate of lime. The characters written with ſolutions of gold and ſilver appeared on the paper like thoſe written on paper ſoaked in acetite of barytes. Thoſe written with ſolutions of lead and biſmuth appeared white; and thoſe written with a ſolution of copper appeared

red. Thoſe written with ſolutions of tin, antimony and zinc, were not legible. Paper impregnated with ſulphite of potaſh was totally deſtroyed in the flame, as above remarked. I thought it neceſſary therefore to make experiments with other ſulphites; becauſe I had before obſerved that ſuch ſalts, by means of inflammable bodies, are converted into ſulphureous bodies.

I wrote alſo with the common diſſolved metals, on paper which had been impregnated with muriate of ſoda. The characters written with a ſolution of gold could ſcarcely be diſtinguiſhed of a dark red colour; but thoſe written with all the other diſſolved metals were not legible.

I wrote with the ſame ſolutions on paper which had been ſoaked in a ſolution of muriate of ammoniac, but none of the characters were viſible on the paper when reduced to coal.

I wrote, in the laſt place, with the ſame ſubſtances on paper which had been ſoaked in a ſolution of nitrite of lime, and, when reduced to coal, I could read the characters written with a ſolution of gold of a beautiful roſe red; and thoſe written with a ſolution of ſilver of a yellow colour; but the charred paper was white. The other characters were not legible, except thoſe written with nitrite of biſmuth, which had aſſumed a blackiſh colour.

The other pieces of paper ſoaked in ſolutions of different ſalts gave no reſult worthy of notice.

The above obſerved effects and before-mentioned chemical preparations were the means of leading me to ſeveral pleaſant experiments. I wiſhed, for example, to bring it about that the burnt paper ſhould be converted into a white indeſtructible coal, on which the characters might be legible of different colours, and accompliſhed my object in the following manner:—I rubbed ſome gum arabic mixed with pure magneſia by means of a hair bruſh, over the paper ſoaked in liquor of flint. When the paper was dry, I wrote on it ſeveral lines, ſome with a ſolution of gold, and others with a ſolution of antimony in aqua-regia. The characters made

with

with both these solutions were totally illegible. I then threw the prepared paper thus written upon into the fire; and when it was wholly reduced to a coal, all the lines could be read of a black colour on a white ground, so that the characters were almost like those written with common ink on white paper. If it be required to make the solutions of gold and antimony black, that the words written with them may be more distinguishable before the paper is burnt, it will only be necessary to add a little common ink to them, but such as contains as small a quantity as possible of the sulphite of iron*.

I dipped paper which had been prepared with liquor of flint in a saturated solution of nitrite of zinc, and suffered it to become exceedingly dry in the sun. I then wrote on several bits of this paper with the solutions of different metals, and a few hours after reduced them all to coal, by holding them one after the other in the fire. Characters written with dissolved nitrite of copper appeared of the colour of metallised copper; those written with dissolved nitrite of iron, or bismuth, of a yellow colour; those with

* In the same manner as charred paper is made to assume a white colour when it has been before washed over with a mixture of gum arabic and magnesia, it may be made to assume any other colour if the paper be dipped sometimes in one and sometimes in another of the above-mentioned solutions, as the characters on the charred paper will then assume sometimes one colour and sometimes another. If paper, for example, which has been soaked in liquor of flint, be held a little in a solution of sulphite of copper, and then dried, the paper will assume a beautiful green colour. If the paper be burnt, it assumes a copper colour. If you write on paper, already tinged green, with any metallic solutions of metals which are not so easily decomposed by the action of the fire, singular phenomena will be observed. If you write on it with sulphite of iron, the characters will be read of a yellowish colour. When the paper is reduced to coal, the characters are still seen yellow. If you write with dissolved nitrite of antimony, the characters appear whitish. If the characters are written on such paper with nitrite of zinc, they are invisible; but when the paper is reduced to coal, they appear of a silver colour, &c.

diſſolved nitrite of antimony, black; and thoſe with a ſolution of gold, of a gold colour. Thoſe made with the laſt ſolution appeared ſeveral times of the colour of black velvet. When you write on the above-mentioned paper with iron diſſolved in diluted nitrous acid, the characters will appear of an orange yellow colour, if the paper be often heated without reducing it to coal.

P. S. I am now employed in endeavouring to diſcover a method of rendering paper prepared with liquor of flint ſtronger, ſo that when burnt it may not be ſo friable, in order that when ſeveral ſheets of paper are burnt upon each other they may be eaſily ſeparated, and the whole writing on them be read. As ſoon as I have derived any reſults from my experiments, I ſhall not fail to communicate them.

XIII. *On Teſt Liquors for detecting Acids and Alkalis in Chemical Mixtures. Extracted from Mr.* WATT's *Paper on that Subject in the* Philoſophical Tranſactions *for* 1798, *Part I.*

MR. WATT of Birmingham, to whom the philoſophical world is ſo much indebted for various diſcoveries and improvements, has turned his attention to this ſubject, and has favoured the world with the reſult of his inveſtigation. He obſerves, that the great degree of ſenſibility of an infuſion of litmus (ſyrup of violets having been for ſome time out of uſe as a teſt, as it has been found not to be ſufficiently accurate), the blue colour of which is changed into red by the preſence of a very minute quantity of any acid, would leave very little neceſſity to ſearch for any other, were there reaſon to believe that it is always a teſt of the exact point of ſaturation of acids and alkalis, which the following fact ſeems to call in queſtion:——"A mixture of phlogiſticated nitrous acid with an alkali will appear to be acid by the teſt of litmus, when other teſts, ſuch as the infuſion of the petals of the ſcarlet roſe, of the blue iris, of violets, and of other

other flowers, will ſhew the ſame liquor to be alkaline by turning green."

Paper ſtained with infuſions, or with the juices of the petals of ſuch flowers as have been juſt mentioned, though an excellent teſt for alkalis, is not ſo eaſily affected by acids as litmus, and, by keeping, loſes in a ſhort time much of its ſenſibility.

To obtain freſh made teſts from vegetables, few of which are to be met with in winter, was a matter of conſiderable moment. Mr. Watt found the red cabbage (braſſica rubra) to furniſh the beſt. In its freſh ſtate it is more ſenſible both to acids and alkalis than even litmus, and more deciſive from its being naturally blue; turning green with alkalis, and red with acids.

Mr. Watt extracts the colouring matter from the thin parts of the leaves only. He minces them ſmall, and digeſts them in water about the heat of 120° for a few hours. If not to be immediately uſed, as it is apt to ſpoil, Mr. Watt recommends to ſpread the minced leaves on paper, to dry them in a gentle heat, and then to put them in bottles well corked. To prepare the teſt, infuſe or digeſt theſe dried leaves in water acidulated with ſulphuric acid till they give out their colour; then ſtrain the liquor through a cloth, and add to it whiting or chalk, ſtirring it frequently, until it becomes a true blue, neither inclining to green nor to purple. When this point is gained, filter it immediately; otherwiſe it will become greeniſh by ſtanding on the chalk. It will depoſit ſome gypſum, and, by adding a little ſpirit of wine, will keep good for ſome days. Too much ſpirit deſtroys the colour. If wanted to be kept longer, neutraliſe it by means of a fixed alkali inſtead of chalk. But as none of theſe means will preſerve the liquor long without requiring to be neutraliſed afreſh juſt before it is uſed; and as the fermentation which it undergoes, and perhaps the alkalis or ſpirit of wine mixed with it, ſeem to leſſen its ſenſibility; in order to preſerve its virtues, while it is kept in a liquid ſtate, ſome freſh leaves, minced as has been directed, may be infuſed in a mixture of vitriolic acid and water, of about the degree of acidity of vinegar; and it may be neutraliſed as it is wanted, by chalk, or fixed or volatile alkali. Avoid an exceſs of alkali, as it will turn the colour yellow.

By the ſame proceſs Mr. Watt made a red infuſion of violets, which on being neutraliſed formed a very ſenſible teſt; but how long it might be preſerved, he had not determined.

Mr. Watt recommends to uſe the teſts in a liquid ſtate; as he obſerves, and with juſtice, that the ſize and alum in writing-paper in ſome degree fix the colour, while paper not ſized becomes too tranſparent, when wetted, to render ſmall changes of colour perceptible.

To the above uſeful hints of Mr. Watt we ſhall add another.—The ſkins of red radiſhes yield by being bruiſed a very ſenſible teſt, and, no doubt, might be preſerved by the means he has pointed out.

XIV. *An Account of the Sugar Maple of the United States, by* Benjamin Rush, *M. D. Profeſſor of the Inſtitutes of Medicine in the Univerſity of Pennſylvania, communicated by* Robert John Thornton, *M. D. Lecturer on Medical Botany at Guy's Hoſpital.*

THE *acer ſaccharinum* of Linnæus, or ſugar maple tree, is found in great abundance in the weſtern counties of all the middle ſtates of the American Union. Thoſe which grow in New York and Pennſylvania yield the ſugar in a greater quantity than thoſe which grow on the water of the Ohio. They are when at maturity, that is, when about twenty years old, as tall as an oak, and from two to three feet in diameter. They put forth a beautiful white bloſſom in the ſpring before they ſhew a ſingle leaf. The colour of the bloſſom diſtinguiſhes the ſugar maple from the *acer rubrum*, or common maple, which has a red flower. Its ſmall branches

branches were cut by the firſt ſettlers for the ſupport of cattle during the winter, who throve greatly upon them. The wood is extremely inflammable, and therefore makes fine fire-wood. Its aſhes afford a great quantity of pot-aſh, exceeded by few, or perhaps by none, of the trees that grow in the woods of the United States.

The acer ſaccharinum is not injured by tapping; on the contrary, the oftener it is tapped, the more ſyrup is obtained from it. The effects of a yearly diſcharge of ſap from the tree in improving and increaſing the ſap, is demonſtrated from the ſuperior excellence of thoſe trees which have been perforated in an hundred places by a ſmall wood-pecker which feeds upon the ſap. The ſap of ſuch trees is much ſweeter to the taſte than that obtained from trees which have not been previouſly wounded, and more ſugar is afterwards procured. In this laſt particular it follows a law of the animal œconomy. It is well known, that when a perſon has been once tapped, the proceſs requires afterwards to be more frequently repeated. A ſingle tree has not only ſurvived, but flouriſhed after forty-two tappings in the ſame number of years.

A tree of an ordinary ſize yields, in a good ſeaſon, from twenty to thirty gallons of ſap, from which are made from five to ſix pounds of ſugar. To this there are ſometimes remarkable exceptions. Samuel Low, Eſq. a juſtice of peace in Montgomery county, in the State of New York, informed Arthur Noble, Eſq. that he had made twenty pounds and one ounce of ſugar from the 14th to the 23d of April, in the year 1789, from a ſingle tree that had been tapped for ſeveral ſucceſſive years before. The quantity obtained per diem varies from five gallons to a pint, according to the variations of the weather. The influence which this has in increaſing or leſſening the diſcharge of the ſap is very remarkable. I have ſeen a journal of the effects of heat, cold, moiſture, drought, and thunder, upon the diſcharges from the ſugar tree; which diſpoſes me to believe there is ſome foundation in Dr. Tongue's opinion, who ſuppoſes that changes in the weather of every kind might be as readily aſcertained by diſcharges of ſap from trees, as by the barometer. (Vide Philoſophical Tranſactions, N° 68.) Warm days ſucceeding froſty nights are moſt favourable to a plentiful diſcharge of ſap. If froſty nights ſucceed a warm day, there is always a total ſuſpenſion of the diſcharge *.

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* Dr. Hale, in his Vegetable Statics, relates that he cut down a vine, and cemented to its mutilated ſtump glaſs tubes, each 7 feet long, and one fourth of an inch diameter, with braſs caps, by which they were ſcrewed on one above another, till they roſe to the height of 36 feet.

By theſe gages it appeared,

1ſt. That the ſap began to riſe March 10, when the thermometer by day ſtood only at 3 degrees above the freezing point.

2dly. That, April 18, it was at its height and vigour.

3dly. That from that time to May 5, the force gradually decreaſed.

4thly. That it conſtantly roſe faſteſt from ſun-riſe to about 9 or 10 in the morning, and then gradually ſubſided till about 5 or 6 o'clock in the afternoon.

5thly. That it roſe ſooner in the morning after cool weather, than after hot days, and in proportion to the coldneſs of the night and ſubſequent heat.

6thly. That after ſeveral ſucceſſive cold days and nights, the ſap would riſe during the whole day, if it chanced to be fine, although ſloweſt at noon.

7thly. That if warm weather had made the ſap flow vigorouſly, that vigour would be abated immediately by a cold eaſterly wind and a cloudy ſun, when the ſap would ſink at the rate of an inch per minute; but when the ſun ſhone out, and the wind ſhifted, it roſe again as uſual.

8thly. The oldeſt vines were ſooneſt affected by a change of temperature, and in them the ſap firſt began to ſink.

9thly. And, on the contrary, when the tube was fixed to a very ſhort ſtump of a young vine, and at only 7 inches from the ground, the ſap flowed inceſſantly, and faſteſt of all, in the greateſt heat of the day, ſinking only after ſun-ſet.

He then makes this general concluſion, that the rapidity with which the ſap circulates in the vine during the ſpring, is five times greater than the rapidity with which the blood flows in the arteries of a horſe; that it is conſiderably ſlower in the ſummer than in ſpring, very languid in autumn, and ceaſes altogether in the winter.

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The ſap uſually flows for ſix weeks, varying according to the temperature of the weather. The ſeaſon for tapping is in February, March, and April. During the remaining part of the ſpring months, as alſo in the ſummer, and in the beginning of autumn, the maple tree yields a thin ſap, but not fit for the manufactory of ſugar.

Baron La Hontan gives the following account of the ſap of the ſugar maple tree, when uſed as drink, and the manner of obtaining it. The tree, ſays he, yields a ſap which has a much pleaſanter taſte than the beſt lemonade or cherry water, and is the wholeſomeſt drink in the world. This liquor is drawn by cutting the tree two inches deep in the wood, the cut being made ſloping to the length of ten or twelve inches; at the lower end of this gaſh, a knife is thruſt into the tree ſlopingly, ſo that the water runs along the cut or gaſh, as through a gutter, pervades the knife, and falls upon ſome veſſels placed underneath to receive it. The gaſh does no harm to the tree. Some trees will yield five or ſix bottles of this water in a day, and many inhabitants of Canada might draw twenty hogſheads of it in one day, if they had a mind to notch all the maple trees upon their plantations; but common things are ſlighted, and ſcarce any but children think of extracting this liquor from the trees.

The mode of tapping is different, and is performed with an axe or an auger. The latter is preferred, from experience of its advantage. It is introduced about three quarters of an inch, and is afterwards deepened gradually to the extent of two inches. A ſpout is introduced about half

The above experiments clearly demonſtrate, that it is not from heat and light alone that the ſap riſes in the vine, or any other tree; for, if that were the caſe, it would increaſe as the heat increaſed; it would be greateſt in the noon-day, and in the height of ſummer, and leſs in ſpring than in autumn, whereas the reverſe is here ſhewn to be the caſe. It muſt therefore depend on the irritability of the fibres compoſing the veſſels, which gets exhauſted by the ſtimulus of heat and light, and is accumulated by its abſence. T.

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an inch into the hole, and it projects from three to twelve inches. The operation of tapping is firſt done on the ſouth ſide; and when the diſcharge of ſap leſſens, an opening is made with the auger on the north ſide, when an abundant flow takes place.

Wooden troughs large enough to contain three or four gallons are placed under the ſpout to receive the ſap, which is carried every day to a large receiver made of wood. From this receiver it is conveyed, after being ſtrained, to the boiler. The following facts have been aſcertained by experiment: The ſooner the ſap is boiled, after it is collected from the tree, the better. The larger the veſſel the more ſugar is obtained. The ſugar is alſo improved by ſtraining the ſap through blankets, or cloth, either before or after it is half boiled. Some fatty ſubſtance is added to the ſap in the kettle, to prevent its boiling over. Lime, eggs, or new milk, is mixed with it in order to clarify it. I have ſeen clear ſugar made without the addition of either of them. A ſpoonful of ſlack lime, the white of one egg, and a pint of new milk, are the uſual proportions of theſe articles, which are mixed with fifteen gallons of ſap. The maple ſugar clarified with milk alone had the evident ſuperiority of all others. After being ſufficiently boiled, it is *grained*, and *clayed*, and afterwards *refined*, or converted into loaf ſugar. The method of conducting each of theſe proceſſes is ſo nearly the ſame with thoſe which are uſed in the manufactory of Weſt India ſugar, and are ſo generally known, that I need ſpend no time in deſcribing them.

There are two other methods of reducing the ſap to ſugar. The firſt is by *freezing*. This method was tried by Mr. Scott, a farmer in this ſtate, with great ſucceſs. He ſays, that one half of a given quantity of ſap reduced in this way, is better than one third of the ſame quantity reduced by boiling. If the froſt ſhould not be intenſe enough to reduce the ſap to the graining point, it may afterwards be expoſed to the action of fire for that purpoſe.

Secondly,

Secondly, by *ſpontaneous evaporation.* The hollow ſtump of a maple ſugar tree, which had been cut down in the ſpring, and which was found ſome time after filled with ſugar, firſt ſuggeſted to our farmers this method of obtaining ſugar. So many circumſtances of cold and dry weather, large and flat veſſels, and above all ſo much time is neceſſary to obtain ſugar by either of the above methods, that the moſt general method among our farmers is to obtain it by boiling.

The kettles and other utenſils of a farmer's kitchen will ſerve moſt of the purpoſes of making ſugar, and the time required for the labour (if it deſerves that name) is at a ſeaſon when it is impoſſible for the farmer to employ himſelf in any ſpecies of agriculture. His wife, and all his children above ten years of age, may aſſiſt him. The following receipt was publiſhed in the Albany Gazette: "Received of William Cooper, Eſq. ſixteen pounds for 640 pounds of ſugar, made with my own hands, without any aſſiſtance, in leſs than four weeks, beſides attending to all the other buſineſs of the farm. John Nicholls."——A ſingle family conſiſting of a man and his two ſons, on the Maple Sugar Lands between the Delaware and Suſquehannah, made 1800 pounds of maple ſugar in one ſeaſon. Not more knowledge is neceſſary for making this ſugar, than is required to make cyder, beer, &c. and yet one or all of them are made in moſt of the farm-houſes in the United States.

Let us now take a comparative view of this ſugar with that obtained from the cane, with reſpect to its *quality*, *price*, and the *quantity* that might probably be made in the United States, each of which I ſhall conſider in order:

1. The *quality* of this ſugar is neceſſarily better than that which is made in the Weſt Indies. It is prepared in a ſeaſon when not a ſingle inſect exiſts to feed upon it, or to mix its excretions with it. The ſame obſervation cannot be applied to the Weſt India ſugar. The inſects and worms which prey upon it, and of courſe mix with it, compoſe a page in a nomenclature of natural hiſtory. I ſhall ſay nothing

thing of the hands which are employed in making ſugar in the Weſt Indies; for ſlaves have not that obligation to cleanlineſs which thoſe have who work for their own benefit, and have received a proper education. It has been conceived that the maple ſugar is inferior to the Weſt India ſugar in ſtrength. The experiments which led to this opinion I ſuſpect have been inaccurate, or have been made with maple ſugar prepared in a ſlovenly way. I have examined equal quantities by weight of both the grained and the loaf ſugar, in hyſon tea, and in coffee, made in every reſpect equal by the minuteſt circumſtances that could affect the quality or taſte of each of them, and could perceive no inferiority in the ſtrength of the maple ſugar. The liquors which were to decide this queſtion were examined at the ſame time by Alexander Hamilton, Eſq. ſecretary of the treaſury of the United States, Mr. Henry Drinhur, and ſeveral ladies, who all concurred in the above opinion.

2. *Price.* Whoever conſiders that the gift of the ſugar maple tree is from a benevolent Providence; that we have many millions of acres in our country covered with them; that the tree is improved by repeated tappings; and that the ſugar is obtained by the frugal labour of a farmer's family; and at the ſame time conſiders the labour of cultivating the ſugar cane, the capitals ſunk in ſugar works, the firſt coſt of ſlaves and cattle, and the expences of proviſions for both, &c. will not heſitate in believing that the maple ſugar may be manufactured much cheaper, and ſold at a conſiderably *leſs price* than that which is made in the Weſt Indies.

3. The reſources for making a ſufficient *quantity* of this ſugar, not only for the conſumption of the United States, but for exportation, will appear from the following facts:—There are in the ſtates of New York and Pennſylvania alone, at leaſt ten millions of acres of land which produce the ſugar maple tree in the proportion of thirty trees to one acre. Now, ſuppoſing all the perſons capable of labour in a family to conſiſt of three, and each perſon to attend 150 trees, and

each

each tree to yield 5 pounds of ſugar, the product of labour of 60,000 families would be 135,000,000 pounds of ſugar, and, allowing the inhabitants of the United States to compoſe 600,000 families, each of which conſumed 200 pounds of ſugar a year, the whole conſumption would be 120,000,000 pounds a year, which would leave a balance of 15,000,000 pounds for exportation. Valuing the ſugar at 6—90 of a dollar per pound, the ſum ſaved would be 8,000,000 dollars of home conſumption, and the ſum gained by exportation would be 1,000,000 dollars.

The maple ſugar alſo affords excellent vinegar; its molaſſes is capable of affording a very pleaſant ſummer beer. The ſap is alſo capable of producing ſpirit; but we hope this wholeſome juice will never be proſtituted to ſuch a purpoſe. A diet conſiſting of a plentiful admixture of ſugar has many advantages.

Sugar affords the greateſt quantity of nouriſhment in a given quantity of matter of any ſubſtance in nature. Hence the Indians uſe it in their excurſions. They mix a certain quantity of maple ſugar with an equal quantity of Indian corn, dried and powdered. This mixture is packed up in little baſkets. A few ſpoonfuls of it mixed with half a pint of ſpring water, afford them a pleaſing and ſtrengthening meal. From the great degree of ſtrength and nouriſhment which are conveyed into animal bodies by a ſmall bulk of ſugar, it may be given to horſes with great advantage. A pound of ſugar with graſs or hay, I have been told, has ſupported the ſtrength and ſpirits of a horſe during a whole day's labour in one of the Weſt India iſlands. A larger quantity given alone has fattened horſes and cattle during the war before laſt in Hiſpaniola, for a period of ſeveral months, in which the exportation of ſugar and the importation of grain were prevented by the want of ſhips.

3. A plentiful uſe of ſugar is the beſt preventative of worms. The author of nature ſeems to have implanted a love for ſweets in all children for their growth, and to ward off the diſeaſe of worms.

4. I think it probable, that the frequency of malignant fevers of all kinds has been leſſened by this diet, and that its more general uſe would defend that claſs of people who are moſt ſubject to malignant fevers from being ſo often affected by them.

5. It has been ſaid, that ſugar injures the teeth; but this opinion now has ſo few advocates, that it does not merit a ſerious refutation.

It has been a ſubject of enquiry, whether the maple ſugar might not be improved in its quality, and increaſed in its *quantity*, by culture. From the influence which culture has upon foreſt and other trees, it has been ſuppoſed, that by tranſplanting the maple ſugar tree into a garden, or by deſtroying ſuch other trees as ſhelter it from the rays of the ſun, much advantage might accrue. I know but of one fact. A farmer in Northampton county, in the ſtate of Pennſylvania, planted a number of theſe trees above twenty years ago in his meadow, and he declares that the quality is ſo improved, that from three gallons of the ſap he obtains every year a pound of ſugar; and it is a known circumſtance that, to produce the ſame quantity of ſugar from the trees which grow wild in the wood, it requires five or ſix gallons of ſap. To tranſmit to future generations all the advantages which have been here enumerated, it is neceſſary that this tree ſhould be cultivated in the old and improved parts of the United States, and a bounty given upon the maple ſugar by Government. Afterwards men would find out their own advantage in rearing them. An orchard conſiſting of 200 trees, planted upon a common form, would yield more profit than the ſame number of apple or any other trees. If a greater expoſure of a tree to the action of the ſun has the ſame effect upon the maple that it has upon other trees, a larger quantity of ſugar might reaſonably be expected from each tree planted in an orchard. Allowing it to be only ſeven pounds, then 200 trees will yield 1400 pounds of ſugar; and deducting 200 from the quantity for the conſumption of the family, there will remain for ſale 1200

pounds,

pounds, which at 6—90 of a dollar per pound will yield an annual profit to the farmer of 80 dollars. Should this mode of tranfplanting for the purpofe of obtaining fugar be fuccefsful, it will not be a new one. The fugar cane of the Weft Indies was brought originally from the woods of the Eaft Indies by the Portuguefe, and cultivated at Madeira, from whence it was tranfplanted directly or indirectly to all the fugar iflands of the Weft Indies.

In contemplating the prefent opening profpects in human affairs, I am led to expect that a material fhare of the happinefs which Heaven feems to have prepared for all mankind, will be derived chiefly from the manufactory and general ufe of the maple fugar, which I flatter myfelf will not be confined to us, but will extend itfelf to other nations. With this view of the fubject, I cannot help contemplating a fugar American maple tree with a fpecies of affection and even veneration; for I have perfuaded myfelf to behold in it the happy means of rendering the commerce and flavery of our African brethren in the Weft India iflands as unneceffary as it has always been inhuman and unjuft *.

XV. *An Account of Mr.* PARK's *Journey into the Interior Parts of Africa. From the* Proceedings of the African Affociation, 1798.

THE account of the proceedings of the African Affociation, from which the following extract is taken, though it abounds with many curious particulars which we have been obliged to omit, contains but a fmall part of the information obtained by Mr. Park during the courfe of his peregrinations in the wild regions of Africa. A detailed relation of

* The friends to the abolition of the Slave Trade fhould not allow the information contained in this article to efcape their notice. It would require very little expence or induftry to introduce the fugar maple into England, where it would probably thrive as well as in America. T.

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this enterpriſing traveller's journey, and of the diſcoveries he made, is reſerved for a large volume, to be publiſhed by ſubſcription, which we are happy to find announced, and we have no doubt that the author will meet with that reward from the public to which he is ſo juſtly entitled by his fortitude and perſeverance. We cannot help obſerving alſo, that great thanks are due to the African Aſſociation, for their exertions to procure information reſpecting the continent of Africa, and thus to pave the way for the civiliſation of its inhabitants. The Report printed for the uſe of the members does great credit to the literary talents of Bryan Edwards, Eſq. by whom it was drawn up.

On the 22d of December 1795, Mr. Park took his departure from the houſe of his friend Dr. Laidley, at Piſania, on the banks of the river Gambia, and directed his courſe eaſterly for the kingdom of Woolli. He was accompanied by two negro ſervants, natives of the country, one of whom ſpoke Engliſh tolerably well, and ſerved him as interpreter; the other was a boy preſented to him by Dr. Laidley. He had alſo a horſe for himſelf, and two aſſes for his ſervants. His baggage conſiſted chiefly of proviſions for two days, a ſmall aſſortment of beads, amber and tobacco, for the purchaſe of a freſh ſupply as he proceeded: a few changes of linen and other neceſſary apparel, an umbrella, a pocket ſextant, a compaſs, and a thermometer, together with two fowling-pieces, two pair of piſtols, and ſome other ſmall articles.

Mr. Park reached Medina, the capital of Woolli, on the third day, and was received by the ſovereign or chief, named Jatta, with much kindneſs. This prince wiſhed to perſuade Mr. Park not to proſecute his journey any farther, by pointing out the dangers and difficulties he would have to encounter; but finding his remonſtrances had no effect, he furniſhed him with a guide to Bondon, and ſuffered him to depart.

Leaving Medina, Mr. Park proceeded onwards, and on the 21ſt of December reached Fatteconda, the capital of the kingdom of Bondou. The king of this country was a Pagan, like that of Woolli: but he had adopted the Mooriſh name of Almami, and ſeems alſo to have imbibed ſomewhat of the Mooriſh diſpoſition; for though Mr. Park preſented to him his umbrella and ſome other articles, he compelled him to ſtrip in his preſence and ſurrender his coat, which he ſaid he ſhould reſerve for his own wearing on great and public feſtivals. In return, however, he gave our traveller five drachms *(minkallies)* of gold duſt, and loaded him with proviſions.

Departing from Fatteconda on the 23d of December, Mr. Park proceeded the two following days to a place called Joag in the kingdom of Kajaaga, a country bounded on the north by the Senegal river. The natives are called Sera-Woollies, and ſeem to be pure negroes. The appearance of a white man among them excited great curioſity. The king commanded that he ſhould be brought before him; and it was with ſome difficulty that Mr. Park, who had been cautioned to avoid him, declined the interview, and got out of his dominions with the loſs of about one half of his goods and apparel.

The name of this rapacious chief was Bacheri. He had recently fallen out with a neighbouring prince, the ſovereign of Kaſſon, a country to the north-eaſt; and it happened that the king of Kaſſon's nephew was in Bacheri's capital, endeavouring, but in vain, to effect a reconciliation at the time of Mr. Park's arrival at Joag. This young man, finding that our traveller propoſed proceeding to Kaſſon, kindly offered to take him under his protection. They accordingly ſet out together, and, after a journey of two days, croſſed the river Senegal at Kayee, the frontier village of the king of Kaſſon's dominions, near which that river ceaſes to be navigable. From Kayee Mr. Park was led by his friendly conductor to Teeſee, the place of his abode, and the reſidence of the king's brother Tigetee-Sego, an old man of a venerable aſpect, but of a ſelfiſh diſpoſition. He had never ſeen, he ſaid, but one white man before, and, on deſcribing him, it was known to be Major Houghton. The circumſtance of having a white man under his roof was highly gratifying to the vanity of Tigetee-Sego, on account of the great number of the natives who reſorted to ſee him. He therefore compelled our traveller to remain with him twelve days, and afterwards to take a journey of two days more to preſent himſelf to the king at his capital of Kooniakary, who detained him another fortnight, but in other reſpects behaved to him with great kindneſs and hoſpitality. Of this prince, whoſe name was Demba Sego Jalla, Mr. Park received the firſt certain account of Major Houghton's death.

Being permitted at length to leave the capital, Mr. Park proſecuted his journey eaſtward, and in five days arrived at Kemnoo, a large and populous town (ſince deſtroyed), at that time the metropolis of Kaarta. The ſovereign, whoſe name was Dayſi Koorabarri, received Mr. Park with great kindneſs. Major Houghton was the only European he had ever before ſeen, and he had conceived the higheſt idea of the ſuperiority of the whites to the blacks in all poſſible reſpects. The language of the country ſeemed to Mr. Park to be a mixture of the Mandingo and Sera-Woolli: but the pure Mandingo, in the attainment of which Mr. Park by this time had made conſiderable proficiency, was very generally underſtood, and with very little aſſiſtance from his interpreter he found no difficulty in conveying his own ſentiments, and comprehending others.

Having informed the king that he propoſed going to Bambara in ſearch of the Joliba river, which was believed to take its courſe through the centre of that extenſive kingdom, he was told that, the Bambarans being at that time in a ſtate of warfare with the Kaartans, he could not without extreme perſonal danger venture into the Bambaran country. His only ſafe route was a northerly courſe to Ludamar, a territory of the Moors in alliance with Manſong the king of

Bambara; from whence, passing as a traveller from the Moorish country, he might venture, by a circuitous journey, to Bambara. To this advice being obliged to submit or give np all thoughts of prosecuting his journey in search of the Niger, the king, as the last proof of his kindness, sent eight horsemen to convey him in safety to Jarra, the frontier town of the Moors, where he arrived on the 18th of February 1796. In the course of his journey he passed through a village not far from Jarra, called Simbing, from whence Major Houghton wrote his last dispatch with a pencil.

The territories which our traveller had hitherto explored, being very generally clothed with native woods, presented to the eye the appearance of great uniformity. In his progress eastward the country rose into hills, and the soil varied to a considerable degree; but wherever the land was cleared, great natural fertility was observed. Bondou in particular may literally be pronounced "a land flowing with milk and honey." Both these articles, together with rice and Indian corn of two or three species, were to be obtained at a small expence. Of their honey, the Pagan natives make an intoxicating liquor, much like the mead of Europe. The price of a fowl in Bondou was a button, or a small bit of amber; goat's flesh and mutton were proportionably cheap; and for six or eight amber beads Mr. Park might at any time have purchased a bullock. The domestic animals are nearly the same as in Europe: the Guinea fowl and red partridge abound in the fields; and the woods furnish a small species of antelope, of which the venison is highly and deservedly prized.

Of the other wild animals in the Mandingo countries the most common are, the hyæna, the panther, and the elephant. But the natives of Africa have not yet acquired the art of taming the last-mentioned animal, notwithstanding his strength and docility, so as to render him serviceable to man; and when Mr. Park told some of them that this was actually done in the countries of the East, his auditors laughed, and exclaimed, "*Tobaubo fonnio!*" A white man's lie!—The negroes frequently find means to deſtroy the wild elephant with fire-arms; they hunt it principally for the ſake of its teeth, which they transfer in barter to thoſe who ſell them again to the Europeans.

The paſtures of Bondou furniſh an excellent breed of horſes, but the uſual beaſt of burthen in all the negro territories is the aſs. The application of animal labour to the purpoſe of agriculture is wholly unknown. The chief implement uſed in huſbandry is the hoe, which varies in form in different diſtricts; and the labour is univerſally performed by ſlaves. Beſides the grains proper to tropical climates, the Mandingoes cultivate in conſiderable quantities ground-nuts, yams, and pompions. They likewiſe raiſe cotton and indigo, and have ſufficient ſkill to convert theſe materials into tolerably fine cloth of a rich blue colour: and they make good ſoap from a mixture of ground-nuts and a ley of wood-aſhes.

The town of Jarra, at which Mr. Park had now arrived, is ſituated in the kingdom of Ludamar, a Mooriſh country, of which it is not known that any account has ever been given in any of the languages of Europe. The town itſelf is extenſive, and the houſes are built of clay and ſtone intermixed; but the major part of the inhabitants are negroes from the borders of the Southern States, who prefer a precarious protection under the Moors, which they purchaſe by a tribute, to being continually expoſed to their predatory hoſtilities.

During his ſtay at Jarra, Mr. Park reſided at the houſe of a Slatee trader, named Daman, who was known to Dr. Laidley. By him Mr. Park was informed that he could proceed no farther on his way to Bambara, without leave from Ali, the Mooriſh chief or king of the country, who was then encamped at a place called Benowm; and that it was abſolutely neceſſary that a preſent ſhould accompany the application by which permiſſion was to be obtained. Mr. Park therefore purchaſed five garments of country cloth, by the

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fale of one of his fowling-pieces. Daman undertook to negotiate the bufinefs, and at the end of a fortnight permiffion arrived from Benowm.

This permiffion was brought by one of Ali's own flaves, who faid he was ordered to ferve Mr. Park as a guide to Bambara; and on the 27th of February he took his departure from Jarra, accompanied by this flave, his own faithful boy, and a negro belonging to Daman; the interpreter refufing to proceed any farther.

On the third day after his departure from Jarra they reached a large town called Deena; on entering which Mr. Park was furrounded by many of the Moorifh inhabitants, who haraffed him with fhouts of infult, fpit in his face, and feized his baggage, which they robbed of what things they fancied. He got refuge, at length, in the houfe of a negro; and after experiencing much difficulty in perfuading his attendants to proceed any farther, he fet out on the fecond day for Sampaka. Here he procured lodging at the houfe of a negro, who underftood the art of making gunpowder. The nitre was obtained in confiderable quantities from the fwamps or ponds, which are filled in the rainy feafon, and to which the cattle refort in the heat of the day for coolnefs. As the water of thefe ponds is flowly exhaled by the fun, the nitre appears in a white efflorefcence on the mud, and is carefully fcraped off in the form of fmall cryftals. Sulphur is purchafed of the Moors, and the feveral ingredients are blended together in fuch proportions as experience has fhewn will anfwer the purpofe; though the powder thus made is far inferior to that of Europe.

On the morning of the 7th of March, Mr. Park had reached a fmall village called Sami, within two days journey of Goomba, the frontier town of Bambara; and was refting himfelf in the hut of a friendly negro, pleafed with the hopes of being foon out of danger, when he was alarmed by the arrival of two Moors, who announced that they came by order of Ali to convey him to the camp at Benowm. They

 added,

added, that, if he consented to go with them peaceably, he had nothing to fear: but that, if he refused, they had orders to carry him by force.

Finding entreaty and resistance equally fruitless, for the messengers were joined by others, all of them armed, our traveller, guarded by the Moors, and accompanied by the negro boy (Daman's negro having made his escape on seeing the Moors, and the slave sent by Ali having previously left him on the road), set out on the evening of the same day for the camp at Benowm, which after a distressing journey they approached on the 12th. It presented to the eye a multitude of dirty-looking tents, scattered without order over a large space of ground; and among the tents were seen herds of camels, bullocks, and goats.

The arrival at the camp of a white man was no sooner made known, than all the people who were drawing water at the wells threw down their buckets, those in the tents mounted their horses, and men, women and children came running or galloping towards him. He soon found himself surrounded with such crowds that he could scarcely walk;—one pulled off his clothes—another took off his hat—a third stopped him to examine his waistcoat buttons—and a fourth called out "*La illa ill Allahi, Mahomed rasowl Allahi* *; and signified in a threatening manner that he must repeat these words. He at length reached the tent of the king, whom he found sitting upon a black leather cushion, clipping a few hairs from his upper lip, while a female attendant held up a looking-glass before him; there were many other females in the tent. The king appeared to be an old man of the Arab cast, with a long white beard. He had a sullen and indignant aspect, and looking at our traveller with attention, enquired of the Moors if he could speak Arabic; but being answered in the negative, he appeared much surprised, and continued silent.

* "There is no god but God, and Mahomet is his prophet."

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The ſurrounding attendants, and particularly the ladies, were far more curious and inquiſitive. They aſked a thouſand queſtions, inſpected every part of Mr. Park's apparel, ſearched his pockets, and obliged him to unbutton his waiſtcoat and diſplay the whiteneſs of his ſkin, &c. They even counted his toes and fingers, as if they doubted whether he was in truth a human being. When the curioſity of the ladies was in ſome meaſure ſatisfied, he was conducted to the tent of Ali's chief ſlave; into which however he was not permitted to enter, nor allowed to touch any thing belonging to it. He requeſted ſomething to eat, and ſome boiled corn with ſalt and water was at length ſent him in a wooden bowl; and a mat was ſpread out on the ſand before the tent, on which he paſſed the night, ſurrounded by the curious multitude. A hut was afterwards erected, in which he was confined and ſtrictly guarded.

Some time after a ludicrous circumſtance took place, which would not deſerve attention did it not tend to throw ſome light on the national manners of the people among whom our traveller reſided. Hearing one morning the ſound of drums, Mr. Park was informed that the noiſe was occaſioned by the celebration of a wedding in one of the neighbouring tents. Soon after an old woman entered his hut with a bowl in her hand, and ſignified that ſhe had brought him *a preſent from the bride*. Before he could recover from the ſurpriſe occaſioned by this meſſage, the woman diſcharged the contents of the bowl full in his face. Mr. Park finding that it was the ſame ſort of *holy water* as that with which the prieſt among the Hottentots is ſaid to beſprinkle a new-married couple, he began to ſuſpect that the old lady was actuated by miſchief or malice: but ſhe gave him ſeriouſly to underſtand that it was *a nuptial benediction from the bride's own perſon*, and which, on ſuch occaſions, is always received by the young unmarried Moors as a mark of diſtinguiſhed favour.

The Mooriſh ladies ſeemed indeed to commiſerate his condition, and one of them once privately ſent him a ſmall ſupply of meal and milk; but their kindneſs extended no farther. If they pitied his ſituation, it is probable that they dared not adminiſter to his wants; and his diſtreſs at length became almoſt inſurmountable. He was allowed a ſingle meal of *kouſcous*, a preparation of boiled corn, once in twenty-four hours. All his effects were taken from him, and he was not even indulged with a change of linen out of the few ſhirts he had brought in his portmanteau: oppreſſed at the ſame time with a burning fever, his ſituation was truly deplorable. "In this condition, from ſun-riſe to ſun-ſet," ſays he, "was I obliged to ſuffer with an unruffled countenance the inſults of the rudeſt ſavages on earth.

In eight or ten weeks, however, circumſtances occurred, which, contrary to their firſt appearance, changed our traveller's ſituation for the better, and in the end produced his deliverance. In the war which prevailed between the kings of Bambara and Kaarta, the Moors at firſt took no active part; but Ali having afterwards engaged to ſend 200 horſe to the aſſiſtance of the fugitive Kaartans, he became panic-ſtruck at the approach of the king of Bambara towards Benowm: broke up his camp, and fixed his tent in a country to the north. Mr. Park was compelled to follow him, and, after a month's confinement at the new camp, was led by Ali to Jarra. At this place he had the mortification to ſee the poor boy who had attended him from the Gambia taken from him, by Ali's command, for the avowed purpoſe of being ſold into ſlavery. After this cruel circumſtance, and the certain information which he received from Ali's own ſon (a youth of ten years of age, who had conceived ſomething like friendſhip for Park, or pity for his misfortunes), that it was in contemplation to deprive Park himſelf of his life, or put out his eyes, he determined rather to riſk periſhing in the woods, of hunger, or by the fury of the wild beaſts, than to remain any longer with a horde of faithleſs barbarians, whoſe tendereſt mercies were cruelty, and from whoſe whofe caprice or fanaticifm he was in hourly danger of deftruction.

On the morning of the 1ft of July 1796, Mr. Park was fo fortunate as to break the bonds of his captivity. He had contrived to procure at his departure his own horfe, faddle and bridle; a few articles of apparel, and alfo his pocket compafs. This laft he had concealed in the fand during his confinement. He rode forwards the whole of the firft day without ftopping. "I felt," faid he, "like one recovered from ficknefs; I breathed freer; I found unufual lightnefs in my limbs. Even the defert looked pleafant; and I dreaded nothing but falling in with fome wandering parties of Moors, who might convey me back to the land of thieves and murderers, from which I had juft efcaped."

The firft emotions of his mind fubfiding however into fober reflection, he foon found his condition to be very deplorable. His horfe grew tired, and he experienced the torments of thirft raging beyond defcription. Whenever he came to a tree, he climbed it in hopes of difcovering a watering-place, but in vain; he chewed the leaves, but found they were all bitter, and afforded no relief. In a vaft wildernefs of the African continent, without an attendant or guide, without food and water, or the profpect of procuring any; in a country where the lion and panther prowling for their prey are lefs to be apprehended than man, what fituation could be more forlorn and dreadful? He proceeded onwards, however, directing his route nearly eaft-fouth-eaft, in the view of reaching by the fhorteft courfe poffible a diftrict that might afford him fhelter. A heavy rain about midnight enabled him to quench his burning thirft, by fpreading his clothes on the ground and fucking the moifture out of them; and a muddy pool, which he found foon after, yielded relief to his horfe. The reft of the night, and nearly the whole of the enfuing day, neither water nor food was to be found: and he muft inevitably have perifhed, had he not fortunately towards evening, lighted upon a few fcattered huts of fome

Foulah

Foulah ſhepherds. Perceiving an aged negro woman among thoſe who gazed at him with great earneſtneſs, he tendered her his pocket handkerchief, and requeſted in exchange a little corn to eat. She gave him a kind anſwer, invited him to her hut, and immediately produced a large wooden bowl of *kouſcous* ready prepared. She procured likewiſe ſome corn and water for the horſe*. Thoſe only who have ſuffered ſimilar miſery can judge of his ſenſibility at this unexpected deliverance. But as the village belonged to the Moors, our traveller had only a ſhort time to reſt. As he approached the territories of the negroes, however, his apprehenſions diminiſhed, and his condition improved.

Procuring precarious ſupport in this manner from the charity of the moſt wretched of human beings, Mr. Park wandered for the ſpace of fifteen days, ſtill however proceeding onwards in the accompliſhment of his miſſion. At length, in the morning of the ſixteenth day, having been joined by ſome Mandingo negroes, who were travelling to Sego, he had the inexpreſſible ſatisfaction to behold the great object of his wiſhes—the long-ſought majeſtic Niger glittering to the morning ſun, as broad as the Thames at Weſt-

* It is worthy of remark, and highly to the credit of the female ſex, that Mr. Park ſeems invariably to have met with compaſſion and relief from women. This perfectly accords with the account given by another enterpriſing traveller, Mr. Ledyard, who expreſſes himſelf as follows: "I have always remarked that women in all countries are civil, obliging, tender and humane; that they are ever inclined to be gay and cheerful, timorous and modeſt; and that they do not heſitate, like men, to perform a generous action. In wandering over the barren plains of *inhoſpitable Denmark*; through *honeſt Sweden*, and *frozen Lapland*, *rude* and *churliſh Finland*, *unprincipled Ruſſia*, and the *wide-ſpread regions* of the *wandering Tartar*, if hungry, dry, cold, wet or ſick, the women have ever been friendly to me, and uniformly ſo: and to add to this virtue, ſo worthy the appellation of benevolence, theſe actions have been performed in ſo free and ſo kind a manner, that if I was dry I drank the ſweeteſt draught, and if hungry I ate the coarſe morſel with a double reliſh." Edit.

minſter, and flowing majeſtically but ſlowly from weſt to eaſt, through the middle of a very extenſive town, which his fellow-travellers told him was Sego, the capital of the great kingdom of Bambara. His emotions at this ſight were exquiſite, and it were unjuſt not to give them in our traveller's own words: "I haſtened," ſays he, "to the brink of the river, and, having drank of the water, lifted up my fervent thanks in prayer to the Great Ruler of all things, for having thus far crowned my endeavours with ſucceſs."—Unhappily, he had yet to ſuſtain many ſevere and bitter trials of his patience and ſortitude.

Information of a conſiderable river flowing through the centre of Africa, between the latitudes of 15° and 20° north, had been received at very early periods from different quarters. At one time it was believed to be a part of the Senegal. The Gambia had the ſame honour aſcribed to it at another. But ſufficient proof was afterwards obtained that neither of theſe rivers was the Niger, and further enquiries confirmed the ancient accounts of a ſtream that was not only of greater magnitude than either the Senegal or the Gambia, but which flowed in *a contrary direction*; running not to the weſtward into the Atlantic, but from weſt to eaſt, to regions unknown. The Moors deſcribed it by the name of *Nil il Abeed*, or the River of Slaves: the negroes beſtowed on it the appellation of *Joliba*, or the Great Waters.

Some doubt however ſtill remained. It was urged that the Moors might poſſibly ſpeak of one river, and the negroes of another; and the account of its direction towards the eaſt was received by our ableſt geographers with much difficulty and heſitation. On both theſe points Mr. Park's teſtimony is clear and deciſive; the Moors, in his hearing, uniformly called it Nil il Abeed; the inhabitants of Sego, the Joliba; and that it flowed from weſt to eaſt, he had ocular demonſtration in a long and perilous ambulation of ſome hundred miles, which he afterwards made on its banks. Thus therefore is all further queſtion obviated concerning the

the existence and direction of this great river; but its termination still continues unknown.

[*To be concluded in the next Number.*]

XVI. *Analysis of the Emerald of Peru.* By M. Vauquelin. *From the* Annales de Chimie, *Vol. XXVI.*

SEVERAL celebrated chemists have already analysed the emerald; but, as I am convinced that science is promoted and individuals instructed by repeating the labours of those who have preceded us, I have again subjected this fossil to a chemical analysis. Klaproth, one of the most accurate analysers of modern times, found in the emerald of Peru siliceous earth 66.25, alumine 31.25, oxyde of iron 0.50. It will be seen in the course of this short memoir, that the result of my labour differs from that of the Prussian chemist, not only in the proportion of the constituent principles, but in their number, and the nature of some of them *.

Exp. I. This stone, broken into small fragments, and exposed to a strong heat, lost a part of its beautiful green colour, and retained only a light shade of it. In many places of it there were cracks; and it lost of its weight 0.02 grains.

Exp. II. Two hundred parts of this fossil, which answered to 200 grains, *poid de marc* (eight ounces to the pound), or 10.615 grammes, were melted for an hour in a silver crucible with 600 parts of caustic potash. The matter had then a greenish yellow colour. This solution, when evaporated to a quarter of its bulk, was converted into a green jelly, the shade of which was much weakened by desiccation.

The residue was diluted in a large quantity of water; and it was observed, that the first portions of this liquid, poured

* According to the first analysis of the emerald, the results of which I presented to the National Institute, I found in it siliceous earth, alumine, lime, and the oxyde of *chrome*; but since that epoch, having discovered a new earth in the beryl, or *aigue marine*, I repeated my analysis, under this new point of view, and I found also that particular earth, as will be seen in the course of this memoir.

6 upon

upon the ſubſtance, made it aſſume a bright and very agreeable green colour. The ſolution of the ſalt had alſo the ſame ſhade, but weaker. There remained a white inſipid ſubſtance, full of grains, which was inſoluble in water, and had all the properties of ſiliceous earth. It weighed 129 parts, after having been expoſed to a red heat.

Exp. III. To the liquor of the ſecond experiment, from which the ſiliceous earth had been ſeparated, I added cauſtic potaſh, more than neceſſary for ſaturation, and then boiled it for ſome time. The greater part of the matter precipitated was at firſt re-diſſolved; but there remained a certain quantity which obſtinately reſiſted ſolution. The ſolution having been filtered, the inſoluble matter, which, when waſhed and dried, weighed ſeven parts, was collected on the filter.

This matter had a light lilac colour, which became green by the heat of the blow-pipe. When melted with borax and the fuſible ſalt of urine, it gave them a ſuperb green colour, perfectly like that of the emerald. This property of thus giving a green colour to borax and microcoſmic ſalt, made me abandon the idea I had firſt conceived, that this matter might be the oxyde of nickel; ſince the oxyde of that metal, though green, communicates to borax a hyacinth colour. As this colour had a perfect reſemblance to that which I obtained from the oxyde of the metal* contained in the red lead of Siberia, I directed my experiments with a view to eſtabliſh that reſemblance. I therefore took this colouring matter, drawn from the emerald, and boiled it to dryneſs with concentrated nitric acid. I then poured upon the reſidue cauſtic potaſh, and obtained a ſolution of an orange-yellow colour; which when mixed with a ſolution of the nitrate of lead immediately produced the red lead of Siberia, and gave, with the nitrate of mercury, a precipitate of a vermilion red colour, abſolutely in the ſame manner as does the acid of the red lead.

* Vauquelin's account of this new metal, called *Chrome*, will be given in our next number. EDIT.

These

These experiments, though not numerous, are sufficient to prove, that the colouring matter of the emerald of Peru is not iron, as announced by Klaproth, but that it is, on the other hand, the oxyde of the new metal which I discovered in the red lead of Siberia. One thing, however, which ought to surprise those acquainted with the sagacity and accuracy which the chemist of Berlin shews in his labours, and which have gained him so high reputation, is, that he did not observe this substance, so easily to be distinguished by a great number of characterising marks, entirely different from those exhibited by other minerals. I shall now proceed to other principles of the emerald.

Exp. IV. The reader will recollect that the liquor of the second experiment, deprived of its siliceous earth, was precipitated by caustic potash, and that the precipitate was, in great part, re-dissolved by an exeess of this alkali. This solution was then supersaturated with the muriatic acid, and carbonate of potash used in commerce was poured over it. This produced a very abundant precipitate, which, being washed, and exposed to a red heat in a silver crucible, weighed fifty-four parts.

These fifty-four parts were dissolved in the sulphuric acid; and the solution, by the addition of a little potash at intervals, gave, by several successive crystallisations, 149 parts of alum crystallised in octaedra, among which there were eight or nine parts of the sulphate of lime; but as these 140 parts of alum contained only about twenty-six parts of pure alumine, and as the mother-water, the taste of which was exceedingly saccharine, gave no more alum by the addition of a new quantity of potash, I diluted it in water, and mixed with it a solution of the carbonate of ammoniac, until there was an excess. I shook this mixture from time to time, for several hours; at the end of which the greater part of the precipitate, which had been at first formed, was dissolved.

I then filtered the liquor, and collected on the paper the undissolved matter, which, when washed and dried, weighed two

two parts, and exhibited all the properties of alumine. The liquor, being exposed to the action of fire, deposited, some moments after, a white insipid dust, full of grains, which dissolved with an effervescence in acids. Being collected with care, washed, and made red-hot, it weighed twenty-six parts. This substance, subjected to different tests, exhibited all the characterising marks of that earth which I found in the beryl; the properties of which I explained at large in a memoir inserted in the preceding number of the Annales, and which has obtained the name of *Glucine*.

It appears from the experiments announced in the course of this analysis, that 100 parts of the emerald of Peru consist of

1st, Siliceous earth - - -	64.60
2d, Alumine - - - -	14.00
3d, The particular earth, or *glucine* -	13.00
4th, Lime - - -	2.56
5th, The oxyde of *chrome* - -	3.50
6th, Moisture, or other volatile matter -	2.00
	99.66

It appears then by the result of this analysis, that there is a very great difference between the proportion, the number, and the nature of the principles which constitute the emerald, and those found by Klaproth; since, according to him, it is composed of only 66.25 of siliceous earth, 31.25 alumine, and 0.50 of the oxyde of iron. There are in this stone then three substances not observed by the above chemist, viz. *glucine*, the oxyde of *chrome*, and lime; while the oxyde of iron, which he announces, does not exist in it.

It follows therefore from this result, that the emerald and the beryl are two stones perfectly similar, and composed of the same principles, the colouring matter excepted; and mineralogy had already got the start of chemistry by bringing together theſe two foſſils, and making them only one ſpecies *.

XVII. *Curſory View of ſome of the late Diſcoveries in Science.*

[Continued from the laſt Number, p. 65.]

METEOROLOGY.

METEOROLOGY, which depends only on an immenſe number of obſervations, has, however, been exalted into a ſcience. It affords general reſults of great importance; a collection of which has been made by Cotte. By theſe it appears that the barometer varies very little under the equator. Its variation becomes greater in proportion as it approaches the poles. It ſeems to experience a diurnal and an annual variation.

Diurnal variation.—Between the hours of ten and two, both of the day and the night, the riſings and fallings of the mercury are the leaſt. The contrary takes place between the hours of ſix and ten of the morning and evening. This ſeems to depend on the ſun and the moon paſſing the zenith.

Annual variation.—The oſcillations are leſs in ſummer, greater in winter, and very great at the equinoxes. This ſeems to depend, like the tides and the winds, on the ſame action of the ſun and the moon.

Thermometers.—The mean degrees of heat are almoſt the ſame in all latitudes. Kirwan has given a table for calculating the mean degrees of heat in different latitudes.

Rains are more frequent in winter than in ſummer; more abundant in ſummer than in winter. Mean quantity of rain at Paris twenty-two inches. The evaporation generally exceeds the rain at Paris. The mean evaporation is thirty-three inches.

Aurora borealis is more frequent about the time of the equinoxes than at any other ſeaſon. This phenomenon is

* See Abbé Haüy on Cryſtalliſation.

almoſt

almoſt continual in winter in the polar regions. For ſome years paſt it ſeems in our climates to have become leſs frequent.

Lunar period of nineteen years.—It appears that the general temperature of a year returns the ſame every nineteen years, an epoch when the phaſes and poſition of the moon, in regard to the earth, are alſo the ſame. From the above period, therefore, we may predict, very nearly, the temperature of any given year. This method is practiſed by the makers of almanacks; and their predictions, to a certain degree, may be depended on. This mode of calculation is well known alſo to merchants who ſpeculate in the price of proviſions.

Maurice at Geneva makes meteorological obſervations of the utmoſt importance, becauſe he has thermometers placed at different heights above the ſurface of the earth, as Pictet had formerly, and others at the depth of four feet below it. He gives an account, therefore, of the evaporation of the earth, electricity, humidity, &c. His obſervations appear every month in an excellent collection, publiſhed by the brothers Pictet, under the title of *Bibliotheque Britannique*. It appears that the thermometer, which is four feet below the earth, ſtands generally between 9° and 10° Reaum. (52° and 54° Fahr.) and that it experiences very little variation.

ZOOLOGY.—Great attention has been paid to the natural hiſtory of animals. Cuvier has publiſhed a number of memoirs on zoology, and ſome have been publiſhed alſo by Geoffroy. Daubenton propoſes to divide the animal kingdom into eight claſſes:—1ſt, viviparous quadrupeds, of which he reckons 415; 2d, cetaceous animals 15; 3d, birds 2,424; all theſe animals have two ventricles in the heart: 4th, oviparous quadrupeds, of which he reckons 113; 5th, ſerpents 175; 6th, fiſhes 866; all theſe animals have only one ventricle in the heart, and their blood is almoſt cold: 7th, inſects, of which he reckons 15,000; their heart is of different forms; their blood is white; they have tracheæ, and breathe by ftigmata: 8th, worms, of which he reckons 1,159; their heart is of different forms, their blood is white, and they have no apparent entrance for the air.

Cuvier and Geoffroy have made feveral interefting refearches in regard to that clafs of animals called mammalia. The former, in a memoir on the rhinoceros, has proved that the two kinds known by Camper, viz. that of Afia and that of Africa, may have one, two, or three horns. The horns, therefore, cannot be a characterifing mark to diftinguifh them. The diftinguifhing mark, however, of the African rhinoceros is, that it has only twenty-eight *dentes molares*, while that of Afia has twenty-eight *molares* and fix *incifores*. He is of opinion alfo, that there are at leaft two other fpecies in exiftence, and perhaps a third.

Camper has proved alfo, that the African elephant is different from that of Afia. The teeth of the latter are compofed of tranfverfal zones, and thofe of the African elephant reprefent on their furface a kind of trefoils or lozenges. It appears, that befides thefe two fpecies there exift two others, and perhaps three. Swediaur fays, that the greater part of the elephants' tufks ufed in commerce are collected in the immenfe paftures of Africa, where thefe animals feed, and that the negroes fet fire to the meadows in order to difcover them.

Audibert propofes to give a hiftory of apes. He has already publifhed one number, containing fix coloured plates, folio fize.

Birds.—Le Vaillant has already publifhed a part of his *Natural Hiftory of the Birds of Africa*, confifting of five numbers, each containing fix coloured plates, in folio and quarto. He has announced that the whole work will contain 600 plates. An edition in twelves, with fome plates, will appear alfo. The two firft volumes will be publifhed without delay. He propofes to give a complete hiftory of birds.

Fifhes.

Fiſhes.—Bloch has publiſhed the laſt ſix volumes of his beautiful work on fiſhes. They contain, like the former ſix, 216 plates, on ſeveral of which are repreſented from two to three ſubjects. He has been obliged to make ſeveral new genera. This is one of the moſt beautiful works that ever appeared on ichthyology.

Lacepede is preparing a large work on the ſame ſubject. He has ſhewn that the anableps, a fiſh hitherto believed to have had four eyes, has in reality only two; but each of its eyes has two corneæ, two cavities for the aqueous humour, two irides, two pupils, but only one cryſtalline humour. Different naturaliſts have publiſhed ſeparate memoirs on ſome particular kinds of fiſh, and their different parts. Herbſt has publiſhed at Berlin a very beautiful work on crabs, with coloured plates.

Inſects.—This part of natural hiſtory is become almoſt as immenſe as botany. Brogniard continues his ſuperb collection of the butterflies of Europe. Fabricius has given a new edition of his *Entomologia Syſtematica, emendata et aucta.* Latreille has publiſhed his *Genera of Inſects*, and D'Anthoine has publiſhed an excellent memoir on the cynips (gall inſect) of the oak. Boſc has deſcribed ſome other ſpecies of the cynips, and Luce has deſcribed a phoſphoreſcent beetle, found near De Graſſe.

Panzer is now publiſhing a work on the inſects of Germany, entitled *Fauna Inſectorum Germaniæ*, printed at Nuremberg. He has publiſhed alſo a hiſtory of the inſects of America. Raeuſchel has printed a work at Leipſic, entitled *Nomenclator Entomologicus emendatus.* Hedwig has given a new edition of the *Fauna ſiſtens Inſecta*, by Roſſi; in which are deſcribed the inſects found in the neighbourhood of Florence and Piſa. Martin has publiſhed the Inſects of England. This work, like that on ſhells, is executed in a maſterly manner.

Polypiers.—There are certain ſubſtances which are neither animals nor vegetables, called *polypiers*; ſuch as coral, corallines, madrepores, &c. Girod Chantram has carefully examined ſome of theſe ſubſtances, which had hitherto been claſſed among the *cryptogamia* kind of plants: ſuch as the *byſſus*, *conferva*, *ulva*, *tremella*, &c.; and obſerved, that the greater part of them are compoſed of tubes or veſſels, in which beings that appear to be animated circulate. He even diſtinguiſhed in one ſpecies of *conferva* a real *volvox*, which had ſome ſimilarity to the *rotator* of Gmelin.

Theſe ſuppoſed plants, by a chemical analyſis, give the ſame reſults as animal ſubſtances. He therefore concludes that they are not plants, but ſpecies of *polypiers*, formed, like coral, by ſmall animals. Of theſe *polypiers* he diſtinguiſhes two kinds; ſome without tubes, and ſome which have tubes. We ſhall then have three orders of *polypiers*:—1ſt, The calcareous, ſuch as corals and madrepores; the ſubſtance of which is hard and calcareous:—2d, Corallines, the ſubſtance of which is ſoft and flexible, like ſponge:—3d, The *confervæ*, the ſubſtance of which is abſolutely herbaceous. It is to be wiſhed that naturaliſts would pay attention to the ſtudy of the inſects which conſtruct theſe different kinds of *polypiers*, as they are ſtill unknown.

[*To be continued.*]

XVIII. *Biographical Memoirs of Peter Bayen. By* M. LASSUS, *Secretary to the Claſs of the Phyſical Sciences in the French Nat. Inſtitute. From the* Annales de Chimie, *Vol. XXVI.*

PETER BAYEN, member of the National Inſtitute in the ſection of chemiſtry, was born at Chalons in the department of la Marne, in the year 1725. His parents, obſerving that he had a happy diſpoſition for learning, took the earlieſt opportunity to improve it, by ſending him to the college of Troyes, where he ſtudied the Latin language with the beſt ſucceſs. Having terminated the courſe of his ſtudies at that place, he turned his attention to natural philoſophy, and, after acquiring the firſt principles of chemiſtry, ſoon

became

became ſenſible that, to make any real progreſs in that ſcience, the ſoundeſt judgment muſt be guided by a particular kind of knowledge not ſupplied by nature, and which can be obtained only by long and aſſiduous labour.

With a tolerable ſtock of knowledge, and a deſire to obtain more, Bayen repaired to Paris, where he reſided with an eminent apothecary, a friend of the celebrated Charras. The intelligence and happy diſpoſitions of the pupil could not eſcape the penetration of the maſter, who, finding in this young man, fond of ſcience, a character and taſte ſimilar to his own, treated him as his friend rather than a pupil, and procured him every means of inſtruction, by entruſting him with the management of his laboratory. His hopes were not diſappointed: Bayen applied for ſeveral years to all the labours of pharmacy, and acquired ſo much ſkill in this art, that, before he had attained to the age of thirty, he was appointed chief apothecary to the army in Germany during the war of ſeven years. The duties of this office he diſcharged with a ſucceſs worthy of the confidence which had been repoſed in him; and he ſought no other recompenſe for the fatigues he underwent, than the ſatisfaction of being uſeful in the hoſpitals.

After the peace he returned to Paris. At that period government was deſirous of executing a plan it had been long meditating, which was, to cauſe an analyſis to be made of all the mineral waters common in France. Rouelle, being appointed to make choice of the chemiſts capable of diſcharging that taſk, pointed out Bayen and Venel. They at firſt carried on their labours in conjunction, and publiſhed the reſult of their obſervations; but as an enterpriſe of this nature, to be completed, would require ſeveral years, and as particular circumſtances obliged Venel to diſcontinue it, the whole devolved upon Bayen, who applied himſelf to it with the utmoſt aſſiduity.

He ſucceſſively publiſhed various works, which contained much more extenſive information reſpecting theſe mineral waters than had ever been before known. The waters which he in particular analysed were those of Barreges, Bagneres, and Luchon. The analysis of the latter is a model of correctness which ought to be followed in works of this nature, and to which nothing could be added. This work, written in a very methodical manner, while it instructs the chemist and the physician, may be usefnl also to the naturalist and the philosopher, and even to the man of letters, by the interest which the author gives to a subject that appears to be little susceptible of it, and the variety of the details which it contains. It is to be wished that this grand enterprise, begun by Bayen and Venel, had been continued; but the funds set apart for the execution of it having been applied to other objects, it was at last dropped; and the knowledge respecting the mineral waters of France is still imperfect.

Bayen, in the course of his travels through the Pyrenees, had studied natural history, and been convinced of the necessity of analysing bodies, in order to acquire a knowledge of the substances which compose them. He therefore collected specimens of those minerals which seemed to be most deserving of particular attention; and these specimens in his hands became valuable materials for the ingenious analysis which he made of them, and in which he was employed for twelve years. To this immense labour the public is indebted for Bayen's different memoirs on marble, serpentines, porphyry, ophites, granites, jasper, argillaceous schists, and the sparry ore of iron, which he presented to the Academy of Sciences, and which that body caused to be inserted among those of the foreign literati.

Stahl, the oracle of chemistry, having maintained that one of the essential principles in nature is pure fire, or the matter which produces fire in combustible bodies, gave to this element thus combined the particular name of *phlogiston*, or the *inflammable principle*. Bayen, who in all his operations sought only for truth, and would not be convinced without evident proofs, because the habit of experience had rendered him mistrustful, began to doubt of the existence of phlogiston,

ton. He at firſt communicated his doubts to ſome friends, and then to the celebrated Macquer, who did not approve of them. The opinion of that learned man did not however diſcourage him; and he continued his reſearches. It was chiefly by examining precipitates of mercury that Bayen convinced himſelf fully of the falſity of Stahl's doctrine, and that he acquired a proof that every thing called *metallic oxyde* is indebted for the exceſs of its weight, its colour, and its ſtate, only to the abſorption of one of the conſtituent parts of the atmoſpheric air. With apparatus, which he invented, he made experiments ſo rigorouſly correct, that he was able to calculate the weight of this ſubſtance fixed in the metals.

When Bayen preſented to the Academy of Sciences the reſult of the experiments above mentioned, Lavoiſier, who was preſent, made metallic oxydes the object of his reſearches alſo. He repeated the experiments of Bayen; found them correct; diſcovered that a portion of the air drawn from metallic calces is much purer than that of the atmoſphere; that this portion is the only part which can ſerve for combuſtion and reſpiration; and gave to this fluid the name of *vital air*. Lavoiſier therefore, by removing entirely the veil which Bayen had only drawn a little aſide, overturned for ever the theory of Stahl, and eſtabliſhed one of the moſt memorable epochs in chemiſtry.

The various experiments which Bayen made, in the courſe of three years, on the precipitates of mercury, led him to a diſcovery of the ſingular property which ſome of theſe precipitates have of exploding with a loud noiſe, when mixed with a very ſmall quantity of the flowers of ſulphur. Bayen's labours alſo in regard to tin ought not to be paſſed over in ſilence. It was a queſtion in chemiſtry, to determine whether that metal really contained arſenic, as Margraff and Henkel had ſaid; and, ſuppoſing it did, whether the quantity would be ſufficient to make the uſe of it be abandoned in economical purpoſes. The long and laborious reſearches of Bayen diſcovered that there exiſts tin without any mixture; and that

that there exiſts ſome alſo, which is united to a very ſmall quantity of the arſenical ſubſtance.

His analyſes taught him alſo, that the tin uſed in commerce, and that manufactured by pewterers, contain copper and antimony, which render it hard; zinc, which gives it a white colour; biſmuth, which renders it ſonorous; and, above all, lead, which diminiſhes its value. It is in particular this metal fraudulently united with tin, that can render the latter dangerous *, as both theſe ſubſtances are ſoluble in vegetable acids. Scarcely had Bayen's reſearches on tin been made public, when the uneaſineſs excited by Margraff and Henkel vaniſhed. It was clearly proved, that the very ſmall quantity of arſenic contained in tin cannot abſolutely be hurtful, and no more ideas were entertained of baniſhing a ſpecies of veſſels ſo long employed by our anceſtors.

Bayen had ſuch a habit of conſidering objects, and of judging of their compoſition by the analyſes he had made of analogous objects, that it was often ſufficient for him to ſee and to touch them in order to tell their nature. As a proof of this aſſertion, may be mentioned the opinion which he gave of one of the marble baluſtrades in the *Place de la Revolution*. Notwithſtanding the poliſh and apparent ſolidity of this marble, he foretold that it would decay in a very little time; and he pointed out to Deyeux, who was preſent, the different places where the alteration would firſt manifeſt itſelf, and thoſe which would endure the longeſt. Scarcely had a year elapſed when the prediction began to be accompliſhed; and in leſs than three years the alteration was ſo great, that conſiderable excavations were formed in the places pointed out. Bayen was of opinion, that the monu-

* The pewter pots in common uſe in London contain lead in their compoſition; and as all the beer drawn in them is more or leſs acid (ſtale), it is evident that thoſe who uſe them are conſtantly taking, though in ſmall quantities, a ſolution of lead, which is highly noxious. It is very improper, therefore, to uſe beer which has ſtood in them for any length of time. EDIT.

ments

ments which have ſubſiſted without any perceptible alteration for a long ſeries of ages, have been thoſe conſtructed of marble, little ſuſceptible of any attack from the action of the air or of water. From all the analyſes which he made of marble belonging to ancient monuments, he concluded, that when a public edifice is to be erected, an architect cannot take too many precautions to be aſſured of the good ſtate of the materials he employs, eſpecially when they are brought from a quarry recently opened. By thus making an uſeful application of chemiſtry to an art which ſeemed to be foreign to it, he revived a truth, too little noticed, that there exiſts between all the ſciences a connection which unites them by fixed and invariable principles.

Beſides the labours above mentioned, Bayen began others, which, on account of the many experiments neceſſary before he could obtain certain reſults, were never finiſhed; for he was of opinion that the operations of chemiſtry ought to be conducted ſlowly, like thoſe of nature. On this account he has been known to employ himſelf whole years in the examination of one ſubſtance, in which he wiſhed to diſcover and to ſeparate a matter, that would have been deſtroyed or altered by too violent means, had he proceeded with more haſte. To this prudent conduct was owing the great perfection to which he always carried his labours; and his accuracy was ſo great, that he was never afraid of ſeeing his experiments repeated by other chemiſts.

This diligent and laborious man, when he had attained to the age of ſixty, found his health, which had hitherto been ſound and robuſt, ſenſibly impaired by a long and painful malady. Several journeys which he was obliged to undertake, the loſs of ſome friends, domeſtic troubles, and weakneſs brought on by his labours, haſtened his death. He ſupported his complicated evils with great patience, and died in the beginning of the preſent year, at the age of ſeventy-two. Bayen lived in celibacy, but he poſſeſſed the virtue neceſſary for that condition. He was a man of a ſound judgment,

ment, directed always by the force of reaſon and experience. In the diſtribution of the places which he had at his diſpoſal, when inſpector of hoſpitals with the army, he obſerved the moſt impartial juſtice; conferring them according to merit, and inexorable even to ſolicitations from his relations or friends. Chemiſtry did not occupy the whole of his attention, and the variety of the knowledge which he had acquired by his ſtudies, rendered his converſation intereſting and agreeable.

INTELLIGENCE

AND

MISCELLANEOUS ARTICLES.

LEARNED SOCIETIES.

IN the public ſitting of the French National Inſtitute, held on the 15th of Meſſidor (July 3), after an account had been given of the labours of the preceding three months, Cit. David Leroy read a memoir on the ſmall ſhips of war of the Ancients, which he examined from the time of the firſt Punic war to the battle of Actium. He made choice of this epoch, as being that which preſented the moſt remarkable improvements, and reſpecting which we have the moſt information. The author, in this memoir, points out the advantages of theſe veſſels, which were exceedingly narrow in proportion to their length, ſeveral of them being eight and even ten times longer than they were broad, which allowed them, though puſhed forwards by oars alone, to advance with great velocity. Cit. Leroi thinks that, notwithſtanding the improved ſtate of navigation, oars ought not to be ſo much neglected; and that ſhips of war like thoſe uſed by the Ancients might ſtill, eſpecially during calms, be attended with great advantages.

A friend

A friend read for Cit. Delambre, who was then engaged near Carcaſſonne in meaſuring a degree of the meridian, an account of the means employed to meaſure, with the greateſt accuracy, a portion of an arc between Melun and Lieuſaint.

Cit. Fleurieu communicated ſome conjectures, perhaps too hypothetical, on the manner in which the north-weſt coaſt of America was peopled; together with a general view of that coaſt, and of both the Americas in regard to civilization. This memoir diſplays the extenſive knowledge of its author.

Cit. Colin-Harleville recited a dialogue between a man and his own conſcience. Several traits of ſentiment were loudly applauded.

Cit. Chaptal communicated a memoir on yellow dyes, to which it has been as yet found impoſſible to give ſplendour and durability. The author pointed out the chemical means to be employed for accompliſhing this object; and took occaſion to ſhew the great obligation which the arts have to chemiſtry.

Cit. Mongez preſented ſome reflections on two antique ſtatues, the dying gladiator, and the *gladiator repellens*, or fighting gladiator; which are now on their way to embelliſh the Muſeum of Antiques, and of which beautiful copies in bronze may be ſeen at the entrance of the court of the Tuilleries. Cit. Mongez is of opinion that theſe two Greek ſtatues do not repreſent gladiators, who were known only among the Romans, whom the people deſpiſed, and who were, however, ſeen with pleaſure—but rather Grecian wreſtlers. It is well known that the Greeks united in their wreſtlers, thoſe ideas of dignity, ſtrength and beauty, which are ſeen imprinted on theſe beautiful ſtatues.

Cit. Lalande, after remarking that the magnetic needle does not point always exactly to the pole, concludes from ſeveral obſervations, which he communicated to the Aſſembly, that it directs itſelf towards a certain place on the ſurface of the earth, which he thinks approaches very near to the

the entrance of Baffin's Bay on the northern coaſt of America.

Cit. Molé read, for Cit. Andrieux, a tale in verſe entitled *Le Doyen de Badajoz.*

The Inſtitute then adjudged the prize propoſed the IVth year, the ſubject of which was "the conſtruction of a pocket time-piece proper for determining the longitude at ſea, &c."

The National Inſtitute at Paris has applied to the Directory for permiſſion to convoke a deputation of the *Literati* of all countries in amity with the French Republic, to eſtabliſh a uniformity of weights and meaſures throughout the civilized world.

A Society of Agriculture and Rural Economy, which has already among its members Creuze-la-Touche, Gilbert, Thouin, Desfontaines, Dubois, Crette-Palluel, Teſſier, Chabert, &c. has been eſtabliſhed at Paris. As this ſociety will hold public meetings, the information it muſt diffuſe in its memoirs will no doubt tend greatly to ameliorate the ſtate of agriculture, and to improve this uſeful art.

On the evening of the 17th inſt. the Members of the Royal Academy of London, by deſire of government, held a meeting at Somerſet-houſe to conſider of ſome beautiful device for our coin, which may render counterfeiting more difficult, and impreſs foreigners with an idea of our national taſte. The idea is good ſo far as it goes, but it ought to go farther. Our coinage ought to be ſo managed as to ſerve for a real hiſtorical ſeries and chronology of all important public events, whether of a proſperous or adverſe nature. The Royal Society and Royal Academy would be uſefully employed in producing the neceſſary devices, legends, &c. We ſay uſefully, for we know of no means that could with equal facility give ſo much information to all ranks in the community. The events recorded on our coins ſhould not be thoſe only that are of a political nature: the æra of uſeful inven-

inventions, and the names of eminent benefactors of mankind, ought in this manner to be handed down to posterity.

ANTIQUITIES.

A DISTINGUISHED Artist, who is travelling through the southern departments of France, charged by government with a mission relative to the arts, in a letter dated Aix, Prairial 14th, says: " Some workmen, who were digging up the ground on the declivity of an eminence which overlooks Vienne, discovered a small group, consisting of two children formed of white marble, in perfect preservation, and exceedingly well executed; one of the children holds a bird, which the other endeavours to snatch from it, and which seems to peck the arm of the latter. Each of the children rests against the trunk of a tree. At the bottom of one of these trunks, and near the child which holds the bird, is seen a serpent; and on the other trunk there is a lizard having in its mouth a butterfly.

DIOPTRICKS.

THE Abbé Hauy, having polished a fragment of transparent native sulphur, found that it possesses the power of double refraction in a very eminent degree. The two faces of this fragment are inclined to each other about twelve degrees, and their greatest distance is fourteen millimetres, or a little more than six lines. If this fragment be placed on a piece of paper on which a line has been drawn, two very distinct images of the line are seen. By observing objects somewhat remote through this fragment, it may be judged, by the distance between the images, that the refraction of sulphur in itself must be very considerable, allowance being made for the density of that substance, the specific weight of which is only double that of water; and this agrees with the results of Newton, in regard to the refractive powers of inflammable bodies. Cit. Hauy proposes to make experiments in order to determine the quantity of this refraction, which has not yet been meaſured, and to compare it afterwards with the reſult of calculation, according to the proportion between the refractive powers of inflammable ſubſtances and their denſities.

ARTS.

AN ingenious Artiſt at Paris has lately completed, with great perſeverance, patience, and mathematical accuracy, a very curious model of that city, on which he has been employed nine years. He has not contented himſelf with comparing and correcting all the plans of Paris ever publiſhed: he meaſured all the ſtreets, ſquares, &c. according to the moſt accurate geometrical methods of meaſurement, and determined the inequalities of the ſite of that immenſe capital by levelling. The greateſt diameter of his model, in the extent from eaſt to weſt, is fifteen feet. The mean ſize of the houſes is three lines. The artiſt has carried his accuracy ſo far, that each inhabitant of Paris can diſtinguiſh his own houſe, court-yard, and garden. The public places and gardens are repreſented with a moſt ſtriking ſimilitude; and not only their dimenſions but their colour and ornaments can be obſerved. The alternate riſing and falling of the plane of the model gives to this repreſentation a correctneſs which produces an effect like enchantment, if the obſerver ſuppoſes himſelf to be ſtanding on Mount-Marte, and to be looking down on the city. The artiſt has with much judgment endeavoured, by the ſhades of his colours, to give a point of reſt to the eye; the want of which is a great failing in that model of Rome which formerly ſtood in the library of St. Genevieve, and which now belongs to the French nation, as it exhibits the tireſome view of a dazzling white maſs of gypſum. Thirty thouſand trees, which diſtinguiſh the different walks, public places, and gardens, form an agreeable variety with the ſlated and tiled roofs. This model may be taken to pieces by means of ſcrews, and can be packed into three large boxes for the purpoſe of tranſportation.

ENGINEERING.

A DIRECT communication between the counties of Kent and Effex has been projected by Mr. Dodd, engineer, by means which we think well calculated to anfwer the intended purpofe. He propofes a cylindrical tunnel under the river Thames, from Gravefend to Tilbury, to be conftructed wholly with key-ftones, and therefore able to bear any preffure; the diameter to be fixteen feet in the clear, which Mr. Dodd imagines will be fufficient for foot, horfe, and carriage-paffengers; the paffage to be illuminated with lamps, and a fteam-engine to be erected in a proper fituation to draw off the drainage water, if any fhould accumulate.

The expence of this ftupendous undertaking is eftimated at fo low a fum as 15,955l. for 900 yards of tunnelling, relaying the bottom, lamps, lamp-irons, fteam-engine, pipes, and other neceffary machinery.

This projected meafure will fave a circuitous route of fifty miles by land (the diftance from Gravefend to Tilbury, along London-Bridge). Independent of the advantage it would afford to commercial eftablifhments and agricultural improvements, the general benefit to the counties of Kent and Effex muft be immenfe.

Mr. Dodd is of opinion, that, whether the meafure is confidered as a great national improvement, or a local one to the two counties, of forming a military poft of the firft confequence in that part of the kingdom, for enabling troops, &c. to pafs through, its importance claims the greateft attention. Another queftion he fuggefts, is, what may be the moft proper method of raifing the fupplies to defray the expence of the undertaking—whether by the joint expence of both counties, or by a fubfcription of private individuals, incorporated by Parliament, with authority to levy tolls? The latter mode he is convinced would be beneficial to the individuals, and amply repay the fhare-holders.

The following are the eftimates of the expence, as fuggefted by Mr. Dodd, in the firft inftance:

To

To 900 yards (running meaſure) of tunnelling, including excavations, vaulting with key-ſtones, &c. at 12l. per yard, - - -	£10,800
To re-laying the bottom with new-made ground, 900 yards, at 1l. each, - - -	900
To placing lamps and lamp-irons through the tunnel, collectors' rooms, and gates at each end, -	400
To making good the entrance roads at each end of the tunnel, - - - -	160
To a ſteam-engine to draw off drainage-water, -	1,780
Neceſſary machinery during the execution, -	500
To ten per cent. upon the whole, for contingencies,	1,415
Total —	£ 15,955

VEGETATION.

IN our firſt number (page 109) we ſtated that, from ſome intereſting experiments which had been recently made by Sir Francis Ford, it had been proved that plants ſprinkled with water, previouſly impregnated with oxygen gas, grew much more vigorouſly, and diſplayed more beautiful tints, than thoſe nouriſhed with common water. The application of oxygen to promote vegetation has been ſince tried in the following ſimple manner, and the reſult has been the ſame as above ſtated: Bottles filled with oxygen gas, being firſt inverted, have had their mouths buried under ground, near the roots of the plants intended to be ſupplied with it. After ſome time the gas in the bottles was found reduced to the ſtandard of common atmoſpheric air: but the oxygen had done its duty; for the plants that had been thus ſupplied with it were much more healthy and beautiful than others of the ſame kinds placed in every other reſpect in ſimilar circumſtances.

Erratum. Page 192, line 13, *for* 22d *read* 2d of December.

THE

PHILOSOPHICAL MAGAZINE.

AUGUST 1798.

I. *Description of the large Orang Outang of Borneo. By F. B. VON WURMB. From the* Tranfactions of the Batavian Society in the Ifland of Java.

MANKIND have beftowed every poffible pains to trace out the progrefs of nature, and to difcover thofe threads by which her works are connected; and their exertions, indeed, have not always been fruitlefs. Thus, for example, the difcovery of animal plants pointed out the tranfition from the vegetable to the animal kingdom. The bat and the flying fquirrel difplayed the connection between quadrupeds and birds; and the feal and the fea-cow that of quadrupeds with fifhes.

The greateft vacuity which appears to us in the plan of nature is, certainly, that obferved between man, a being endowed with reafon, and the irrational animals. Naturalifts hitherto have endeavoured, but in vain, by the moft accurate refearches to acquire fome fatisfaction on this point; and we may almoft confider it as certain that the links of the great chain, here wanting, are not to be found in the world which we at prefent inhabit. Were nothing more required but fimilarity of bodily conformation, this tranfition, without doubt, would be found in the four-handed race of apes. But as the qualities of the mind are here as much considered as the form of the body, it is evident that the ape, which does not deserve the second rank among the irrational animals, cannot form the link that connects quadrupeds with man. The external figure, however, of this animal has since the earliest periods engaged the attention of naturalists; and by the similitude of its body we are led to suspect a similitude of mental powers in beings to which the all-wise Creator has given so much likeness. But as the discoveries made by the searchers into nature are frequently not so much the truth as something suited to the systems which they have adopted, this circumstance has given rise to a great deal of error. The celebrated Linnæus himself was induced by a figure which Bontius * delineated of an orang outang, or wild man, seen in the island of Java, and the accounts of some travellers, to class his *homo nocturnus* or night-man between man and the ape, and thereby to establish the existence of a being, the truth of which is as yet very doubtful.

Buffon proceeded in a much more cautious manner. That celebrated naturalist suspected, and not without reason, that the accounts given with so little accuracy of the night-men alluded only to the white negroes or kakerlaks, considered in a false light or under the veil of prejudice; and, indeed, the description given by Bontius of the orang outang differs only in some very inconsiderable circumstances from the figure of the white negro or kakerlak Saudami described by M. van Iperen †. If we take from this description of Bontius the ruff under the chin, and the few hairs which cover the head, a more beautiful human form

* Bontius resided as a physician at Batavia in the last century, and wrote *Hist. Nat. et Med. Ind. Orient.* Edit.

† See the first part of the *Transactions of the Batavian Society in the Island of Java.*

would

would appear than that of Saudami *; and had the latter grown up, not at the court of the prince of Tabana, but in the solitary woods of the island of Bali, his mental powers would have been so little expanded, that an inattentive observer might have classed him among the pongos, varis, orang outangs, &c. of Battel, Pyrard, Leguat, and others. But the figure which Bontius has given us of the orang outang may have been delineated with too great a resemblance to that of man, and contrary to truth; for, if we adhere only to the description, we can discover nothing more than a common large orang outang or pongo. Brisson, who classes the orang outang of Bontius along with the vari, appears to have been of the same opinion. An instance of such a false and too human-like representation of this animal occurs also in the figure of an orang outang of the island of Borneo, given in Beckman's voyage; where the author speaks, without all doubt, of the same species as that transmitted to our society from that island. But be this as it may, it is certain that since the time Bontius resided in Java, or the middle of the last century, no orang outang, such as that delineated by him, has been found either in this island or in any of those in the neighbourhood; and as he asserts that he saw several such animals of both sexes, it is certainly incomprehensible why the least traces of them are not now to be discovered. The oldest and most experienced Javanese are acquainted with no other orang outangs than such as are real apes; and they distinguish under this Malayan name

* "The description of the white negro," says the author in his *Letters from India*, "will afford a new and incontestable proof to our naturalists, that every thing hitherto said of whole races of *kakerlaks* or white negro night-men, and the like, is mere fables, and that such men are sometimes produced here and there only by accident. The parents of this white negro, who is called Saudami, were, like the other inhabitants of their native country, the island of Bali, of a dark brown colour, and their son was not sickly, but large and strong. I found him to be five feet two inches and a half in height, Rhinlandish measure." Edit.

two kinds without tails, which Buffon places among the pongos or jockos. Both are natives of Borneo, the only place almoſt where they are found; and whatever travellers may ſay, they are as little to be ſeen in the foreſts and wilds of Java as the lions and elephants repreſented on ſome charts of that iſland. The ſmall ſpecies which Buffon, by abbreviating the Congo name, calls jocos, are often brought to Java by ſhips coming from Bangarei; and of this kind was that ſent alive to Europe in 1776, and of which an accurate deſcription has been given by Woſmaer. The orang outang of the large kind, or the pongo of Buffon, is not common even in its native country Borneo; and much pains and labour had been in vain employed for upwards of twenty years, in endeavouring to catch one of theſe ſtrong and miſchievous animals. M. Palm, the reſident at Rembang, was at length ſo fortunate, on occaſion of his being ſent on an important miſſion to Sukkadana, to procure after a great deal of trouble one of theſe animals, which he ſent to the Batavian Society preſerved in arrack. The following accurate deſcription of it will, in my opinion, ſhew how fruitleſs it will be to ſearch for the wild men of Bontius in this ſpecies of orang outang.

The head in a certain degree is ſomewhat ſharpened from behind towards the top. The mouth projects a little forwards, and on each cheek is a fleſhy excreſcence (*vleeſachtige kwabbe*) which extends ſidewiſe more than the thickneſs of the head. The ears are ſmall, and lie flat to the head. The eyes are ſmall and prominent. The noſe, without any perceptible elevation, conſiſts merely of two long noſtrils, placed in an oblique direction towards each other. The mouth is ſurrounded by thick lips, and in the inſide has no pouches (*zacken*). The tongue is thick and broad. On that of the animal in queſtion there were found ſome remains of green herbs which it had eaten. Each jaw is furniſhed before with four broad inciſors, ſtanding between two thick canine teeth, which riſe above them. The face is of a dark brown

colour,

colour, and has no hair, except a very thin beard. The neck is exceedingly ſhort. The breaſt is much broader than the hips. At the rump there is no appearance of a tail, nor of any tough projecting hide. The penis ſeems to be drawn back into the body. The hands are long, and the palms as well as the fingers are of a dark brown colour, and have no hair. The legs are ſhort and thin, but the muſcles are ſtrong. The feet have a great reſemblance to the hands. The toes and fingers are furniſhed with black nails, almoſt like thoſe of a man, except the large toes, which are ſmaller and ſhorter; a difference that ariſes perhaps from the frequent uſe made of them. The breaſt and the belly are moſtly bare. The other parts of the body, the face, the ears, the palms of the hands, the feet and the fingers excepted, are covered with brown hair, which in many places is fully as long as the finger.

Under the ſkin of the throat and breaſt of the animal tranſmitted to the ſociety, there were found two bags, one of which occupied the greater part of the breaſt, and, as well as the ſmaller which was incloſed in it, had a communication with the wind-pipe. As this rare animal was deſtined for the cabinet of the Prince of Orange, it was ſubjected to no farther anatomical reſearches, for fear of deſtroying its configuration. The bowels, to guard againſt corruption, were taken out before it had been tranſmitted to Batavia. We, however, flatter ourſelves with the well-grounded hope of being able to give, at ſome future period, a particular and accurate account of the properties, habits and manner of living of this large orang outang, as the juriſdiction of the Eaſt India Company, under the preſent government, has been ſo conſiderably extended in Borneo, that acceſs is now opened for us to the interior parts of that great iſland *. With regard to the manner in which this

* In the ſecond part of the Tranſactions of the Batavian Society there is a pretty circumſtantial deſcription of this iſland, together with a ſhort extract from the journal of the above-mentioned M. Palm.

animal was caught, we were informed by M. Palm, that it defended itſelf ſo furiouſly with ſharp-pointed ſticks, which it broke off from the trees, that it was impoſſible to take it alive. This property it ſeems to poſſeſs in common with the African pongos, which, as Beutel ſays, attack elephants with theſe weapons, and drive them from their places of reſort*.

The following is an accurate meaſurement of the different parts of this animal, according to the Rhinlandic foot† divided into twelve inches:

Whole length of the animal from the ſoles of the feet to the crown of the head 3 feet $10\frac{3}{8}$ inches. This, however, does not agree with the meaſurement made in the iſland of Borneo, where the whole length was found to be 49 inches; but perhaps a different ſtandard was employed, or the body of the animal might have become contracted by lying in arrack. Circumference of the body at the ſhoulders 3 feet $\frac{5}{8}$ of an inch. Circumference of the body below the breaſt 3 feet $3\frac{1}{2}$ inches. Circumference at the hips 2 feet $4\frac{1}{4}$ inches. Aperture of the mouth $4\frac{1}{8}$ inches. Length or projection of the muzzle $3\frac{1}{2}$ inches. Diſtance from the middle of the upper lip to the eyebrows $4\frac{7}{8}$ inches. Diſtance between the corners of the eyes $1\frac{1}{8}$ inch. Breadth of the eye the ſame. Diſtance from the eyebrows to the hinder part of the head $6\frac{5}{8}$ inches. Diameter of the head from top to bottom $10\frac{3}{8}$ inches. Diameter of the head acroſs, meaſured at the diſtance of $3\frac{3}{8}$ inches from the top of the above line, $6\frac{1}{2}$ inches. Diameter of the head meaſured as before, at the diſtance of $6\frac{3}{8}$ inches from the crown, $9\frac{1}{2}$ inches. External circumference of the ear $3\frac{1}{2}$ inches. Circumference of the ear below where it adheres to the head 3 inches. Height of the ear $1\frac{5}{8}$ inch. Breadth [illegible]/4 of an inch. Diſtance from the

* Ought not this property to procure to the orang outang the firſt rank among animals next to man? For, whatever Buffon may ſay to the contrary, we know of no other animal which willingly employs for its defence any weapons but thoſe beſtowed on it by nature.

† The Rhinlandiſh is to the Engliſh foot as 1033 to 1000. It is therefore equal to 12.396 Engliſh inches. Edit.

the ſhare bone to the collar bone 2 feet $\frac{1}{4}$ of an inch. Diſtance of the breaſt bone from the ſhare bone 1 foot $\frac{7}{8}$ of an inch. Diſtance between the nipples of the breaſt $9\frac{3}{4}$ inches. Length of the arms to the tips of the fingers 3 feet $\frac{1}{2}$ of an inch. Circumference of the arm at the ſhoulder $11\frac{1}{8}$ inches; in the middle 1 foot $\frac{3}{8}$ of an inch; at the elbow 11 inches. Circumference of the fore part of the arm in the middle $10\frac{7}{8}$ inches; at the hand $8\frac{1}{4}$ inches. Length of the upper part of the arm 1 foot $\frac{1}{4}$ of an inch. Length of the lower part of the arm 1 foot $2\frac{1}{4}$ inches. Length of the hand from the joint to the tip of the middle finger $9\frac{3}{4}$ inches. Length of the thumb 3 inches; of the ſecond finger $4\frac{1}{4}$ inches; of the middle finger $5\frac{3}{8}$ inches; of the fourth finger $5\frac{1}{8}$ inches; of the little finger $4\frac{1}{8}$ inches. Circumference of the hand meaſured at the root of the thumb $9\frac{5}{8}$ inches; of the thumb and the three following fingers $3\frac{5}{8}$ inches; of the fifth finger $3\frac{1}{8}$ inches. Length of the palm of the hand $5\frac{1}{2}$ inches. Breadth of the palm of the hand $4\frac{1}{4}$ inches. Thickneſs of the hand $1\frac{1}{8}$ inch. Length from the heel to the upper end of the thigh bone 1 foot $8\frac{3}{8}$ inches. Length of the thigh bone 1 foot $5\frac{1}{4}$ inches. Circumference of the thigh 1 foot $5\frac{1}{4}$ inches. Length of the leg from the knee to the ſole of the foot $11\frac{1}{8}$ inches. Circumference of the leg cloſe under the knee 11 inches; at the middle of the leg $10\frac{5}{8}$ inches; at the ancle 10 inches. Circumference of the foot where the large toe begins $10\frac{3}{4}$ inches. Length of the great toe $2\frac{1}{2}$ inches; of the ſecond toe $4\frac{3}{8}$ inches; of the third toe 5 inches; of the fourth toe $4\frac{3}{4}$ inches; of the fifth toe $4\frac{1}{2}$ inches. Breadth of the ſole of the foot where the great toe begins 4 inches. Breadth of the ſole of the foot at the heel 3 inches. Length of the ſole from the heel to the beginning of the toes $6\frac{5}{8}$ inches. Circumference of the great toe 4 inches; of the three following toes $3\frac{1}{2}$ inches; of the fifth toe $3\frac{3}{8}$ inches. Width between the root of the great toe and the root of the ſecond toe 4 inches.

II. *Observations on a singular Phenomenon called the Spectre of the Broken. By J. L. JORDAN. From* Gottingisches Journal der Naturwissenschaften, *by J. F. GMELIN. Vol. I. Part III.* 1798.

IN the course of my repeated tours through the Harz*, I ascended the Broken twelve different times; but I had the good fortune only twice (both times about Whitsuntide) to see that atmospheric phenomenon called the Spectre of the Broken, which appears to me worthy of particular attention, as it must, no doubt, be observed on other high mountains which have a situation favourable for producing it.

The first time I was deceived by this extraordinary phenomenon I had clambered up to the summit of the Broken, very early in the morning, in order to wait there for the inexpressibly beautiful view of the sun rising in the east. The heavens were already streaked with red; the sun was just appearing above the horizon in full majesty, and the most perfect serenity prevailed throughout the surrounding country, when the other Harz mountains in the south-west, towards the Worm mountains, &c. lying under the Broken, began to be covered by thick clouds. Ascending at that moment the granite rocks called the Teufelskanzel, there appeared before me, though at a great distance, towards the Worm mountains and the Achtermannshöhe, the gigantic figure of a man, as if standing on a large pedestal. But scarcely had I discovered it when it began to disappear; the clouds sunk down speedily and expanded, and I saw the phenomenon no more.

The second time, however, I saw this spectre somewhat more distinctly, a little below the summit of the Broken, and near the Heinrichshöhe, as I was looking at the sun rising about four o'clock in the morning. The weather was rather tempestuous; the sky towards the level country was

* The Harz mountains are situated in Hanover.

pretty

pretty clear, but the Harz mountains had attracted several thick clouds, which had been hovering around them, and which beginning to settle on the Broken confined the prospect. In these clouds, soon after the rising of the sun, I saw my own shadow, of a monstrous size, move itself for a couple of seconds exactly as I moved; but I was soon involved in clouds, and the phenomenon disappeared.

It is impossible to see this phenomenon, except when the sun is at such an altitude as to throw his rays upon the body in a horizontal direction; for, if he is higher, the shadow is thrown rather under the body than before it.

In the month of September last year, as I was making a tour through the Harz with a very agreeable party, and ascended the Broken, I found an excellent account and explanation of this phenomenon, as seen by M. Haue on the 23d of May 1797, in his diary of an excursion to that mountain. I shall therefore take the liberty of transcribing it. "After having been here for the thirtieth time," says M. Haue, "and, besides other objects of my attention, having procured information respecting the above-mentioned atmospheric phenomenon, I was at length so fortunate as to have the pleasure of seeing it; and perhaps my description may afford satisfaction to others who visit the Broken through curiosity. The sun rose about four o'clock, and, the atmosphere being quite serene towards the east, his rays could pass without any obstruction over the Heinrichshohe. In the south-west, however, towards Achtermannshöhe, a brisk west wind carried before it thin transparent vapours, which were not yet condensed into thick heavy clouds.

"About a quarter past four I went towards the inn, and looked round to see whether the atmosphere would permit me to have a free prospect to the south-west; when I observed, at a very great distance towards Achtermannshöhe, a human figure of a monstrous size. A violent gust of wind having almost carried away my hat, I clapped my hand to it

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by moving my arm towards my head, and the coloſſal figure did the ſame.

"The pleaſure which I felt on this diſcovery can hardly be deſcribed; for I had already walked many a weary ſtep in the hopes of ſeeing this ſhadowy image, without being able to gratify my curioſity. I immediately made another movement by bending my body, and the coloſſal figure before me repeated it. I was deſirous of doing the ſame thing once more—but my coloſſus had vaniſhed. I remained in the ſame poſition, waiting to ſee whether it would return, and in a few minutes it again made its appearance on the Achtermannshöhe. I paid my reſpects to it a ſecond time, and it did the ſame to me. I then called the landlord of the Broken; and having both taken the ſame poſition which I had taken alone, we looked towards the Achtermannshöhe, but ſaw nothing. We had not, however, ſtood long, when two ſuch coloſſal figures were formed over the above eminence, which repeated our compliments by bending their bodies as we did; after which they vaniſhed. We retained our poſition; kept our eyes fixed on the ſame ſpot, and in a little the two figures again ſtood before us, and were joined by a third. Every movement that we made by bending our bodies theſe figures imitated—but with this difference, that the phenomenon was ſometimes weak and faint, ſometimes ſtrong and well defined. Having thus had an opportunity of diſcovering the whole ſecret of this phenomenon, I can give the following information to ſuch of my readers as may be deſirous of ſeeing it themſelves. When the riſing ſun, and according to analogy the caſe will be the ſame at the ſetting ſun, throws his rays over the Broken upon the body of a man ſtanding oppoſite to fine light clouds floating around or hovering paſt him, he needs only fix his eyes ſtedfaſtly upon them, and, in all probability, he will ſee the ſingular ſpectacle of his own ſhadow extending to the length of five or ſix hundred feet, at the diſtance of about two miles

miles before him. This is one of the most agreeable phenomena I ever had an opportunity of remarking on the great observatory of Germany."

III. *An Account of Mr.* PARK'*s Journey into the Interior Parts of Africa. From the* Proceedings of the African Association, 1798.

[Concluded from Page 204.]

THE city of Sego, at which Mr. Park had now arrived, consisted of four divisions or quarters, two on each side of the water; and each of them being surrounded by a mud wall, it had the appearance of four distinct towns. The houses are built of clay, and have flat roofs; but some of them have two stories, and many are white-washed. Besides these buildings, Moorish mosques are seen in every quarter. These objects, with the numerous boats on the river, a crowded population, and the cultivated state of the surrounding country, formed altogether a prospect of civilisation and magnificence which our traveller little expected to find in the bosom of Africa. From the best inquiries he could make, he had reason to believe that the place contained altogether about 30,000 inhabitants.

The boats on the Niger are formed of the trunks of two large trees rendered concave, and joined together, not side by side, but lengthways, the junction being exactly across the middle of the boat. They are therefore very long, and disproportionably narrow; and have neither decks nor masts: they are however roomy. Mr. Park observed in one of them four horses and a great many people crossing at a ferry.

To this ferry Mr. Park proceeded, intending to cross over to the largest quarter of the city, where he was informed the king of Bambara held his residence; but the number of people pressing for a passage was such as to prevent his embarkation.

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The multitude gazed on the ſtranger with ſilent wonder; and he diſtinguiſhed with concern many Moors among them. In the mean time, information that a white man was waiting for a paſſage was conveyed to the king; who immediately ſent a meſſenger to inquire what brought him to Sego, and what he wanted? Our traveller, having given the beſt anſwer he could as to the motives of his journey, added, that he was there in his way to Jenné, and, having been robbed of all he poſſeſſed, implored the king's bounty and protection. The meſſenger told him to go to a diſtant village, which he pointed out, and wait for the king's farther orders.

Mr. Park complied with theſe directions, but found that the inhabitants of the village were either averſe or afraid to give him lodging or entertainment; and having turned his horſe looſe, he ſought ſhelter from a ſtorm of thunder and rain under a tree. At length, as night approached, the kindneſs and humanity inherent in the female ſex, to which he had often been indebted on former occaſions, came to his relief on the preſent. A poor negro woman returning from the labours of the field obſerved that he was wet, weary and dejected, and, taking up his ſaddle and bridle, told him to follow her. She led him to her cottage, lighted up a lamp, procured him an excellent ſupper of fiſh, and plenty of corn for his horſe; after which, ſhe ſpread a mat upon the floor, and ſaid he might remain there for the night. For this well-timed bounty our traveller preſented her with two of the four braſs buttons which remained on his waiſtcoat. Mr. Park relates that this good woman, having performed the rites of hoſpitality herſelf, called in the female part of her family, and made them ſpin cotton for a great part of the night. They lightened their labour by ſongs: one of which muſt have been compoſed extempore; for our traveller was himſelf the ſubject of it; and the air was, in his opinion, the ſweeteſt and moſt plaintive he had ever heard. The words, as may be expected, were ſimple, and may be literally tranſlated as follows: "The winds roared, and

and the rain fell. The poor white man, faint and weary, came and ſat under our tree. He has no mother to bring him milk—no wife to grind his corn."——*Chorus.* "Let us pity the white man; no mother has he, &c. &c."

Mr. Park continued all the next day in the village, without receiving any orders from the king, and found himſelf the object of univerſal inquiry. He ſoon heard enough, however, to convince him, that the Moors and Slatees or ſlave traders, reſiding in Sego, were exceedingly ſuſpicious concerning the motives of his journey, and in the higheſt degree hoſtile towards him. He learnt that many conſultations had been held with the king concerning his reception and diſpoſal; and the villagers openly told him that he had many enemies, and muſt expect no favour.

On the third day the meſſenger arrived; and, bringing a bag in his hands, ſignified to our traveller that he muſt depart forthwith from the vicinage of Sego; but that Manſong the king, wiſhing to relieve a white man in diſtreſs, had ſent him 5000 kowries * to enable him to purchaſe proviſions in the courſe of his journey. The meſſenger added, that if Park's intentions were really to proceed to Jenné, he had orders to accompany him as a guide to Sanſanding.

Being thus compelled to leave Sego, Mr. Park applied himſelf to collect all the information he could from his guide. Though it was evident that this man was ſent principally in the view of diſcovering the motives and object of his journey, he was found to be very friendly and communicative. By him Mr. Park was frankly told, that if Jenné was the place of his deſtination, he had undertaken an enterpriſe of greater danger than probably he was appriſed of; for, although the town of Jenné was nominally a part of the king of Bambara's dominions, it was in fact a city of

* Kowries or cowries are ſmall ſhells which in Africa and many parts of the Eaſt Indies paſs current as money. In Bambara a hundred of them would purchaſe a day's proviſion for a traveller, and corn for his horſe.

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the Moors; the principal part of the inhabitants being Bushreens or Mahometans; and even the governor himself, though appointed by Mansong, was of the same sect. Mr. Park's reflections on this occasion were aggravated by the circumstance, that his danger was likely to increase as he advanced on his journey; for he learnt that the places beyond Jenné were under the Moorish influence, in a still greater degree than Jenné itself; and that Tombuctoo, the great object of his research, was altogether in the possession of that savage and merciless people.

Notwithstanding these discouraging reflections, Mr. Park persisted in what he conceived to be his duty; and the first town of note at which he arrived after leaving Sego, was called Kabba. It is situated in the midst of a beautiful and highly cultivated country, "bearing," says Mr. Park, "a greater resemblance to the centre of England, than to what I should have supposed had been in the middle of Africa;" and the season was that of the *shea* harvest, or the gathering in the fruit which produces the *shea-toulou* or tree-butter, the great abundance of which in this quarter was astonishing. The tree itself very much resembles the American oak; and the nut, from the kernel of which the butter is prepared by boiling it in water, has somewhat the appearance of a Spanish olive. The kernel is enveloped in a sweet pulp under a thin green rind; and it is Mr. Park's opinion, that the butter produced from it, besides the advantage of its keeping without salt the whole year, is whiter, firmer, and of a richer flavour than the best butter he ever tasted made from cow's milk. The growth and preparation of this commodity seem to be among the first objects of African industry in this and the neighbouring states; and it constitutes a main article of their inland commerce.

On the afternoon of the second day Mr. Park and his guide reached Sansanding, a very large town situated on the banks of the Niger, much resorted to by the Moors, who bring thither large quantities of salt, which they barter for

shea

ſhea toulou and gold duſt. Leaving this place early next morning, he proceeded to a town called Nyara, and from thence to Modibao, a delightful place on the banks of the river, which is here very broad, and enlivened with many ſmall and verdant iſlands, all of them ſtocked with cattle and crowded with villages. Here he was compelled to ſet off again abruptly, for fear of the Moors, the *dooty* or chief man giving him a guide to Kea; but his horſe, which had been long reduced to a mere ſkeleton, dropped on the road, and he was obliged to quit him. At Kea he embarked in a fiſhing canoe, and was landed in ſix hours at Silla, a large town on the ſouthern ſide of the Niger. At this place the *dooty* was nearly as ſavage as the Moors, and it was with great difficulty our traveller could get ſhelter for the night. He was now convinced by painful experience, that the obſtacles to his farther progreſs were inſurmountable, and that in attempting to reach Jenné, unleſs under the protection of ſome men of weight and influence among the Moors, which he had no poſſible means of obtaining, he ſhould ſacrifice himſelf to no purpoſe; for his diſcoveries would periſh with him. He conſidered at the ſame time, that by returning to Gambia in a different route, he might ſtill promote in ſome degree the purpoſe of his miſſion; for, having diſcovered the Niger at a great diſtance from its head, he ſhould be adding conſiderably to the geography of Africa, in tracing this myſterious river up the ſtream to its ſource. On theſe and ſimilar conſiderations Mr. Park determined to return to Sego, and, proceeding from thence along the banks of the river, truſt for his ſupport to the hoſpitality of the negroes in the ſouthern ſtates, out of the reach of Mooriſh fanaticiſm and malice.

The town of Silla, from which Mr. Park began his return homewards, is within two ſhort days journey of Jenné, which is ſituated on an iſland in the river. At the diſtance of two days more the river empties itſelf into a conſiderable lake, called Dibbie or the Dark Lake; concerning the extent of of which, all the information which could be obtained was, that in croffing over it from weft to eaft the canoes lofe fight of land one whole day. From this lake the water iffues in many ftreams, which terminate in two large branches. One of thefe flows towards the north-eaft, and the other to the eaft; but they join again at Kabra, one day's journey to the fouthward of Tombuctoo, and the port or fhipping-place of that city. The tract of land which the two ftreams encircle is called Jinbala, and is inhabited by negroes; and the whole diftance by land from Jenné to Tombuctoo is twelve days journey. From Kabra, at the diftance of eleven days journey down the ftream, the river paffes to the fouthward of Houffa, which is two days journey diftant from the river. Of the further progrefs of this great river, and its final exit, whether it be the fame that paffes by Kaffina*, or whether, as ancient charts feem to indicate, it fpreads into one or more inland lakes, or at an immenfe diftance intermixes with the waters of the Nile, are queftions which future difcovery can alone refolve.

On the third day of Auguft Mr. Park left Silla, intending to return through Sego in his way back to Gambia; and at Modibao he had the good fortune to recover his horfe, which he found fomewhat improved in condition. Here he learnt that Manfong, having been perfuaded by the Moors that our traveller had come into his country with fome mifchievous intention, had given orders to apprehend him. He therefore thought it prudent to avoid Sego altogether; which he accordingly did, by taking a circuitous route until he had got confiderably to the weft; when turning towards the Niger, he paffed through many towns and villages on its banks; the largeft of which, called Sammee, he left on the 14th of Auguft, and lodged that night at Benni. On the morning of the 16th he arrived at Jabbee, a large town with a Moorifh mofque in it. The fame day

* Erroneoufly fpelt *Cafhna*.

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he paſſed through Yamina, and on the 20th reached Koolikorro, a great ſalt-market. On the following day he proceeded to Marraboo, and in two days more arrived at Bammakoo, the frontier of the kingdom of Bambara.

During the courſe of this peregrination through the king of Bambara's dominions, our traveller had to encounter the tropical rains in all their violence; and he was principally indebted for his daily ſupport to the dooty or chief man in the ſeveral towns through which he paſſed. This officer ſeems to poſſeſs in ſome reſpects the authority of mayor in the corporate towns of England; and it reflects great honour on the police of the African kingdoms, or on the benevolent manners of the natives, that it is conſidered one part of the dooty's obligation to provide food for the neceſſitous traveller:—*To ſuffer the king's ſtranger to depart hungry*, ſuch is the phraſe uſed, is an offence of a very heinous nature. On many occaſions Mr. Park offered payment, for what he received, out of the kowries that ſtill remained of the king's preſent, and his offer was ſometimes accepted, and ſometimes refuſed. On others he remunerated his hoſt in a ſingular manner, the particulars of which deſerve to be recited. Among the various impoſtures practiſed by the Moors towards the poor negroes, they frequently ſell them ſcraps of paper with an Arabic inſcription (commonly a paſſage from the Koran), which are called *ſaphies* or charms. With one of theſe about his perſon, the poſſeſſor conſiders himſelf invulnerable, and neither the lurking ſerpent nor the prowling leopard is any longer the object of his dread. In the circumſtances to which Mr. Park was reduced, he had the good fortune to diſcover that the negro natives aſcribed to him the power of granting ſaphies of even more than Arabian virtue. "If a Moor's ſaphie is good," ſaid the dooty of Sanſanding, "a white man's muſt be better;" and Mr. Park, at his requeſt, gave him one poſſeſſed of all the virtues he could concentrate, for it contained the Lord's Prayer. The pen with which it was written was made of a

 reed;

reed; a little charcoal and gum-water made very tolerable ink, and a thin board anſwered the purpoſe of paper. In his journey weſtward this merchandize turned to extraordinary good account; and it is ſurely needleſs for Mr. Park to frame any apology for having availed himſelf of ſuch a reſource in his ſituation.

At Bammakoo the Niger ceaſes to be navigable. It takes its riſe at a ſmall village called Sankari in the high lands of Jallonkondoo, about ſix days journey S. W. from Bammakoo; and the country becoming mountainous, our traveller on the 22d took the path for Sibidooloo, where he arrived at the end of two days. On the 30th he came to Wonda, a fine village regularly built and ſurrounded by a wall. Here he was confined ſeveral days by ſickneſs; and having nothing elſe to offer to the friendly negro, in whoſe houſe he was accommodated, Mr. Park preſented him, at parting, with his horſe, now indeed become unable to proceed any farther. On the 8th of September he ſet out on foot for Kinneyeto, a conſiderable town, which he reached on the 11th, and in three days more arrived at Kamalia. At this place Mr. Park, worn down by fatigue and the viciſſitudes of the weather, having ſometimes been plunged up to the neck in rivers and ſwamps, and ſometimes loſt in woods and deſerts, without ſhelter, clothing, or food, fell into a ſevere and dangerous fit of ſickneſs, in which the remembrance of paſt ſuffering, and the hopes of future enjoyment, had nearly been extinguiſhed together. On his arrival at Kamalia he had ſtill a ſpace of 500 miles to traverſe before he could reach any friendly country on the Gambia; and being informed that great part of the way lay through a deſert, which it was impoſſible he could croſs ſingly and unſupported, he had no other reſource but to wait for the firſt caravan of ſlaves that might travel the ſame track. Such a one was expected to paſs through Kamalia at the end of three months, and the chief director of it reſided in that place. To him, therefore, Mr. Park applied; and for the value of one ſlave, to be paid on his ſafe arrival at the Gambia, this worthy negro, whoſe name was Karfa Taura, not only undertook to conduct him ſafe to Piſania, but offered him likewiſe the accommodation of his houſe until the time of the caravan's departure. Under this man's roof our traveller was confined to a mat, which was his only bed, by a ſevere and dangerous fever for upwards of a month. Five months longer he was detained for the caravan. During this long interval not a murmur eſcaped the lips of Karfa, or of any of his wives, at the trouble and expence which their inmate brought upon them. To the kind attentions, the tender ſolicitude, the cheerful aſſiduity, and warm hoſpitality of theſe poor Pagans, Mr. Park declares he is indebted not only for his ſafe return to Great Britain, but alſo for the preſervation of his life; and he admits that he made his friend Karfa but an inadequate return, though the beſt in his power, by preſenting him, on their arrival at Gambia, with double the ſum that he had originally promiſed.

The whole of Mr. Park's route, both in going and returning, having been confined to a tract of country bounded nearly by the 12th and 15th parallels of latitude, it muſt be imagined that he found the climate in all places exceedingly hot. On the borders of the deſert, where the fierceneſs of the tropical ſun is reflected from the ſands, the heat was ſcarcely ſupportable. Having been robbed of his thermometer, he had no means of forming a comparative judgment; but he well remembers that in the dry ſeaſon, when the wind blows from the eaſt and north-eaſt acroſs the deſert, the ground became ſo hot in the middle of the day as not to be borne by the naked foot. In the camp at Benowm even the negro ſlaves, accuſtomed as they were to this temperature, could not walk from one tent to another without their ſandals. At this time of the day the Moors lie ſtretched at length in their tents, either aſleep or unwilling to move; and Mr. Park declares, that, as he lay liſtleſsly along after their manner in his hut of reeds, he could not hold his hand

 againſt

againſt the current of air which came through the crevices, without ſuffering very ſenſible pain from its ſcorching effect. In the ſouthern diſtricts, which abound with wood and water, the climate improves; and in the mornings and evenings the air is ſerene, temperate and pleaſant. During the rainy ſeaſon the prevailing wind is from the ſouth-weſt. The monſoon commonly changes about the latter end of June, and the wind continues to blow from the ſouth-weſt quarter until the middle or end of October. In this interval the country is flooded, and the rains are preceded and followed by dreadful tornadoes or typhons. The commencement of this monſoon is the ſpring or ſeed-time, and its termination is commonly the ſeaſon of harveſt.

Among the principal productions of the negroe territories is the *lotus*. It is rather a thorny ſhrub than a tree, and abounds in all the countries which Mr. Park traverſed; but it thrives beſt in a ſandy ſoil. Its fruit is a ſmall yellow farinaceous berry, about the ſize of an olive, which being pounded in a wooden veſſel, and afterwards dried in the ſun, is made into excellent cakes reſembling in colour and flavour the ſweeteſt gingerbread. Some of the natives prepare from it alſo a liquor deliciouſly ſweet.

Of one ſpecies of their corn the negroes make excellent beer, by malting the ſeeds nearly in the ſame manner as barley is malted in England; and the beer which is thus made was to Mr. Park's taſte equal to the beſt ſtrong beer he had ever drank in his native country.

In the latter end of April 1797 the *coffle* or caravan being at length completed, and our traveller's health re-eſtabliſhed, he ſet out from Kamalia in company with ſeventy perſons, of whom only thirty-ſeven were ſlaves for ſale. In nine days they came to Maana, bordering on a branch of the Senegal. In ten days more they reached the ſmall but fertile ſtate of Dentilla, and croſſed in their journey ſome of the ſtreams that contribute to the great river of Gambia. On the 4th of June they fell in with that river, about two days journey above

above the falls of Baraconda, to which place it is navigable for canoes from its mouth; and in six days more, on the 10th of June, Mr. Park, to his infinite satisfaction, having undergone in his journey, from the heat of the weather, from fatigue, and from hunger, more than he could find words to describe, entered the hospitable mansion of Dr. Laidley, from which he had set out eighteen months before.

On the 15th of the same month he embarked in a slave ship bound to America; which being driven by stress of weather to Antigua, Mr. Park took his passage from thence in a vessel bound to Great Britain; and on the 25th of December last arrived safely in London.

IV. *Explanation of the French Measures and Weights, pointing out their Value and principal Uses, according to the Law of Germinal 18th, 3d Year of the Republic. From the* Journal de Physique, 1798.

MEASURES OF LENGTH.

CENTIMETRE. The hundreth part of the metre. This is rather a subdivision than a particular measure *.

Decimetre. Tenth part of the metre. The double decimetre makes a very convenient measure for the pocket.

METRE. The standard of the measures of the republic being the ten-millionth part of a quarter of the meridian, or the length of about 3 feet $11\frac{44}{100}$ lines; it may serve for measuring cloth, stuffs, &c. It makes about the ordinary height of a walking-stick, which any person may carry in the hand. The demi-metre and the double metre may be useful for different kinds of measurement.

Decametre. Ten times the length of the metre. About thirty feet ten inches. Proper to form a chain for land-surveying.

* The millimetre, or the thousandth part of the metre, might be here mentioned; but it is of little use in commerce.

Hectometre. Length of a hundred metres. Will not be uſed.

Kilometre. Equal to a thouſand metres, or about 580 toiſes. Four will make about a common league.

Myriametre. Its value is ten thouſand metres, or about 5800 toiſes, which is a little more than one ſtage. The kilometre and the myriametre will be convenient to expreſs diſtances in itineraries, and to regulate boundaries in order to meaſure the highways.

MEASURES OF CAPACITY.

Centilitre. There is no need for a ſmaller meaſure of this kind. It may be conſidered as equal to a ſmall glaſs for ſpirits and liquors. The double of it would ſerve extremely well for the ſame purpoſe.

Decilitre. This is almoſt equivalent to a common goblet. The uſe of it may be readily conceived. Its half and its double are analogous to other meaſures now employed for liquids.

LITRE. Its content is equal to a cubic decimetre. It differs very little from the *litron*, and the Paris pint; and may be employed in the ſame manner, either for liquids or dry ſubſtances. Its half and its double will be alſo very uſeful.

Decalitre. It may be ſubſtituted, as well as the double decalitre, for meaſuring corn and all ſorts of grain.

The *demi-decalitre* may ſupply the place of the *picotin* (peck).

Hectolitre will ſerve for various dry ſubſtances, ſuch as grain, ſalt, plaſter, lime, coals, &c. The content of this meaſure might be given to caſks for wine. The *demi-hectolitre* will be alſo exceedingly uſeful, and particularly for grain.

Kilolitre. Equal in content to a cubic metre. It is equivalent almoſt to the ton uſed in ſhipping, which is not

not so much an instrument of measurement as a mode of valuation.

The *myrialitre* is superfluous *.

WEIGHTS.

The *milligramme* would weigh a little less than $\frac{1}{51}$ of a grain, consequently would give much more exactness than the 32ds which have been used hitherto; but as this measure is employed only in very nice operations, which do not occur in the common usages of commerce, weights may be confined to the following:

Centigramme. The hundredth part of a gramme, or about $\frac{1}{5}$ of a grain.

Decigramme weighs a little less than two grains. The demi-decigramme is almost equal then to the common grain.

GRAMME. Equivalent to the weight of a cubic centimetre of water, which makes about nineteen grains. Very analogous to the *gramma* of the Greeks, from which it takes its name. It is exceedingly proper to serve as unity in weighing valuable articles, such as gold and silver, and all those which require a great deal of accuracy.

Decagramme. The weight of ten grammes. Its half makes about a *gros* (a dram) and a third. Its double is a little less than two thirds of an ounce.

Hectogramme. The weight of a hundred grammes.

Kilogramme. The weight of a thousand grammes, very convenient to be used in the sale of the most common articles. Its half exceeds our usual pound by about three *gros*.

Myriagramme. The weight of ten thousand grammes, a little less than $20\frac{1}{2}$ pounds. Its double will form the largest

* If the series of decimal litres increased by the doubles and halves of each be compared with the ancient measures, it will be seen that, from the *centilitre* to the *decalitre*, they agree perfectly for liquids; and from the *demilitre* to the *hectolitre*, for the various dry articles.

 weight

weight neceſſary to be employed, and will anſwer with great advantage for that purpoſe *.

AGRARIAN MEASURES.

Centiare. Deciare. The centiare and deciare are only ſub-diviſions of the *are.* The firſt is equal to a ſquare metre. The ſecond is equal to ten.

ARE. The unity of meaſures for land or ſurveying. It is equivalent to a ſquare decametre, or a hundred ſquare metres (about 25 ſquare toiſes). It is well ſuited for the meaſurement of the valuable ground in cities, gardens, and ſmall poſſeſſions, or ſuch as are of a moderate extent. The denomination of *deca-are*, or *decare* by ſhortening it, will ſcarcely be of any uſe.

Hectare. This is a ſuperficies containing a hundred ares. It may be employed for meaſuring lands of a certain extent. The hectare is ſomewhat leſs than double the large acre of 100 ſquare perches, the perch being 22 feet.

The *kilare* is of no importance.

Myriare. Equal to ten thouſand ares, or a ſquare the ſide of which is a kilometre. It is conſequently proper for the meaſurement of lands of little value, ſuch as commons, &c. when it is not neceſſary to expreſs them in ſquares of long meaſure.

MEASURES FOR FIRE WOOD.

STERE. A quantity equal to a cubic metre. By giving the length of a metre to billets, nothing more will be neceſſary, in order to obtain the ſtere, than to range them within

* The utility of the doubles and halves of each of the weights, which compoſe the decimal ſeries, may be readily conceived. By forming of the whole one ſeries, it will be ſeen that it is extremely analogous to that of the ancient weights, for which it may be ſubſtituted with great advantage in all commercial tranſactions.

a ſquare

a ſquare frame (*chaſſis*), each ſide of which is equal to a metre. If the billets have another length, for example $3\frac{1}{2}$ feet, as required by the ordinance reſpecting waters and foreſts, a ſmall change only will be required in the height of the frame; and this will be attended with no difficulty.

The ſtere will be very convenient. It will be about half the *demi-voie* * of wood at Paris.

The *demi-ſtere* and the double ſtere may alſo be employed. Laſtly, the *deci-ſtere*, or rather the double *deci-ſtere*, may be uſed likewiſe to regulate the ſize of faggots, and the meaſure of ſmaller pieces of wood (*cottrels*), by determining their proper length.

The other combinations of the ſtere do not ſeem to preſent any utility of conſequence.

MONEY.

The different diviſions of money are conſidered here as imaginary coins, without paying any regard to the proper value of the principal unity.

Centime. The hundredth part, or value of the hundredth part of a franc.

Decime. Tenth of a franc, equal to two ſous.

FRANC. Principal unity of the French money, or the ſame as the livre of 20 ſous. Its abſolute value, that is to ſay, the quantity which it will purchaſe of a certain ſort of merchandiſe, varies, as is well known, according to circumſtances.

* A *voie* is equal to half a cord, the cord being eight feet in length and four in height. The *demi-voie* then is equal to a quarter of a cord. EDIT.

V. *Account*

V. *Account of Dr. PERKINS's Discovery of the Influence of Metallic Tractors, in removing many of the Diseases of the Human Body.*

THIS discovery has made some noise in America, and, like every novelty, has its advocates and its opponents. The son of the inventor, now in London, has published a small work on the subject, to introduce it to the notice of medical men in this country, from which we extract the following particulars:

Galvani, the celebrated professor at Bologna, was the first who announced some curious phenomena, observed from an accidental application of metallic substances to the nerves and muscles of animals. The subject immediately engaged the attention of philosophers throughout Europe, and the public, in consequence, were soon favoured with a confirmation of Galvani's assertions, by the publication of the experiments of Valli, Volta, Fowler, Monro, Cavallo, &c. The result of these various researches proved that "the influence is not peculiar to a few animals only, but seems to be a property of all." Although the living animal is most susceptible of the influence, yet, from a combination of different metals, the nerves and muscular fibres, long after every appearance of vitality was removed, have been excited to powerful action.

From the discovery of a new law *, acting so important a part in the animal œconomy, it might rationally be expected that attempts would be made to ascertain how far this principle could be applied in a remedial point of view to human diseases. This has been the particular enquiry of Doctor Perkins.

* The term ANIMAL ELECTRICITY, which arose from the many analogies that were observed between the influence discovered by Galvani and electricity, has by later writers given place to GALVANISM, a compliment well merited by the ingenious discoverer.

Several

Several phenomena relating to the influence of metals in cafes of pains, he had obferved before the news of Galvani's difcovery had reached America; and when the phyfiologifts of Europe were engaged in experimenting on the denuded nerves and mufcles of the fmaller animals, with a view to afcertain the agency of this incomprehenfible property in them, Dr. Perkins was profecuting a feries of experiments, which confifted in applying externally, to parts affected with difeafe, metals and compounds of metals, of every defcription, which occurred to him, and conftructed into various forms and fizes. The refult proved, that on drawing lightly over the parts affected certain inftruments, termed TRACTORS, which he formed from metallic fubftances into pointed fhapes, he could remove moft of thofe topical difeafes of the human body, where an extra degree of nervous energy or vital heat was prefent; unlefs fuch difeafe was fituated in fome of the internal vifcera, too remote from the part where the inftruments could be applied. The difeafes which have been found moft fufceptible of the influence of the tractors, are rheumatifm, fome gouty affections, pleurify, ophthalmias, eryfipelas, violent fpafmodic convulfions, as epileptic fits and the locked jaw, the pain and fwelling attending contufions, inflammatory tumors, the pains from a recent fprain, the painful effects of a burn or fcald, pains in the head, teeth, and indeed moft kinds of painful topical affections, excepting where the organic ftructure of the part is deftroyed, as in wounds, ulcers, &c. and excepting alfo where oils or fome other non-conducting fubftances are prefent.

This practice, like all confiderable innovations, on its firft introduction, encountered the fevereft fcepticifm and ridicule, and a medical fociety pronounced it a revival of the exploded practice of animal magnetifm: but the prefident and many of the members of that fociety afterwards applied the tractors to practice, and have fince publifhed the fuccefs of their numerous experiments.

As

As most phenomena are learned from observation long before we arrive at the theory which connects and explains them, so with this metallic influence, no clear and satisfactory explanation of the *modus operandi* has yet appeared.

Notwithstanding the assiduity with which physiologists have pursued their enquiry, and are still pursuing*, to discover the laws and properties of Galvanism, and to ascertain the extent of its action in the animal œconomy; yet, like many other phenomena, they still remain mysteries.

Mr. Meigs, professor of natural philosophy at Newhaven, in a letter on Dr. Perkins's discovery, conceives the principles of metallic irritability so little understood, that he will not pretend to explain *how* the tractors produce their effects; but seems satisfied in finding that the effects are produced. After stating an experiment on his own child, eight years of age, very dangerously ill with a peripneumonic complaint, and to which the tractors gave almost instantaneous relief, he says, "I have used the tractors with success in several other cases in my own family; and although, like Naaman the Syrian, I cannot tell why the waters of Jordan should be better than Abana and Pharpar, rivers of Damascus; yet, since *experience* has proved them so, no reasoning can change the opinion. Indeed, the causes of all common facts are, *we think*, perfectly well known to us; and it is very probable, fifty or an hundred years hence, we shall as well know why

* The celebrated Von Humboldt of Germany has lately published a volume of 500 pages 8vo. and is now preparing another. These consist of numerous experiments, chiefly on the nerves and muscular fibre; and from the success with which his enquiries have already been attended, great hopes are entertained that something important will result. M. Creve, professor of medicine at Mentz, has lately published an important tract on Metallic Irritability. He maintains, from a variety of experiments made on the dead bodies of men and animals, that even the symptoms of putrefaction do not constitute an *infallible* evidence of death, but that the application of metals will in all cases ascertain it beyond the possibility of mistake. This discovery is of great importance, as it may be applied to prevent the dreadful error of premature inhumation.

the

the metallic tractors ſhould in a few minutes remove violent pains, as we now know why cantharides and opium will produce oppoſite effects: viz. we ſhall know but *very little* about either, excepting *facts*."

Mr. Woodward, profeſſor of natural philoſophy at Dartmouth, in a letter alſo on the ſame ſubject, has ſtated a number of ſuccesſful experiments in pains of the head, face, teeth, and in one caſe of a ſprain.

Dr. Vaughan, a member of the Philadelphia medical ſociety, has lately publiſhed an ingenious tract on Galvaniſm, the object of which is to account for the influence of the tractors in removing diſeaſes. After a citation of numerous experiments made on the nerves and muſcles of animals, he obſerves, "If we only take an impartial view of the operations of nature herſelf, and attend diligently to the analytical inveſtigations of the aforementioned experimentaliſts on this ſublime ſubject, I think the ſceptic muſt admit that the principle of nervous energy is a modification of electricity. As ſenſation is dependent on this energy, a pleaſurable ſenſation, or what may be termed a natural or healthy degree thereof; then certainly pain or ſuperſenſation can only depend on an accumulation of the electric fluid, or extra degree of energy in the part affected. On this principle the problem admits of eaſy ſolution; namely, that the metals, being ſuſceptible of this fluid, conduct the extra degree of energy to parts where it is diminiſhed, or out of the ſyſtem altogether, reſtoring the native law of electric equilibrium."

Drs. Tilton, Baker, Hall, Lord, Brewſter, Dalho, Dyer, Johnſon, Backus, Lee, Willard, Marvin and Goſs, of America, have publiſhed their approbations of the uſe of metallic tractors; which are in fact only pieces of pointed iron or braſs, &c. How far the attempt of the author to explain their action upon the principles of Galvaniſm has been ſucceſsful, we will not take upon us to determine We ſhall only obſerve, that were it even demonſtrated to be a revival of animal magnetiſm, *if its efficacy be at the ſame time demonſtrated,*

monstrated, it will not be therefore rejected; for in that case it would only be a proof that the empiricism of the practisers of magnetism, by introducing absurd glare, show and mystery, had been the means of obscuring the principles on which it was founded. We are led to make this remark by an observation of the author, "That in some instances the metallic influence, *when excited by different persons*, produces *different effects*. Experiments made to ascertain the point, proved that there were persons who might use the tractors for any length of time, in diseases which were suitable for the operation, and *produce no perceptible effect*; when by placing them in the hands of another person, who should perform the operation precisely in the same manner as before, *the pain or inflammation would be removed directly*." A note introduced here by the author, to prove by this fact the analogy between the influence of the tractors and Galvanism, does not appear, to us, to be in point. "On the application of zinc and silver to the tongue, the sensation of taste is very slight to some, while with others it is very strong:—when the experiment is applied to the sense of sight, some are hardly sensible of it, while others observe a strong flash." Here, however, the cause of the different effects produced must be sought for in the modification, or peculiar structure, of the organs of sensation *in the patient*—not in *the operator*.

We mean not by this observation to detract from the merit of the discovery: that must rest, independent of all theory, on the degree of evidence that may be brought forward to support it. If the facts shall be sufficiently conclusive to establish the efficacy of the tractors, in removing only *one species of disease*, the inventor has nothing to fear from the opposition of the faculty in England:—the gentlemen who compose that body are too liberal to oppose any beneficial innovation, merely because it comes from a foreigner. On the other hand, if the cures reported to have been performed in America cannot be effected here by the same means, and in cases in which there can be no ambiguity, they

they are too enlightened to be impoſed upon, and induced to give the practice a countenance and ſupport to which it may have no claim.

VI. *An Analyſis of the Waters of two Mineral Springs at Lemington Priors, near Warwick; including Experiments tending to elucidate the Origin of the Muriatic Acid. By* WILLIAM LAMBE, *M. A. late Fellow of St. John's College, Cambridge. From the* Memoirs of the Literary and Philoſophical Society of Mancheſter, *Vol. V. Part I.*

THE author of this ingenious paper has ſhewn himſelf a maſter in the art of analyſis. The apparent diſcovery of the origin of the muriatic acid, to which Mr. Lambe's labours have led, is ſo well worthy of the attention of philoſophers, as it may lead to a diſcovery of the compoſition of other acids whoſe baſes are at preſent unknown, that we have not a doubt but the path he has laid open will be explored by all the able chemiſts of Europe.

After ſome very pertinent introductory remarks, the author obſerves, that as both the ſprings riſe many feet below the earth, it ſeems needleſs to enter into any particulars concerning the nature of the ſurface, or the qualities of the ſoil of the circumjacent diſtrict, and therefore proceeds to the objects of his enquiry as follows:

ON THE WATER OF THE NEW BATHS.

The ſpring was diſcovered in the year 1790, at the depth of 42 feet from the ſurface of the ground. A well is ſunk about 24 feet deep. In the courſe of this depth there is a rock the thickneſs of 8 or 10 feet; afterwards a bed of marl; after penetrating which, another rock, much harder than the former, is found. Through this ſecond rock a bore is made 18 feet deep, where there is a ſmall cleft in the rock. There are many little ſprings found in this courſe;

but from this cleft the water rises with violence to the level of 4 feet above the surface of the ground; and it affords a constant and copious supply of fresh water.

I. ON THE GASEOUS FLUIDS.

The water, when fresh drawn, smells of sulphurated hydrogen, or *hepatic* * gas; but it quickly becomes inodorous by exposure to the atmosphere. I have obtained no more than 4 cubic inches of gaseous fluid from a wine-gallon of the water. Of these, hardly half a cubic inch is absorbed by the water; and, 1. Nitric acid dropped into this solution causes a minute precipitate of sulphur; hence some hepatic gas has been expelled by the boiling. 2. I put some of the water, which had not been boiled, into a bottle, leaving a part of the bottle empty: I then filled the bottle entirely with lime-water, and stopped it. A white precipitate fell, which, with the addition of distilled vinegar, effervesced sensibly, but not strongly. The half cubic inch is, therefore, mostly carbonic acid. 3. Into the portion of the air which was not absorbed by water, I plunged a lighted candle; it was instantly extinguished. This portion is, therefore, azotic gas.

II. THE SPONTANEOUS PRECIPITATE.

A sediment falls to the bottom, and adheres to the sides of the bath. It is of a yellow colour, and acquires additional brightness by exposure to the atmosphere. A similar sediment may be separated by boiling the fresh water. From a gallon of water, .75 of a grain is procured. This dissolves readily in acids, and shews all the common and well known appearances of oxyd of iron. It must have been united with the carbonic acid, which has been already detected. (1, 2.)

* I must take leave to retain this name in the following pages, preferring it (if for no better reason, at least for its shortness) to the compound term.

III. SOME

III. SOME ANOMALOUS APPEARANCES WITH PRECIPITANTS.

1. After the ſpontaneous precipitate has been ſeparated, a little oxygenated muriate of mercury was diſſolved in a glaſs full of the water. A white matter ſeparated during the ſolution, and, in ſome hours, collected in conſiderable quantity.

2. A piece of ſulphate of argill was dropped into a jar of the ſame water; preſently a ſtratum of white matter was formed at the bottom of the jar: but this appearance is tranſitory; for in the courſe of an hour or two the precipitate is re-diſſolved, and the water reſumes its tranſparency. This is an appearance which I had not found noticed by writers on the ſubject, though I have reaſon to think it not uncommon. The waters of Aſtrop, near Banbury, contain carbonat of lime diſſolved by the carbonic acid: and, when the carbonat has been ſeparated, by boiling the water, the ſame appearance is produced by ſulphate of argill. Its origin, and that of the decompoſition of the mercurial ſalt, will be ſhewn in the ſequel.

IV. THE METALLIC SALTS.

Several phenomena demonſtrate the exiſtence of ſome metallic ſubſtance in this water, beſides the precipitate already deſcribed (II.): but it is ſo peculiarly combined, or otherwiſe modified, as to elude, in a great meaſure, the action of the ordinary re-agents. When the water is boiled in contact with ſome of the metals, it becomes turbid; and the metal is partly oxydated, and partly diſſolved. The iron, which has been uſed in the conſtruction of the baths, is almoſt deſtroyed: the tin, which lined a veſſel uſed as a warm bath for children, has ſuffered in like manner. If the water be only boiled and poured into a wine-glaſs with a bright key in it, the liquor becomes turbid before it is cold. Copper ſeems to reſiſt its action better; but this is only in a low temperature; for, if the water be boiled in a copper veſſel, ſimilar effects are produced; a precipitate is formed, and ſome copper is diſſolved in the water. 1. This is readily proved by putting a bright piece of iron into the liquor, which, in a few hours, acquires a coppery coating *. Lead alſo I have found to be acted upon.

I examined, with ſome minuteneſs, the precipitates formed by iron and by copper. 2. The firſt is of a yellow colour; and, though it is not magnetic, it may be made ſo by the flame of a blow-pipe upon charcoal. It conſiſts, therefore, of oxyde of iron, either totally or in part; but whether it is derived from the liquor, or from the iron which was uſed to procure it, cannot be determined by this experiment. But the following obſervation demonſtrates, that iron is contained in the water itſelf. 3. The water was boiled in a copper veſſel, and the precipitate formed was collected. This is alſo of a yellow colour; and, expoſed to the flame of a blow-pipe on charcoal (like the former precipitate), it became magnetic. It ſeems alſo to contain copper; for, precipitating its ſolution in muriatic acid by ammoniac, the liquor became blue; the colour however was by no means ſtrong.

When the ſalts of the water have been concentrated by evaporation, copper is acted upon more powerfully; in ſo much that if a ſilver ſpoon be uſed for the evaporation it is much tarniſhed, and the ſalts acquire a cupreous taſte and a yellow tinge, though they are colourleſs if the evaporation be made in glaſs. Theſe veſtiges of the copper muſt be attributed to the alloy of the ſpoon.

The appearances I have deſcribed ſurpriſed me the more, as, from the uſe of ſome of the common re-agents, I had formed oppoſite concluſions. 4. Pruſſiat of pot-aſh, before the water has been boiled, forms a green cloud, but in a

* This remark evinces the ſtrong neceſſity of a chemical examination of all the ſubſtances uſed as medicines. It is very common to warm the water with a view of quickening its laxative power. It is evident with what caution veſſels in which copper is an ingredient ſhould be uſed for this purpoſe; or, rather, with what care they ſhould be utterly avoided.

quantity

quantity hardly sufficient to precipitate. After boiling there is no decomposition; nor is there any if the liquor be evaporated to half its original bulk. 5. Tincture of galls strikes a purple colour before the water is boiled: after boiling there is a precipitate likewise, but of a dull lemon colour; after a partial evaporation the colour approaches to whiteness. In each of the two last cases, the liquor gradually acquires a deep yellow tinge. In these experiments, we have none of the ordinary signs of iron, except the carbonat (11.), though its existence in the water has been proved beyond question (3).

V. MANGANESE IS DISSOLVED IN THIS WATER.

As zinc is known to have a stronger affinity to acids than the other metals have, I hoped by its mean to obtain some information on the cause of the facts I have described. 1. I boiled, therefore, some of the water in a glazed vessel, in contact with some pieces of zink: a small precipitate was formed, but enough to be collected for examination with the blow-pipe. This was fused with borax; and a globule was formed of a rich red colour, precisely that communicated by *manganese* *. Continuing the fusion, the colour vanished; nor could I make it re-appear by the yellow flame of the blast: probably because the manganese was mixed with another metal. The globule was removed to a silver spoon; and, then, by fusion, it regained the red colour. To avoid the possibility of error, a little manganese, fused with borax in the same manner, was placed beside the red globule; and no difference could be observed in the colour of the two globules, except a slight variety in the intensity †. 2. The *lemon-coloured* precipitate, formed by the tincture

* For the properties of this mineral see Scheele's Essay on Manganese; or Bergman on the White Ores of Iron.

† I am aware of the observation of Bergman, that zink does not precipitate solutions of manganese. See his Essays, vol. iii. p. 414. But, besides

tincture of galls (IV. 5.), yields the same result. By using a large quantity of the water, I collected sufficient for examination. This I put over a fire on an iron plate: the vegetable part took fire and burnt away: the powder became of an ochry yellow, and was magnetic:—fused with borax by the blow-pipe, it acquired the redness which manganese imparts.

3. The same fact may be proved by a single experiment. It is known that tartrite of pot-ash decomposes salts of manganese by a double affinity; in consequence of which, tartrite of manganese, which is a substance insoluble in water, precipitates*. I poured, therefore, a solution of tartrite of pot-ash into water, and there fell a copious crystalline precipitate. Much iron fell down with the manganese, as might be expected from the affinity between the oxydes of these metals: for, by fusing the precipitate with nitre, green spots were formed on the sides of the crucible.

Tartrite of pot-ash decomposes likewise salts of lime, as is well known; but the tartrite of lime is precipitated in the form of a white powder, which is not sensibly crystalline. But as there is a great abundance of lime in this water (XIV.), it seems probable that it had entered into the composition of these crystals.

Manganese has been but rarely noticed as entering into the composition of mineral waters. The reason, perhaps, is, that it has been seldom looked for, rather than that it seldom exists; since it is now known to be a substance abundantly diffused through the earth. The waters of Astrop, which I have mentioned above (III. 2.), decompose tartrite of pot-ash, and form a crystalline precipitate when its carbonate of lime has been thrown down by boiling. This water, in these circumstances, hardly affects either tincture of galls or

sides that I describe only what I have seen, it will appear that the salt in question is of so peculiar a nature, that it cannot be expected to obey the usual analogies of the other solutions.

* See Scheele as above.

prussiat

pruſſiat of pot-aſh. Every chalybeat ſpring may be ſuſpected to contain ſome manganeſe likewiſe; and ſhould therefore be examined accordingly.

VI. TESTS OF MANGANESE AND IRON.

As I ſhall have frequent occaſion to mention this mixture of oxydes of manganeſe and iron, I will enumerate the teſts I have uſed, to avoid uſeleſs repetitions. Theſe are, 1. The magnet: to this the ſmalleſt particle of iron may be rendered obedient, by expoſing it to a due heat, on charcoal, by the blow-pipe. 2. The tinge communicated by the proceſs to a globule of borax: this from iron is green or yellow; from manganeſe it is hyacinthine; or, when the globule is more loaded with the metal, a fine rich red. This colour diſappears by the blue conical flame; and may be re-produced by the gentler yellow flame which ſurrounds the cone. 3. Fuſion with nitre, or with carbonate of ſoda: manganeſe imparts to them a fine blue colour; but if it be mixed with the oxyde of iron the colour is green.

VII. AN HYPOTHESIS TO EXPLAIN THE CAUSE OF THE PHENOMENA.

The firſt hypotheſis which I framed, to account for the facts in queſtion, was deduced from the well-known property which manganeſe poſſeſſes of oxygenating the muriatic acid. My reaſoning was as follows:—Since, during the ſolution of the black oxyde of manganeſe in the muriatic acid, a portion of the acid becomes oxygenated, it muſt follow, that, if this portion ſhould meet and combine with a metallic oxyde, the ſalt formed by ſuch an union muſt be ſuperoxygenated. But in the ſtate of oxydation, doubtleſs, is a great part of the iron which is ſo abundantly diffuſed through the earth. Are then the appearances in queſtion the reſult of theſe circumſtances? In ſhort, are the ſalts muriat of manganeſe and oxygenated muriat of iron? In purſuance of this idea I formed ſome oxygenated muriat of iron, by mixing some yellow oxyde of iron (the *rubigo ferri* of the shops) with water, and exposing it, by a proper apparatus, to the oxygenated muriatic acid gas. The gas readily dissolves a part of the oxyde, a few bubbles (perhaps of carbonic acid) escaping during the solution. 1. The salt which is formed is deliquescent; colourless; of a pure bitter taste, without any of the sweet astringency of the common salts of iron *. Alcalies precipitate a white oxyde. The mineral acids, also, decompose the salt; and at the same time a white matter, of a crystalline form, precipitates, but an excess of acid re-dissolves the precipitate †. 2. If some metallic iron be digested in a solution of this salt, an ochre precipitates copiously, which is very soluble in acids. Copper also decomposes the salt; but the matter precipitated is in small quantity, and hardly soluble in acids. 3. Prussiat of pot-ash is totally unaffected by this salt; so likewise is tincture of galls when the salt is quite perfect ‡; but, after iron has been digested with it, galls communicate a yellow tinge, or even precipitate a brownish matter; still the prussiat of potash has no effect. These properties of the salt bear so strong a resemblance to appearances which I have remarked in the water, particularly in the effects of the metals (IV. 2 & 3.) and the failure of the re-agents (IV. 4 & 5.), that it strongly confirmed me in the hypothesis I had adopted. On pursuing the experiment, however, the analogy failed. I added to the salt of iron very minute quantities of muriat

* By far the best method of making this salt is to put the rust in a saucer, and to put the mixture of manganese and muriatic acid, diluted to avoid a strong effervescence, in a cup on the same saucer; then to cover the cup with an inverted glass: thus the oxygenated vapour will be confined as it is slowly extricated. If distillation is used, the salt can be hardly made free from an astringent taste.

† The sulphuric acid does not re-dissolve the precipitate; the others do. Some further remarks on this subject will be found (XIV. 6.).

‡ I once saw the galls form a white precipitate; but I suspect the oxygenated was contaminated with some common muriatic acid, formed by its decomposition during the digestion.

of

of manganefe; but how fmall foever was the quantity ufed, and however much it was diluted, the manganefe was inftantly detected by pruffiat of pot-afh. I was therefore forced to conclude that, if oxygenated muriat of iron is really an ingredient of this water, it muft be formed by a procefs different from that which I had imagined.

VIII. THE APPEARANCES IN QUESTION ARE PRODUCED BY THE ACTION OF HEPATIC GAS ON IRON AND MANGANESE.

An obfervation of Bergman, though in part erroneous, has conducted me, as I think, to the true caufe of thefe appearances; and I am greatly miftaken if its confequences, when fully purfued, are not of confiderable importance to chemical fcience. Bergman has afferted that hepatifed water in which iron filings have been kept for fome days, in a well-clofed veffel, grows *purple* with tincture of galls: if the iron be diffolved by an acid, the colour approaches more to *violet*. He moreover adds, that the folution of iron in hepatifed water *is not at all rendered turbid by pruffiat of potafh* (*Bergman's Effays, Differtation* VII. 4. L.) This latter fact promifed to throw fome light on the fubject of my enquiry, particularly when it was joined to the fact of the hepatic fmell, which the water has when recently drawn (1.). I was the more ftrongly induced to pay attention to this combination, from the contradiction of another very eminent chemift. Mr. Kirwan has denied that hepatic gas can diffolve iron, or any other metal (*Philofoph. Tranfac.* 1786). To afcertain this point, I have made numerous experiments with the greateft caution and accuracy that I have been able to apply. The hepatic gas which I have ufed, was obtained from fulphuret of iron, formed by fufing equal parts of iron and flowers of fulphur; and (except in fome inftances, which will be particularly noticed as they occur) was extricated by diluted fulphuric acid. The gas was collected under water; which method was preferred, to purify it if poffible from extraneous acid. 1. I digested iron filings, previously purified by repeated washings with distilled water, in a solution of hepatic gas in distilled water: the bottle was filled with the solution, and corked. The iron was presently acted upon; numerous bubbles arose, which drove the cork out of the bottle; they were strongly inflammable, and probably, therefore, pure hydrogen gas: the liquor gradually lost its hepatic odour; and at the end of some days it had a smell a good deal resembling that of stagnant rain water; as the bubbles ceased to be produced it recovered its transparency. The liquor was then examined by re-agents. Infusion of galls struck a yellow tinge; prussiat of potash gave a little whitish cloud; nitrate of silver and muriat of barytes, each very minute precipitates; pure potash a yellow precipitate, but not till the liquor had stood an hour or two. The liquor does not deposit any thing, either by exposure to the atmosphere or by a boiling heat: but by this last process something, perhaps a little gas which has escaped the action of the iron, flies off; since the precipitate with nitrat of silver was white after the boiling, which had previous to it been black. Very little can be deduced with certainty from these trials, except the presence of a little sulphuric acid. It seemed of consequence to determine whether this is generated in the process, or is accidental from the sulphuric acid which was used to extricate the gas.

2. To determine this point I repeated the experiment, using the muriatic acid to generate the gas, instead of the sulphuric. In this case, the liquor, as Bergman has said, is not at all rendered turbid by prussiat of potash; neither does the muriat of barytes precipitate any thing: the precipitate by pure potash is now white, but as minute as before: nitrat of silver makes a yellow cloud both before and after boiling: infusion of galls strikes a yellow tinge. Hence it is clear, that hepatic gas, when produced by sulphuric acid, carries with it a little of the acid which cannot be separated by passing it through water. It seems probable also, that a little

little muriatic acid is carried up in like manner when this is used to extricate the hepatic gas. We may farther conclude, that though the remark of Bergman on the effect of the pruffiat of potash is true; the remark which accompanies it (on the colour produced by infusion of galls) is erroneous. A purple colour is always, I believe, occasioned by extraneous acid; in which case the pruffiat of potash is also precipitated. From the same facts we are enabled to detect another error also, into which the same great man has been betrayed. In his analysis of the acidulous waters of Medvi, in Oftro-Gothland (*Bergman's Essays, Dissertation* VIII. 6.), he has noticed a residuum of $4\frac{1}{2}$ grains of iron, dissolved partly by hepatic gas, partly by carbonic acid. Now we have seen that there is no decomposition of these liquors by boiling; nor does any oxyde precipitate, how long soever the evaporation be continued. The hepatic gas seems to be totally decomposed: nitric acid dropped into these liquors precipitates nothing.

Are we then to conclude with Mr. Kirwan, that hepatic gas does not decompose iron or any other metal? As the gas itself is decomposed, this, in strict propriety of language, must be allowed to be true; but that some solution is effected during the decomposition the following remarks evince. 3. A piece of clean and bright iron was put into some of the hepatised solution (if I may be allowed so to call it, while its true composition is unknown): it soon became turbid; a copious ochry precipitate fell down; and in 24 hours the whole surface of the iron was covered with rust. 4. Let the solution be boiled in a copper vessel, a precipitate also separates of an ochry colour; but it is smaller in quantity than in the former experiment. 5. Digest a piece of clean iron in the solution after it has been boiled in a copper vessel; much ochry matter still separates; but there is no vestige of metallic copper on the iron plate. 6. Digest copper filings in the liquor in which iron filings have been previously digested; separate the copper filings, and

now

now let a piece of bright iron be put into the liquor; in this case, copper is deposited on the surface of the iron in a metallic state. 7. Put a small piece of sulphat of argill into a glass of the solution, after fresh iron filings have been digested in it; a white stratum forms at the bottom of the glass, but after some time it is re-dissolved, and the liquor resumes its transparency. 8. Put a little oxygenated muriat of mercury into a glass of the hepatised solution; as it dissolves, a white matter collects on the sides, and falls to the bottom of the glass. 9. Infusion of galls, after the fresh iron has been digested with the solution, precipitates the iron of a dark colour; still the prussiat of potash does not become turbid. From all these facts it is clear, that as the iron combines with the sulphur of the hepatic gas, a peculiar substance is formed and dissolved in the water, which has hitherto been unnoticed by chemical writers, as far as has fallen within my information. That this substance is contained in the waters of the spring under our present examination, seems fully established by the concurrent evidence of so many phenomena in which they completely coincide. Compare III. 1 & 2. IV. 1, 2, 3, 4, & 5.

IX. MANGANESE EXPOSED TO HEPATIC GAS.

To complete the demonstration, it is necessary to examine the action of hepatic gas upon manganese.

1. I digested some black oxyde of manganese in hepatised water: it had been previously purified, by being boiled repeatedly in distilled water *. The hepatic smell of the gas is quickly impaired; and in 24 hours, if enough of the oxyde has been used, it is perfectly destroyed; still the liquor has a peculiar smell, which can hardly be called offensive: no gas is extricated in this process. The liquor, after filtration, was

* The readiest method of purifying this substance is to boil it first in a very large quantity of rain water; after which, a single boiling in distilled water will be sufficient to extract every *soluble* impurity.

examined by the fame re-agents as the hepatifed folution of iron (VIII. 1.) with nearly a fimilar refult; a minute quantity of fulphuric acid was detected; pruffiat of potafh gave a fmall white cloud; tincture of galls a flight yellow tinge. Repeating the experiment with gas extricated by the muriatic acid, there was, in this cafe, no trace of fulphuric acid, and the liquor was not at all rendered turbid by pruffiat of potafh. From both thefe folutions pure potafh feparates a very minute white precipitate. 2. But, in one refpect, thefe folutions differed from the folutions of iron; for, by thefe, nitrat of filver is inftantaneoufly decompofed, and a copious precipitate feparates; it is of a dark brown or yellow colour, as if from a combination of fulphur. Oxygenated muriat of mercury let fall a white matter, much more plentifully than from the folutions of iron. Tartrite of potafh is decompofed, and a fine cryftalline fubftance is feparated, which is the tartrite of manganefe.

3. This folution is affected by metals in a manner fimilar to the folution of iron. A piece of clear iron becomes quickly covered with ruft, and an ochry matter feparates. If the liquor be boiled in a copper veffel, fome matter alfo feparates of the fame colour, and the furface of the veffel is evidently acted upon. Thus the analogy between thefe hepatifed folutions and the water of this fpring appears to me completely eftablifhed; and it may be concluded that this water contains a triple compound, the bafis of which is iron and manganefe, and the folution of which is effected by hepatic gas.

X. ORIGIN OF THE MURIATIC ACID.

The coincidence between the artificial products and the natural waters of the fpring is fufficiently proved: another coincidence remains to be confidered, much more interefting and more unexpected—the coincidence between the hepatifed folution of iron and the oxygenated muriat of iron. I had almoft concluded, from the refemblance between the

properties

properties of this ſalt and the phenomena of the water, that the water contains this very ſalt: now, I conclude, that they contain a matter, be it what it may, produced by the action of hepatic gas on iron. But they are the very ſame facts which form the baſis upon which each ſeparate inference is built:—does it not then follow as a neceſſary conſequence, that the hepatiſed ſolution itſelf contains a muriat of iron highly oxygenated, and that, therefore, *in this proceſs muriatic acid is generated?* This concluſion ſeems authoriſed by reaſon, and experiment has confirmed it. 1. I evaporated a ſmall quantity of the ſolution (VIII. 1.) in a watch glaſs to dryneſs: a bitter deliqueſcent ſalt is left behind: on this ſalt a little ſtrong ſulphuric acid was dropped, and paper moiſtened with ammoniac was held over the glaſs; white vapours were immediately formed over the glaſs: ſome volatile acid is, therefore, ſeparated by the ſulphuric acid. 2. I evaporated about 8 ounce-meaſures of the ſame liquor, and, as before, dropped a little ſulphuric acid on the reſiduum; in this caſe a ſtrong efferveſcence was excited, very pungent acid fumes aroſe, which, from their ſmell, were readily known to be muriatic. The ſame truth was eſtabliſhed beyond a doubt by holding a bit of paper moiſtened with ſimple water, which made the vapours viſible in the form of a grey ſmoke—a diſtinguiſhing characteriſtic of the muriatic acid. (*Bergman's Eſſays, Diſſertation* II. II. b. 3.) The evaporation had been performed in a copper veſſel, except at its cloſe; and though it was carried on very rapidly, the deliqueſcent matter had acquired a ſtrong cupreous taſte. 3. The hepatiſed ſolution of mangane ſe (IX. 1.) evaporated to dryneſs, leaves a deliqueſcent ſalt of a peculiar mawkiſh taſte; and it ſhews the ſame ſigns of muriatic acid as the ſolution of iron, when treated with ſulphuric acid in the ſame way. I have expoſed black oxyde of mangane ſe to oxygenated muriatic acid, and find that a deliqueſcent ſalt is formed, which is affected neither by pruſſiat of potaſh nor tincture of galls;—alkalies ſeparate from it (what I did not

expect

expect) *white* precipitates; tartrite of potash, a crystalline insoluble salt: all properties resembling the hepatised solution of manganese. 4. Common iron rust, purified by boiling in distilled water, was digested in hepatised water. In a day or two the hepatic odour is destroyed, and the liquor has properties similar to that which was formed with the iron filings. The same kind of deliquescent salt is left by evaporation, shewing the same appearances of muriatic acid. However, this liquor resembles the solution of manganese in precipitating nitrat of silver readily, and of a brown colour (IX. 2.). 5. I treated mercury in the same way: no gas escapes in this experiment, as it does with the iron; a black substance is formed; but the hepatic odour was not destroyed, though the hepatic gas was kept in contact with the mercury many weeks. After filtrating the liquor, I boiled it to expel the superfluous hepatic gas. A small portion of the liquor was suffered to evaporate spontaneously: a crystalline matter was left behind of an acrid taste. Another portion was evaporated, with intention to collect more of those crystals; but, by accident, it was left exposed to heat too long, by which it became perfectly dry, and the residuum became quite black. A little sulphuric acid was dropped on this black matter, by which it effervesced strongly, and very pungent fumes arose which had all the properties of muriatic acid.

[*To be concluded in the next Number.*]

VII. *Method employed between Melun and Lieusaint in France, to measure the Base of a Triangle, in order to determine the Length of an Arc of the Meridian. From the* Journal de Physique, 1798.

THE high road between Lieusaint and Melun has lately been the theatre of an operation extremely interesting, which will form an epoch in the history of the sciences. In order to fix invariably the ſtandard of the *metre* *, two celebrated aſtronomers, Delambre and Mechain, were commiſſioned to meaſure an acre of the meridian, by a ſeries of triangles carried from Dunkirk to Barcelona †. To calculate the ſides of theſe triangles, it was neceſſary to ſet out from a primitive baſe. None of thoſe meaſured for the meridian of 1740 had been determined with ſufficient accuracy, and ſome errors were ſuſpected. As the baſe neareſt to Paris, between Villejuif and Juviſy, preſented a length of little more than 5000 toiſes ‡, with conſiderable inequalities of the ground; the road from Lieuſaint to Melun, which gave a length by eſtimation of 6076 toiſes, in almoſt a ſtraight line and with very little variation in the level, was with great reaſon preferred. To prepare for the meaſurement of this baſe, the two ſignals or obſervatories, now to be ſeen, the one at the end of Lieuſaint, and the other at the entrance of Melun, were firſt erected. Within each of theſe ſignals a large ſtone was ſecured in a piece of ſtrong maſon-work, and from this ſtone aroſe a cylinder of copper, faſtened into it with a maſs of lead. The axes of theſe cylinders, which were fourteen lines in diameter, correſponded perpendicularly with the upper points of the ſignals. As the line of the baſe formed towards the middle a ſmall bending, the angle was meaſured, and found to be 179° 11′, which produced in the total length a difference of 10½ inches. Departing from the

* See the preceding table of the new French meaſures. EDIT.

† It was propoſed to extend this labour to Majorca; but it was found impoſſible to proceed to that ſtation, on account of the too great diſtance of the ſignals.

‡ The object of Delambre and Mechain's labour being to eſtabliſh a relation between the old and the new meaſures, and this labour having been begun in 1791, it was neceſſary that the meaſurement ſhould be expreſſed in toiſes, and fractions of a toiſe; the uſe of which could not be abandoned till the *metre* was exactly determined. The commiſſion of weights and meaſures gave, according to the ancient mode of calculation, a proviſional metre, the approximation of which is more than ſufficient for common uſes. This metre ſurpaſſes the half toiſe by 11.44 lines.

ſummit

summit of this angle, poles in the direction of each of the signals were erected, at the distance of every hundred toises. At the bottom of each of these poles, a wooden wedge was driven into the ground to such a depth that nothing could alter its position, and the place of each of the wedges was marked by heaps of stones disposed along the road.

After these preliminary labours, Delambre began the operation of measurement on the 5th of Floreal, at the base of the signal of Melun. The instruments constructed for this purpose were four rules of platina, each two fathoms in length (at a given temperature); six lines in breadth, and two thirds of a line in thickness. Each rule was mounted on a piece of wood, sufficiently strong to be secure against all warping and bending; and was covered, at the distance of three inches, with a slight case of wood, at the two extremities of which arose two points made of iron, to serve as marks to direct the sight. On the rule of platina there was placed another rule of copper of the same strength, but somewhat less in length, which served to measure the expansion of the platina. It is well known by experience, that the expansion of platina is to that of copper as 12 is to 25. The two rules were fixed upon each other, in an invariable manner by their anterior extremity, in order that the effect of the expansion might be carried entirely to the other extremity. The rules being plunged into melting ice, and consequently at 0° of Reaumur's thermometer (32° Fahr.), the extremity of the copper coincided on the platina at a line marked; but as soon as they were exposed to another temperature, the copper extended on the platina, on account of the different expansion of the two metals. An ingenious apparatus constructed on this principle, afforded, with the assistance of a nonius and microscope fitted to it, the means of estimating the dilatation of the platina to nearly $\frac{1}{100000}$ of a toise. This apparatus formed at the same time a very sensible metallic thermometer, each part or degree of which corresponded to a dilatation of 0,000009245 of a toise, on each

each rule of the platina *. The four rules were placed at the end of each other, supported by iron tripods mounted on three screws, to make the extremities correspond at equal heights, and brought into a line by marks to direct the sight, placed successively on the wooden wedges before mentioned. Had each rule been placed in immediate contact with its neighbour, the operator in placing one rule might have deranged the preceding, and the contact besides would never have been perfect. To prevent this inconvenience, care was taken to leave a sufficient interval from one rule to another; but the extremity of each rule was furnished with a small rule, or slip of platina, which could be pushed into a groove to fill up the interval, and to form a perfect contact with the following rule: a scale fitted with a nonius, viewed through a microscope, measured the length of the small rule, to nearly $\frac{1}{100000}$ of a toise. But in thus measuring a line on ground, which often rises or falls insensibly, it was necessary to pay great attention to the differences of the level. For this purpose the case of each rule had, at equal distances from its extremities, two small cubes made of copper, which rose to equal heights on the plane of the rules; and upon which were laid the two branches of a square, bearing a spirit level. This level being twice placed on each rule, in the two contrary directions, gave the mean inclination almost to a minute; so that with a very simple formula each measure was found reduced to the horizontal line, and the series of observations gave at the same time the complete level of the base. In commencing the operation, the first rule was placed in such a manner that the centre of a plummet, suspended at its anterior extremity, should fall exactly on the centre of the copper cylinder, already mentioned, which

* Allusion is made here not to common thermometers, but to newly invented metallic thermometers, divided according to a new decimal scale, of which 2.316 parts correspond to one degree of Reaumur. To express, therefore, that degree of expansion of the platina, 0.00009245 must be multiplied by 2,316, which gives a little more than 0.00002.

formed

formed a point of departure under the ſignal of Melun. The rules 2, 3 and 4 were placed in a ſeries after the firſt, and brought into a line with the ſight. The ſmall rules, or ſlips, were puſhed in to fill up the intervals; and the lengths of theſe ſlips, as well as the expanſion of each rule, and the obſervations of the level, read by Delambre, were written, as he dictated, by two aſſiſtants, who each held a paper divided into columns for that purpoſe. After this the firſt rule was removed and placed after the fourth rule, and the ſame operation was repeated, directing the line always by the ſight-points, removed ſucceſſively at the diſtance of every hundred toiſes, and taking care at each change of the rule to read the expanſion, the length of the ſlip, and the two obſervations of the level.

This operation being repeated 3021 times, rendered it conſequently neceſſary to make 6042 obſervations by the microſcope, and as many of the level. This was continued without interruption during the day; and when night obliged the operators to ſuſpend their labour, the following method was employed to fix the point where they left off, and which was to ſerve next morning for the point of departure. Towards the extremity of the laſt rule an iron ſtake was ſunk into the ground, and a pretty deep hole dug around it. The iron ſtake was then removed, and its place ſupplied by a wooden ſtake, on the ſurface of which was nailed a plate of lead. The laſt rule was placed in ſuch a manner that a plummet, nicely adjuſted and ſuſpended from its extremity, ſhould fall on this plate; the point where it touched the lead was marked as exactly as poſſible, and the wooden ſtake was defended by a ſtrong covering of wood, which was itſelf covered with earth, ſo that carriages could paſs over it without cauſing any derangement. Things remained in this ſtate till next morning, when the operations were reſumed in the like manner as that of the firſt day. The whole operation laſted forty days, three of which only were interrupted. The operators generally advanced eighty-eight lengths of

 the

the rule every day. On the 15th of Prairial at noon, Delambre arrived at the cylinder of copper, forming the other extremity of the base, under the signal of Lieusaint; the extremity of the last rule was found to pass the centre just 48½ lines; and this deduction being made, as well as all the necessary calculations, the result was a length of 6075,784689 toises.

Though these details are sufficient to enable the reader to judge of the great precision employed in this operation, Delambre added many other ingenious and nice precautions which are too long to be repeated here, and which ensured to his labour the highest degree of exactness possible. We shall only add, that, by the accuracy of the instruments and methods employed, errors of inches and seconds are as little to be presumed in the present measurement, as errors of toises and minutes were formerly This great perfection is chiefly owing to the labours of Borda.

VIII. *Chemical Reflections on the Effect produced by Mordants in dyeing Cotton red. By. J. A. CHAPTAL. From the* Annales de Chimie, *Vol. XXVI.*

IN regard to the beautiful red colour given to cotton by means of madder, the case is the same as with certain pharmaceutic preparations, the ridiculous receipts for preparing which have been hitherto respected, because apprehensions have been entertained that their effect would be altered by introducing the least change in the process. A month's labour would scarcely be sufficient to terminate all the operations which have been judged indispensibly necessary for obtaining that beautiful colour called the Turkey or Adrianople red. Soda, oil, gall nuts, sumach, the sulphate of alumine, blood, the gastric liquor, madder, soap, the nitromuriate of tin, are employed in succession. The true means of simplifying this process is not to labour at hazard, and to make trial of the different methods practised without a guide and without principles. Such a proceeding conducts rarely and with slow steps to any happy results. I am acquainted but with one method of making progress in the arts, which is, to bring back and reduce all operations to simple principles: by these means we obtain fixed points of departure, to which all results and all our labours may be referred. Chemistry is now sufficiently advanced to supply us with these bases, and nothing therefore is necessary but to establish them. In the hands of the artist they will become what formulæ are in the head of the mathematician. I shall therefore attempt to give an example by subjecting to chemical principles the three chief mordants in dyeing cotton red; viz. oil, gall nuts, and alum.

It is known that cotton does not receive the red of madder in a fixed manner until it has been properly impregnated with oil. The red applied by printing is far from possessing the same degree of fixity, since it will not stand when washed with soda. This preliminary preparation is given to cotton by forming a cold soapy liquor from the combination of oil and a weak solution of soda. The use of this alkaline ley is attended with no other advantage than that of diluting and dividing the oil, and enabling the operator to convey it to all the parts of the cotton in an equal and easy manner. I have found by experience that potash produces the same effect as soda; and, in my opinion, this fact merits some consideration, as soda, which is scarce and dear in the north, may be supplied by potash, which is there common.

From this principle it follows, that all kinds of soda or oil cannot be employed indiscriminately. In order that the soda may have the proper qualities, it must be caustic, and contain little muriate. It must not be rendered caustic by lime, as it then makes the colour brown. Its causticity must be the effect of its calcination.

The carbonate of soda, and soda mixed with much muriate, combine with oil but very imperfectly. Therefore foda that has been long prepared, or is impure, cannot be applied to the purpofes of dyeing in this manner.

The choice of the oil is equally effential as that of the foda. The oil, to be good, muft unite very perfectly with the ley of foda, and muft remain in an abfolute and permanent ftate of combination. The oil fitteft for this dye is not fine oil, but that rather which contains a large portion of the extractive principle. The former does not preferve its ftate of combination with the foda, and requires fuch a ftrength in the ley as would be injurious to the fubfequent operations. The latter forms a thicker and more durable combination, and requires only a weak ley of one or two degrees.

The neceffity of producing a perfect and intimate combination of the oil and the foda will be readily perceived, by reflecting that the ley of foda is only employed to divide, dilute, and convey the oil in an equal manner to all the parts of the cotton: for it follows from this principle, that if the oil is not well mixed, the cotton made to pafs through this mordant will take the oil unequally, and the colour, therefore, will be badly united. Hence it happens that the workman places the whole fecret of a well-united and ftrong colour in the choice of good oil and fuitable foda. It thence follows from thefe principles that the oil ought to be in excefs, and not in a ftate of abfolute faturation; for in the latter cafe it would abandon the ftuff in wafhing, and the colour would remain dry.

When the cotton has been properly impregnated with oil, it is fubjected to the operation of being galled. The ufing of the gall nuts is attended with feveral advantages: 1. The acid which they contain decompofes the faponaceous liquor with which the cotton is impregnated, and fixes the oil on the ftuff. 2. The character of animalifation which the galls have, predifpofes the cotton to receive the colouring matter. 3. The aftringent principle unites with the oil, and forms with it a compound which blackens as it dries; which

which is not very ſoluble in water, and which has the greateſt affinity with the colouring principle of the madder. The dyer may acquire a competent knowledge of this laſt combination, and ſtudy its properties, by mixing a decoction of gall nuts with a ſolution of ſoap.

It follows from theſe principles: 1. That the place of the gall nuts cannot be ſupplied by any other aſtringent, let the quantity employed be what it may. 2. That the galls ought to be ſtrained as hot as poſſible, that the decompoſition may be ſpeedy and perfect. 3. That the galled cotton ought to be ſpeedily dried, in order to prevent its aſſuming a black colour, which would injure the brightneſs of the red intended to be given to it. 4. That dry weather ought to be choſen for the proceſs of galling, becauſe in moiſt weather the aſtringent principle communicates a black colour, and dries ſlowly. 5. The cotton ought to be preſſed together with the greateſt care, in order that the decompoſition may be effected in an equal manner at every point of the ſurface. 6. That a proportion ought to be eſtabliſhed between the gall nuts and the ſoap: if the former predominates, the colour is black; if the latter, the portion of the oil not combined with the aſtringent principle then eſcapes by the waſhings, and the colour remains poor.

The third mordant employed in dyeing cotton red is the ſulphate of alumine (alum). This ſubſtance not only has of itſelf the property of heightening the red of madder, but it contributes alſo by its decompoſition and the fixation of its alumine to give ſolidity to the colour. To judge of the effects of alum in dyeing cotton, it will be ſufficient to mix a decoction of gall nuts with a ſolution of alum. The mixture becomes immediately turbid, and there is formed a greyiſh precipitate, which, when dried, is inſoluble in water and alkalies.

Every thing that takes place in this experiment of the laboratory may be obſerved in the proceſs of aluming in dyeing. Cotton, when galled and plunged in a ſolution of the ſulfate or acetite of alumine, immediately changes its colour, and becomes grey; the bath presents no precipitate, because the operation takes place in the tissue of the cloth itself, where the production remains fixed. It is however to be observed, that if the galled cotton be passed through a too warm solution of alum, a portion of the galls escapes from the tissue of the stuff, and the decomposition of the alum takes place in the bath itself; which diminishes the proportion of the mordant, and impoverishes the colour.

We have here therefore a combination of three principles (oil, the astringent principle, and alumine) which serve as a mordant for the red dye of madder. Each of them employed separately produces neither the same fixation nor the same lustre in the colour.

This mordant, without dispute, is the most complex known in dyeing, and it presents to chemistry a sort of combination which it is of the utmost importance to study. It is from the precision in this combination, and the judgement shewn by the artist himself to produce it, that a beautiful colour can be expected; but if it be possible for him to conduct himself through the labyrinth of these numerous operations, by taking the clue of experiment as his guide, it will at any rate be very difficult for him to simplify his progress, or bring it to perfection. It is only by reasoning on his operations, and calculating the result and principle of each, that he can hope to become master of his processes, to correct their faults, and to obtain invariable products. Without this, the practice of the most experienced artist will afford nothing in his hands but the discouraging alternative of success and disappointment. I wished therefore in this short analysis of the process for dyeing red, which is the most complicated of all, to give an instance of what chemistry can do in the arts when its principles are properly applied. I will venture to assert, that the most uninformed workman will here find the principle of his art and the rule of his conduct.

IX. *On*

IX. *On a new metallic Substance contained in the Red Lead of Siberia, to which it is proposed to give the Name of Chrôme* on account of the Property it possesses of colouring every Substance combined with it. By M. VAUQUELIN. From the* Annales de Chimie, *Vol. XXV.*

IN proportion as the means of chemistry are multiplied and brought nearer to perfection, we have seen the number of simple bodies increase. Scheele enriched this science with two metallic substances and several acids, &c. and Klaproth lately has made known two new metals and two earths. It appears, therefore, that we are not yet arrived at its utmost boundaries; and, that when mankind shall dig more frequently, and to a greater depth in the earth, many bodies will be discovered, of which at present we have no idea. I will even venture to assert that when chemistry, armed with all the means it possesses at present, shall get possession of all the objects preserved in cabinets with so much care, as so many relicks which it is unlawful to touch, it will procure useful discoveries from bodies that at present excite only idle curiosity.

In the year 1789 M. Macquart, a physician at Paris, together with myself, analysed the red lead of Siberia, and announced that this mineral was an intimate combination of the super-oxygenated oxyde of lead and the iron of alumine. Since that epoch Bindheim also said, that he had found in it copper, cobalt, nickel, iron, and the molybdic acid. Some days ago I likewise subjected this substance to a new examination, and I hope to prove that every thing hitherto published on this subject is incorrect; and though I have not yet given to my researches all the extent which I propose, for want of a sufficient quantity of matter, they have been carried far enough to prove that the red lead contains a new metallic acid possessing characterising marks

* From χρωμα colour. EDIT.

well defined, and ſome properties which may render it applicable to the arts.

Exp. I. A hundred parts of this mineral reduced to a fine powder, were mixed with 300 parts of the ſaturated carbonate of potaſh, and about 4000 parts of water; and this mixture was expoſed for an hour to a boiling heat. I obſerved, 1ſt, that when theſe matters began to act upon each other there was produced a ſtrong effervefcence which continued a long time; 2d, that the orange colour of the lead became a brick red; 3d, that at a certain period the whole matter ſeemed to diſſolve; 4th, that in proportion as the effervefcence advanced the matter re-appeared under the form of a granulated powder, of a dirty yellow colour; 5th, that the liquor aſſumed a beautiful golden yellow colour. When the effervefcence had entirely ſubſided, and appeared to have no longer any action on the ſubſtances, the liquor was filtered, and the metallic duſt collected on the paper. After being waſhed and dried, it weighed no more than 78 parts: the potaſh therefore had taken from it 22 parts.

Exp. II. I poured upon the 78 parts juſt mentioned, ſome of the nitric acid, diluted in twelve parts of water, which produced a briſk effervefcence. The greater part of the matter was diſſolved: the liquor aſſumed no colour, and there remained only a ſmall quantity of powder of an orange-yellow colour. I ſeparated the liquor of the reſiduum by the help of a ſyphon, waſhed the matter ſeveral times, and united the waſhings with the firſt liquor. This reſiduum, dried, weighed no more than 14 parts: from which it follows, that the nitric acid had diſſolved 64.

Exp. III. I again mixed theſe 14 parts with 42 parts of the carbonate of potaſh and the neceſſary quantity of water. I then treated them as in Experiment I. and the phenomena were the ſame. The liquor, after being filtered, was united to the former; and the reſiduum, waſhed and dried, weighed no more than 2 parts, which were ſtill red lead, and therefore thrown away.

Exp. IV.

Exp. IV. The two nitric ſolutions united and evaporated, produced 92 parts of nitrate of lead, cryſtalliſed in octaedra, perfectly white and tranſparent. Theſe 92 parts of nitrate of lead, diſſolved in water, were precipitated by a ſolution of the ſulfate of ſoda. This produced 81 parts of the ſulfate of lead, which were equivalent to 56,68 of metallic lead.

Exp. V. The alcaline liquors united, had an orange-yellow colour. They depoſited at the end of ſome days two parts of a yellow powder which contained no more lead. Theſe liquors, ſubjected to evaporation until a ſaline pellicle was formed on their ſurface, produced, on cooling, yellow cryſtals; among which there was carbonate of potaſh, not decompoſed. Theſe cryſtals diſſolved in water, and the ſolution united with the mother water, the whole was mixed with weak nitric acid until the carbonate of potaſh was ſaturated. The liquor then had a very dark orange-red colour. Being united with a ſolution of the muriate of tin, newly made, it firſt aſſumed a brown colour, which afterwards became greeniſh. Mixed with a ſolution of the nitrate of lead, it immediately produced the red lead. Laſtly, evaporated ſpontaneouſly, it produced ruby-red cryſtals, mixed with cryſtals of the nitrate of potaſh. Ninety-eight parts of this mineral, decompoſed as above mentioned, having produced 81 parts of the ſulfate of lead, 100 parts would have given 82.65, which are equivalent to 57.1 of metallic lead. But admitting, as experiment proves, that 100 parts of lead abſorb, in combining with acids, 12 parts of oxygene, the 57.1 of metallic lead ought to contain in the red lead 6.86 of this principle, and we ought to have for the mineraliſing acid 36.4.

Exp. VI. To verify by ſyntheſis the proportions of the principles of the red lead found by analyſis, I diſſolved 50 grains or about 2.654 grammes of metallic lead in the nitric acid; and the ſolution having been divided into two equal parts, the one was completely precipitated by the neceſſary

quantity

quantity of the combination of the acid of red lead with potash, and I obtained 43 grains, or about 2.282 grammes of red lead, as beautiful as the natural mineral. The other portion of the nitrate of lead, precipitated by caustic potash, gave 28 grains of the white oxyde of lead. Thus, by this synthesis, 100 parts of red lead would be composed of 65.12 of the oxyde of lead and 34.88 of acid. By analysis, as has been shewn, it gives only 1.72* less in the acid which mineralises the red lead—a difference which approaches as near to correctness as chemical means will admit†.

Though the properties above shewn were more than sufficient, strictly speaking, to convince any one well acquainted with the differential characters of metallic substances, that the one in question belongs to a particular species, I thought it my duty to compare its acid by a series of combinations with the molybdic acid, in some properties of which it seems to partake.

Comparative Experiments on the Molybdic Acid and that of Red Lead. The Combination of the former with Potash is distinguished by the Letter A, *and the Combination of the latter with Potash by the Letter* B.

The combination of the molybdic acid with potash furnishes a salt which has no colour.

The combination of the acid of red lead with potash gives a salt of an orange colour.

A, Mixed with filings of tin and the muriatic acid, immediately becomes blue, and precipitates flakes of the same

* There must be a mistake in some of the cyphers; for the difference between 36.4 given by analysis, and 34.83 obtained by synthesis, is only 1.52. Edit.

† It is known by the experiments of C Macquart, that the red lead of Siberia contains a small quantity of the water of crystallisation, which amounts to three or four centiemes. It may be possible, therefore, that this difference may be owing to that substance.

colour,

colour, which disappear at the end of some time, if an excess of muriatic acid has been added, and the liquor assumes a brownish colour.

B, Treated in the same manner, becomes at first yellowish-brown, and afterwards assumes a beautiful green colour.

A, Mixed with a solution of hydro-sulfure of potash, gives no precipitate, but by the addition of some drops of the nitric acid there is immediately formed a precipitate of a chesnut-brown colour.

B, Mixed with the same reagent, gives, without the addition of the nitric acid, a green precipitate, which, by that acid, becomes yellowish.

A, With a solution of the nitrate of lead, forms a white precipitate, soluble in the nitric acid.

B, Mixed with the same solution, gives an orange precipitate, absolutely of the same shade as that of the red lead pulverised.

A, Mixed with a little alcohol and nitric acid, does not change its colour.

B, Added to the same reagent, immediately assumes a blueish green colour, which preserves the same shade even after desiccation: ether alone gives it the same colour.

A, With a solution of the nitrate of mercury, gives a white flaky precipitate.

B, With the same solution of mercury, gives a precipitate of a dark cinnabar colour.

A, With a solution of the nitrate of silver, forms a white flaky precipitate.

B, With the same reagent, gives a precipitate, which, the moment it is formed, appears of a most beautiful carmine colour, but becomes purple by exposure to the light. This combination, exposed to the heat of the blow-pipe, melts before the charcoal is inflamed. It assumes a blackish and metallic appearance. If it be then pulverised, the powder is still purple; but after the blue flame of the lamp is brought in contact with this matter, it assumes a green colour,

lour, and the ſilver appears in globules diſſeminated through-out its ſubſtance.

A, With the nitrate of copper, forms a greeniſh precipitate.

B, With the ſame ſolution, gives a cheſnut-red precipitate.

A, With the ſolutions of ſulfate of zinc, muriate of biſmuth, muriate of antimony, nitrate of nickel, the muriates of gold and platina, produces white precipitates, when theſe ſolutions do not contain exceſs of acid.

B, With the ſame ſolutions, produces almoſt the ſame phenomena; except that the precipitates are for the moſt part yellowiſh. That of gold is greeniſh.

The Molybdic Acid alone.

1. The molybdic acid melted with borax gives it a blueiſh colour.

2. Paper dipped in the molybdic acid becomes in the ſun of a beautiful blue colour.

3. The molybdate of lead diſſolves in the muriatic acid, and the ſolution does not aſſume any colour even by ebullition.

Acid of the Red Lead alone.

1. The acid of the red lead melted with borax communicates to it a very dark green colour.

2. Paper impregnated with the acid of red lead aſſumes in the light a greeniſh colour.

3. The red lead diſſolves even without the application of heat in the muriatic acid, and the ſolution has an orange-red colour; but by ebullition it aſſumes a beautiful green colour, and there is formed muriatic acid highly oxygenated.

From the phenomena above mentioned, I entertain no doubt that the acid which mineraliſes the red lead of Siberia has for its baſis a particular metal, hitherto unknown. If it be compared indeed with all the other metals, there will be be found no perfect analogy between them. The uranium does not become acid; it cannot be combined with caustic alkalies, and does not redden vegetable blue colours. Titanium dissolves in acids, produces crystallisable salts, and does not combine with alkalies. Tungsten becomes yellow in acids, without being dissolved; and gives, with alkalies, white crystallisable salts. It would be useless to continue the comparison of this substance with other metals; their properties are too well known; and it is evident that they exhibit no phenomena of the like kind.

[M. Vauquelin's second memoir on the properties of this new metal will be given in the next number of the Philosophical Magazine.]

X. *An Account of the* Jumping Mouse of Canada, Dipus Canadensis. *By Major General* THOMAS DAVIES, *F.R.S. and L.S.* *From the* Transactions of the Linnean Society, *Vol. IV.* 1798.

As I conceive there are few persons, however conversant with natural history, who may have seen or known there was an animal existing in the coldest parts of Canada, of the same genus with the Jerboa, hitherto confined to the warmer climates of Europe and Africa; I take the liberty of laying before this society the following observations (accompanied by a drawing) on an animal of that kind, procured by myself in the neighbourhood of Quebec, during my last residence in that country. As I do not recollect to have seen this animal either figured or described by any author in natural history, I flatter myself, these observations may afford some satisfaction to the president and members of the Linnean Society. The specimens from which I made the drawing are now in my collection. With respect to the food, or mode of feeding, of this animal, I have it not in my power to speak with any degree of certainty, as I could by no means procure any kind

kind of sustenance that I could induce it to eat; therefore, when caught, it only lived a day and a half. The first I was so fortunate to catch was taken in a large field near the falls of Montmorenci, and by its having strayed too far from the skirts of the wood, allowed myself, with the assistance of three other gentlemen, to surround it, and after an hour's hard chase to get it unhurt, though not before it was thoroughly fatigued; which might in a great measure accelerate its death.

During the time the animal remained in its usual vigour, its agility was incredible for so small a creature. It always took progressive leaps of from three to four, and sometimes of five yards, although seldom above 12 or 14 inches from the surface of the grass; but I have frequently observed others in shrubby places and in the woods, amongst plants, where they chiefly reside, leap considerably higher. When found in such places, it is impossible to take them, from their wonderful agility, and their evading all pursuit by bounding into the thickest cover they can find.

With respect to the figure given of it in its dormant state, I have to observe, that specimen was found by some workmen, in digging the foundation for a summer-house, in a gentleman's garden about two miles from Quebec, in the latter end of May 1787.

It was discovered enclosed in a ball of clay, about the size of a cricket-ball, nearly an inch in thickness, perfectly smooth within, and about 20 inches under ground. The man who first discovered it, not knowing what it was, struck the ball with his spade, by which means it was broken to pieces, or the ball also would have been presented to me. The drawing will perfectly shew how the animal is laid during its dormant state.

How long it had been under ground it is impossible to say; but as I never could observe these animals in any parts of the country after the beginning of September, I conceive they lay themselves up some time in that month, or beginning of of October, when the froſt becomes ſharp: nor did I ever ſee them again before the laſt week in May, or beginning of June. From their being enveloped in balls of clay, without any appearance of food, I conceive they ſleep during the winter, and remain for that term without ſuſtenance. As ſoon as I conveyed this ſpecimen to my houſe, I depoſited it, as it was, in a ſmall chip-box, in ſome cotton, waiting with great anxiety for its waking; but that not taking place at the ſeaſon they generally appear, I kept it until I found it begin to ſmell: I then ſtuffed it, and preſerved it in its torpid poſition. I am led to believe its not recovering from that ſtate, aroſe from the heat of my room during the time it was in the box, a fire having been conſtantly burning in the ſtove, and which in all probability was too great for reſpiration. I am led to this conception from my experience of the ſnow bird of that country, which always expires in a few days (after being caught, although it feeds perfectly well) if expoſed to the heat of a room with a fire or ſtove; but being nouriſhed with ſnow, and kept in a cold room or paſſage, will live to the middle of ſummer.

The animal above deſcribed belongs to Schreber's genus of Dipus, and may be characteriſed

Dipus Canadensis *palmis tetradactylis, plantis pentadactylis, caudâ annulatâ undique ſetosâ, corpore longiore.*

Fig. 1. Plate VIII, repreſents the Dipus Canadenſis.

Fig. 2 ſhows it in its torpid ſtate.

XI. *On the Theory of the Structure of Cryſtals, by the Abbé* Hauy. *From Vol. XVII. of the* Annales de Chimie.

[Continued from Page 169.]

4. *Intermediate Decrements.*

THERE are certain cryſtals in which the decrements on the angles do not take place in lines parallel to the diagonals, but

but parallel to lines ſituated between the diagonals and the edges. This is the caſe when the ſubtractions are made by ranges of double, triple, &c. moleculæ. Fig. 47, (Plate IX.) exhibits an inſtance of the ſubtractions in queſtion; and it is ſeen that the moleculæ which compoſe the range repreſented by that figure, are aſſorted in ſuch a manner as if of two there were formed only one; ſo that we need only to conceive the cryſtal compoſed of parallelopipedons, having their baſes equal to the ſmall rectangles *a b c d*, *e d f g*, *h g i l*, &c. to reduce this caſe under that of the common decrements on the angles. I give the name of *intermediate decrement* to this particular kind of decreaſe, the progreſs of which will be better illuſtrated by the following example.

Syntactic Iron Ore (*Fig.* 48).

De l'Iſle *Cryſtallographie*, tom. iii. p 198 and 199. *var.* 9 and 10.

Geomet. charact. Reſpective inclination of the trapeziums *b c g o*, *n q g o*, of the riſing pyramids 135° 34′ 31″; of the edges *c g*, *g q*, 129° 31′ 16″. Angles of the trapezium *b c g o*, *b* or *c* = 103° 48′ 35″; *o* or *g* = 76° 11′ 25″.

This variety of iron ore, which for the moſt part appears under the form of two oppoſite pyramids, riſing from a common baſe, is found at Framont in les Voſges. There are ſome groupes the ſurface of which, like the iron ore of the iſland of Elba, reflects the moſt lively priſmatic colours. The cryſtals are often ſo ſmall, that they might be taken for ſimple tetragonal laminæ; but, on cloſe inſpection, the ſmall ſpots which form the faces of the riſing pyramids may be ſeen.

Theſe cryſtals, which M. de l'Iſle claſſed among the modifications of the dodecaedron with iſoſceles triangular planes, have for nucleus a cube which performs the functions of the rhomboid, as in the ore of the iſland of Elba. The two regular hexagons, by which they are terminated, ariſe from a decrement by a ſingle range of cubic moleculæ on the angles *c*, *n*, (*fig.* 46) of the nucleus.

To

To form an idea then of the effect of the intermediary law, combined with the preceding, and which gives riſe to the lateral trapeziums, let us ſuppoſe that *c b p r* (*fig.* 49) repreſents the ſame ſquare as fig. 46, ſubdivided into ſmall ſquares, which are the external faces of as many moleculæ. If we take theſe moleculæ by pairs, ſo that they form rectangular parallelopipedons, having for baſes the oblong ſquares *b n g h*, *h g m* G, &c. and if we imagine that the ſubtractions are made by two ranges of theſe double moleculæ, the edges of the laminæ of ſuperpoſition will be ſucceſſively ranged in lines, as P G, T L, R *p*, S *p*, *k z*, *y z*, &c. and the ſum of all theſe edges will produce two faces which, departing from the angles *b*, *r*, will converge, the one towards the other, and will unite themſelves on a common ridge, ſituated above the diagonal *c p*, but inclined to that diagonal. We ſhall then have twelve faces as the complete reſult of the decrement; and calculation ſhews, that the ſix ſuperior faces, being prolonged to the point where they meet the ſix lower faces, will form with them the ſurface of a dodecaedron, compoſed of two right pyramids united at their baſes These pyramids are here incomplete by the effect of the firſt law, which gives the hexagon *a b c d r u* (*fig.* 48) and its oppoſite *.

5. *Mixed Decrements.*

In other cryſtals the decrements, either on the edges or on the angles, vary according to laws, the proportion of which cannot be expreſſed but by the fraction $\frac{2}{3}$ or $\frac{3}{4}$. It may happen, for example, that each lamina exceeds the following by two ranges parallel to the edges, and that it may at the ſame time have an altitude triple that of a ſimple molecula. Figure 54 repreſents a vertical geometrical ſection of one of the kinds of pyramids which would reſult from this decrement; the effect of which may be readily conceived by conſidering

* The term *ſynthetic* denotes the combination of decrements, one of which takes place by a ſingle range of ſimple moleculæ, and the other by two ranges of double moleculæ.

ſidering that AB is a horizontal line taken on the upper baſe of the nucleus, *b a z r* the ſection of the firſt lamina of ſuperpoſition, *g f e n* that of the ſecond, &c. I call *mixed decrements* thoſe which exhibit this new kind of exception from the ſimpleſt laws.

Theſe decrements, as well as the intermediary ones, rarely exiſt any where elſe, and it is particularly in certain metallic ſubſtances that I have diſcovered them. Having tried to apply the ordinary laws to a variety of theſe ſubſtances, I found ſo great errors in the value of the angles, that I at firſt believed they were inconſiſtent with theory. But after I had conceived the idea of giving to this theory the extent of which I have juſt ſpoken, I arrived at reſults ſo correct, that I no longer entertained any doubt of the exiſtence of the laws on which theſe reſults depend.

Reflections on the preceding Reſults.

All the metamorphoſes to which cryſtals are ſubjected depend on thoſe laws of ſtructure juſt explained, and others of the like kind. Sometimes the decrements take place at the ſame time on all the edges; as in the dodecaedron having rhombuſes for its planes, as before mentioned; or on all the angles, as in the octaedron originating from a cube. Sometimes they take place only on certain edges or certain angles. Sometimes there is an uniformity between them, ſo that it is one ſingle law by one, two, three ranges, &c. which acts on the different edges, or the different angles; as is obſerved in the two ſolids of which I ſhall ſpeak hereafter. Sometimes the law varies from one edge to the other, or from one angle to the other; and this happens above all when the nucleus has not a ſymmetrical form; for example, when it is a parallelopipedon, the faces of which differ by their reſpective inclinations, or by the meaſure of their angles. In certain caſes the decrements on the edges concur with the decrements on the angles to produce the ſame cryſtalline form. It happens alſo ſometimes that the ſame

edge,

edge, or the ſame angle, is ſubjected to ſeveral laws of decrement, that ſucceed each other. In a word, there are caſes where the ſecondary cryſtal has faces parallel to thoſe of the primitive form, and which combine with the faces produced by the decrements to modify the figure of the cryſtal.

I call *ſimple ſecondary forms*, thoſe ariſing from an unique law of decrement, the effect of which entirely conceals the nucleus; and *compound ſecondary forms*, thoſe which ariſe from ſeveral ſimultaneous laws of decrement, or from one ſingle law which has not attained to its extent, ſo that there remain faces parallel to thoſe of the nucleus, which concur, with the faces produced by the decrement, to diverſify the aſpect of the cryſtal. I ſhall ſoon make new applications of theory to the compound ſecondary forms, of which ſyntactic iron ore has already preſented us an example.

If amidſt this diverſity of laws, ſometimes inſulated, ſometimes united by combinations more or leſs complex, the number of the ranges ſubtracted were itſelf extremely variable; for example, were theſe decrements by twelve, twenty, thirty or forty ranges, or more, as might abſolutely be poſſible, the multitude of the forms which might exiſt in each kind of mineral would be immenſe, and exceed what could be imagined. But the power which effects the ſubtractions ſeems to have a very limited action. Theſe ſubtractions for the moſt part take place by one or two ranges of moleculæ. I have found none which exceeded four ranges, except in a variety of calcareous ſpar, forming part of the collection of C. Gillet Laumont, the ſtructure of which I have lately determined, and which depends on a decrement by ſix ranges; ſo that, if there exiſt laws which exceed the decrements by four ranges, there is reaſon to believe that they rarely take place in nature. Yet, notwithſtanding theſe narrow limits, by which the laws of cryſtalliſation are circumſcribed, I have found, by confining myſelf to two of the ſimpleſt laws, that is to ſay, thoſe which produce ſubtractions by one or two ranges, that calcareous ſpar is ſuſceptible

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of two thouſand and forty-four different forms: a number which exceeds more than fifty times that of the forms already known*, and if we admit into the combination decrements by three and four ranges, calculation will give 8,388,604 poſſible forms in regard to the ſame ſubſtance. This number may be ſtill very much augmented in conſequence of decrements either mixed or intermediary.

The ſtriæ remarked on the ſurface of a multitude of cryſtals afford a new proof in favour of theory, as they always have directions parallel to the projecting edges of the laminæ of ſuperpoſition, which mutually go beyond each other, unleſs they ariſe from ſome particular want of regularity. Not that the inequalities reſulting from the decrements muſt be always ſenſible, if the form of the cryſtals had always that degree of finiſhing of which it is ſuſceptible; for, on account of the extreme minuteneſs of the moleculæ, the ſurface would appear of a beautiful poliſh, and the ſtriæ would elude our ſenſes. There are therefore ſecondary cryſtals where they are not obſerved in any manner, while they are very viſible in other cryſtals of the ſame nature and form. In the latter caſe, the action of the cauſes which produce cryſtalliſation not having fully enjoyed all the conditions neceſſary for perfecting that ſo delicate operation of nature, there have been ſtarts and interruptions in their progreſs, ſo that, the law of continuity not having been exactly obſerved, there have remained on the ſurface of the cryſtal vacancies apparent to our eyes. In a word, it is ſeen that ſuch ſmall deviations are attended with this advantage, that they point out the direction according to which the ſtriæ are arranged in lines on the perfect forms where they eſcape our organs, and thus contribute to unfold to us the real mechaniſm of the ſtructure.

The ſmall vacuities which the edges of the laminæ of ſuperpoſition leave on the ſurface of even the moſt perfect ſe-

* In my Eſſay, p. 217 *et ſeq.* I carried the number of theſe forms only to 1019, becauſe I had not introduced as an element in my calculation a modification of the law of decrements, with the exiſtence of which I was not then acquainted.

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condary cryſtals by their re-entering and ſalient angles, thus afford a ſatisfactory ſolution of the difficulty a little before mentioned; which is, that the fragments obtained by diviſion, the external facets of which form part of the faces of the ſecondary cryſtal, are not like thoſe drawn from the interior part. For this diverſity, which is only apparent, ariſes from the facets in queſtion being compoſed of a multitude of ſmall planes, really inclined to one another, but which, on account of their ſmallneſs, preſent the appearance of one plane; ſo that, if the diviſion could reach its utmoſt bounds, all theſe fragments would be reſolved into moleculæ, ſimilar to each other, and to thoſe ſituated towards the centre.

The fecundity of the laws on which the variations of cryſtalline forms depend, is not confined to the producing of a multitude of very different forms with the ſame moleculæ. It often happens alſo, that moleculæ of different figures arrange themſelves in ſuch a manner as to give riſe to like polyedra in different kinds of minerals. Thus the dodecaedron with rhombuſes for its planes, which we obtained by combining cubic moleculæ, exiſts in the granite with a ſtructure compoſed of ſmall tetraëdra having iſoſceles triangular faces, as I ſhall prove hereafter; and I have found it in ſparry fluor, where there is alſo an aſſemblage of tetraedra, but regular; that is to ſay, the faces of which are equilateral triangles. Nay more: it is poſſible that ſimilar moleculæ may produce the ſame cryſtalline form by different laws of decrement*. In ſhort, calculation has conducted me to another reſult, which appeared to me ſtill more remarkable, which is, that, in conſequence of a ſimple law of decrement, there may exiſt a cryſtal which externally has a perfect reſemblance to the nucleus, that is to ſay, to a ſolid that does not ariſe from any law of decrement †.

* *Mem. de l'Acad.* an 1788, p. 17 & 26.

† *Ibid.* p. 23.

Various Examples of compound ſecondary Forms.

Priſmatic Calcareous Spar (*Fig.* 1. *Plate* II.)

Spath calcaire en priſme hexaèdre. Daubenton *Tab. Miner.* edit. 1792, p. 15, n° 6. De l'Iſle *Cryſtallographie*, tom. i. p. 514. var. 10.

The baſes of this priſm are produced in conſequence of a decrement by a ſingle range on the angles of the ſummits *b a f*, *g a f*, *b a g*, *d e x*, *d e c*, *c e x* (*fig.* 4.), of the primitive form. The ſix planes reſult from a decrement by two ranges on the angles *b d f*, *f x g*, *b c g*, *d f x*, *d b c*, *c g x*, oppoſite to the preceding. Let *a b d f* (*fig.* 50.) be the ſame face of the nucleus as *fig.* 4. The decreaſing edges ſituated towards the angle of the ſummit *a* will ſucceſſively correſpond with the lines *bi*, *k l*, &c. and thoſe which look towards the inferior angle *d* will have the poſitions pointed out by *mn*, *op*, &c. But in conſequence of the firſt decrement taking place by one range, we prove that the face which reſults from it is perpendicular to the axis; and calculation ſhews, in the like manner, that the ſecond decrement, which takes place by two ranges, produces planes parallel to the axis, and thus the ſecondary ſolid is a regular hexaedral priſm.

To diſplay farther the ſtructure of this priſm let us remark that, in the production of any one *a b c n i h* (*fig.* 1.) of the two baſes, we may confine ourſelves to conſider the effect of one only of the three decrements which take place around the ſolid angle *a* (*fig.* 4.), for example, of that which takes place on the angle *b a f*, ſuppoſing that the laminæ applied on the two other faces, *f a g x*, *b a g c*, do not decreaſe but to aſſiſt the reſult of the principal decrement, which takes place in regard to the angle *b a f*. But here theſe auxiliary decrements are altogether ſimilar to that the effect of which they are ſuppoſed to prolong.

The caſe will be totally different if we apply the ſame obſervation to the decrements which are effected by two ranges on the inferior angles *b d f*, *d f x*, *f x g*, &c. and which produce

duce the ſix planes of the priſm. For example, if we conſider the effect of the decrement on the angle *d f x*, it is neceſſary alſo that the laminæ applied on the faces *a f d b*, *a f x g* (*fig.* 4.), ſhould experience towards their lateral angles *a f d*, *a f x*, adjacent to the angle *d f x*, variations which ſecond the effect of the generating decrement. But here theſe variations are intermediary decrements by ranges of double moleculæ.

To conceive a better idea of theſe variations, let us reſume the face *a b d f* (*fig.* 50.). The variations in queſtion will take place parallel to the lines *c e*, *r x*, *g z*, *v y*, &c. that is to ſay, by one range of double moleculæ, and in ſuch a manner that there will always be two laminæ on a level at their edges in the direction of the height. By this it is evident why the laminæ taken from the priſm by the firſt ſections are trapeziums, ſuch as *p l u s* (*fig.* 1.), in which the aſſortment of the ſmall compoſing rhombuſes will be the ſame as on the trapezium *u s o p* (*fig.* 50.). We may in the like manner aſſign the reaſon of the different figures through which the laminæ, ſucceſſively detached, before arriving at the nucleus, are obliged to paſs. But this detail would lead us too far. In a word, I muſt here repeat, that every thing is included in the effect of the principal decrements: that is to ſay, in the preſent caſe, of thoſe which take place on the ſuperior and inferior angles, or parallel to the horizontal diagonals; and after the firſt lamina of ſuperpoſition, the figure of the cryſtal is given according to this ſingle condition, that the initial faces be prolonged ſo as to interſect each other.

The priſm is ſuſceptible of varying in the length of its axis compared with its thickneſs, which depends on the different epochs at which the decrements commence, or are ſuppoſed to commence. For example: if we ſuppoſe that the decrement, which takes place towards the inferior angle, acts alone at firſt on a certain number of laminæ, the axis of the cryſtal will be ſo much the longer as the commence-

 ment

ment of the decrement on the ſuperior angles ſhall have been retarded. This difference of epochs becomes ſenſible by inſpecting the dodecaedron, *fig.* 2, which is one of the reſults of the mechanical diviſion of the priſm. It is there ſeen that the pentagonal laminæ of the ſummits, ſuch as A O I R S, decreaſe only by their edge R S, which correſponds to the inferior angle *b d f* (*fig.* 4.), while, by their upper parts, they continue to envelop the cryſtal without experiencing any decrement towards that ſide; ſo that it is only on the laminæ moſt diſtant from the axis, as that correſponding to *p s u l*, that the two decrements take place at the ſame time.

The reſult which we have explained is general; that is to ſay, that, whatever may be the angles of the primitive rhomboid, the ſecondary ſolid will always be a regular hexaedral priſm.

Amphitrigonous Iron Ore.

(*Fig.* 51 repreſents this cryſtal in a horizontal projection, and *fig.* 52 in perſpective.)

Mine de fer a 24 faces. Daubenton *Tab. Miner.* edit. 1792, p. 30, n° 2. De l'Iſle *Cryſtallographie*, tom. iii. p. 193 et ſuiv. var. 5, 6, 7.

Geomet. charact. Reſpective inclination of the triangles *g c n*, *g c d*, &c. from the ſame ſummit 146° 26′ 33″; of the lateral triangles *b g u*, *b g q*, to the adjacent pentagons, ſuch as *g u t m n*, 154° 45′ 39″.

This form is that under which the iron ore of the iſland of Elba moſt commonly appears. It reſults from a decrement by two ranges on the angles *c*, *n* (*fig.* 46.), to the ſummits of a cubic nucleus which produces the iſoſceles triangles *g c n*, *g c d*, *n c d* (*fig.* 51 and 52), and of a ſecond decrement by three ranges on the lateral angles *c b p*, *c r p*, *c r s*, &c. which produce the triangles *m n r*, *r n k*, *u g b*, *q g b*, &c. Theſe two decrements ſtop at a certain term, ſo that there remain faces parallel to thoſe of the nucleus, viz. the pentagons *g u t m n*, *b d n k l*, &c. (*fig.* 51.)

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The firſt decrement is the ſame as that which produces the rhomboidal iron ore already mentioned. The ſecond has this property, that, if its effect were complete, it would give a dodecaedron of iſoſceles triangles, or compoſed of two right pyramids united at their baſes. In the caſe of any other decrement by two, four or more ranges, the faces of the dodecaedron would be ſcalene triangles.

The triangles of the ſummits are frequently furrowed by ſtriæ, parallel to the baſes *g n*, *d n*, *g d*, of theſe triangles, and which point out the direction of the decrement.

Analogical Calcareous Spar (*Fig.* 53).

De l'Iſle *Cryſtallographie*, tom. i. p. 543, pl. 4, fig. 36.

Geomet. charact. Inclination of any one, *i m e h*, of the trapezoids of the ſummits to the correſponding vertical trapezoid *e c p g* 16° 33′ 54″; angles of the ſame trapezoid, $i = 114° 18' 56''$; $e = 75° 31' 20''$; m or $h = 85° 4' 52''$. Angles of the trapezoid *e h o g*, $e = 90°$; $o = 127° 25' 53''$; $g = 67° 47' 44''$; $h = 74° 46' 23''$; of the trapezoid *c e g p*, $e = 60°$; $p = 98° 12' 46''$; c or $g = 100° 53' 37''$.

Geomet. propert. 1. In each vertical trapezoid the triangle *c e g* is equilateral. 2. The height *e x* of this triangle is double the height *p x* of the oppoſite triangle *c p g*. 3. In the trapezoid *e h o g* and the others ſimilarly ſituated the angle *h e g* is a right angle. 4. If the diagonal *g h* be drawn, the triangle *h e g* will be ſimilar to any one *a o f* (*fig.* 4.) of thoſe which would be produced by drawing, in the primitive rhombus, the two diagonals *b f*, *a d*. 5. If in the trapezoid *e m i h*, or any other ſituated at the ſummits, the diagonals *e i*, *m h*, be drawn, the height *e l* of the inferior triangle *m e h* will be double the height *i l* of the ſuperior triangle *m i h*. 6. The triangle *m i h* is ſimilar to a half of the rhombus of very obtuſe ſpar, divided by the horizontal diagonal; and the triangle *m e h* is ſimilar to a half of the rhombus of the acute ſpar, divided in the ſame manner.

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The numerous analogies by which this variety is connected with different cryſtalline forms, whether we conſider certain angles formed by planes, as the angle *b e g* of 90°, the angle *c e g* of 60°, or certain triangles obtained by drawing the diagonals of the trapezoids, have induced me to give it the name of *analogical ſpar*. It is derived from three other varieties mentioned before, viz. very obtuſe ſpar by the trapezoids *e m i h*, *f i h t*, &c.; metaſtatic ſpar by the trapezoids *e m d c*, *e h o g*, *o h t z*, &c. and the priſmatic ſpar by the trapezoids *b d c k*, *c e g p*, &c. which are conſequently parallel to the axis.

It often happens that the trapezoids *i m e h*, *f i h t*, &c. are ſeparated, by an intermediary ridge, from the vertical trapezoids *c e g p*, *g o z r*, &c. In that caſe the trapezoids *c d m e*, *g e h o*, &c. are changed into pentagons. I have here ſuppoſed the cryſtal brought back to the moſt ſymmetric figure, that is to ſay, having its ſurface compoſed only of quadrilaterals, as ſometimes happens. This variety is found in Derbyſhire.

Icoſaedral Sulfure of Iron (*Fig.* 55.).

Pyrite ferrugineuſe polyèdre à vingt faces triangulaires. Daubenton *Tab. Miner.* edit. 1792, p. 30. De l'Iſle *Cryſtallographie*, tom. iii. p. 233, var. 22.

Geomet. charact. Reſpective inclinations of the iſoſceles triangles P L R, P S R, 126° 52′ 11″; of any one P N L of the equilateral triangles, to each adjacent iſoſceles triangle P L R or L N K 140° 46′ 17″. Angles of the iſoſceles triangle P L R, L = 48° 11′ 20″; P or R = 65° 54′ 20″.

This variety reſults from a combination of the law which produces the octaedron originating from a cube (*fig.* 42.), with that which takes place for the dodecaedron with pentagonal planes (*fig.* 19 *and* 20). The firſt law gives birth to the eight equilateral triangles which correſpond with the ſolid angles of the nucleus, and the ſecond to twelve iſoſceles triangles,

triangles, ſituated, two and two, above the ſix faces of the ſame nucleus. If we had a dodecaedron ſimilar to that of *fig.* 20, and wiſhed to convert it geometrically into an icoſaedron, ſuch as that in queſtion, it would be ſufficient to make the planes of eight ſections paſs through it in the following manner, viz. one through the three angles P, N, L, (*fig.* 19.), another through the angles P, M, S, a third through the angles L,R,U, &c. A compariſon of the figures 19 and 55 will ſhew, by the correſpondence of the letters, the relation between the two polyedra; but this is an operation merely technical, to which nature could not deſcend. I ſhall obſerve, beſides, that the nucleus of the icoſaedron, to which we ſhould arrive, would be much ſmaller than that of the dodecaedron, ſince the ſolid angles of the latter nucleus would be confounded with the angles D, C, G, &c. (*fig.* 20.) of the dodecaedron; whereas the other nucleus would have its ſolid angles ſituated in the middle of the equilateral triangles MPS, NPL, URL, &c. (*fig.* 55.).

The icoſaedron of the ſulphure of iron has been confounded with the regular icoſaedron of geometry, which differs from it very ſenſibly, ſince all its triangles are equilateral. It is demonſtrated by theory, that the exiſtence of the latter icoſaedron is as impoſſible in mineralogy as that of the dodecaedron; ſo that among the five regular polyedra of geometry, viz. the cube, the tetraedron, the octaedron, the dodecaedron, and the icoſaedron, the three former only can exiſt there, in conſequence of the laws of cryſtalliſation. It is not uncommon therefore to find them among cryſtals of various kinds of minerals.

The icoſaedron of the ſulphure of iron is much leſs common than the dodecaedron. It is found in ſolitary cryſtals. I have one which is complete, and about half an inch in thickneſs.

Polynomous

Polynomous Petunzé (Fig. 56) *.

Spath étincelant ou feld-ſpath en priſme à dix pans avec des ſommets à deux faces et quatre facettes. Daubenton *Tab. Miner.* edit. 1792, p. 4, var. 2.

Geomet charact. Reſpective inclination of the narrow planes *onkm*, *cfhg*, to the adjacent planes on each ſide 150°; of the planes *ctFg*, P*om*N to thoſe contiguous to them by the edges *t*F, PN 120°; of the heptagon *p*G*cldez* to the enneagon B*zebno*P*rs*, 99° 41′ 8″; of the trapezium *dafc* both to the plane *nbafhilk* and to the heptagon *p*G*tcdez*, 135°; of the facet *deab* or AB*zp* to the ſame heptagon, 124° 15′ 15″.

I have not yet obſerved the petunzé naturally cryſtalliſed under its primitive form. This form, ſuch as it is given by the mechanical diviſion of ſecondary cryſtals, is that of an oblique priſm of four planes (*fig.* 58), two of which, ſuch as GOAD, RBHN, are perpendicular to the baſes ADNH, OGRB. The other two, viz. BOAH, RGDN, make, with the former, angles of 120° at the ridges OA, RN, and angles of 60° towards the oppoſite ridges BH, GD. Theſe planes are inclined to the baſes at the place of the ridges GO, BR, 111° 29′ 43″, and at the oppoſite ridges 68° 30′ 17″.

This form is at the ſame time that of the moleculæ. Theory ſhews that the two parallelograms GOAD, OGRB, as well as their parallels, are equal in extent; and that the parallelogram BOAH, or its oppoſite, RGDN, is double each of the preceding; which may ſerve to explain the roughneſs of the ſections made in the direction BOAH, when compared with thoſe obtained in the directions of the

* I have adopted the name petunzé, which is that given to this ſubſtance in China, where it is employed in making porcelain. The word ſpar (*ſpath*) has become ſo vague, by the application of it to ſubſtances very different in their nature, that it is much to be wiſhed that it were baniſhed from the nomenclature of minerals.

ſmall

ſmall parallelograms, and which are always extremely ſmooth and brilliant. Moreover, if the diagonal O R be drawn, it will be found perpendicular to O A and R N; or, what amounts to the ſame, will be ſituated horizontally, by ſuppoſing that the ridges O A, B H, &c. have a vertical poſition. We ſhall ſoon have occaſion to make uſe of this obſervation.

The polynomous petunzé preſents the moſt complicated variety which I have obſerved among cryſtals of this kind. To form an idea of its ſtructure, let us ſuppoſe that *b p y r* (*fig.* 57) repreſents a ſection of the nucleus A R (*fig.* 58) made by a plane perpendicular to the parallelograms GOAD, BOAH, and ſubdivided into a multitude of ſmall parallelograms, which are the analogous ſections of ſo many moleculæ. Here the ſide *y r* (*fig.* 57) which is the ſame ſection of the cutting plane as G O A D, is greater than it ought to be in regard to the ſide *c r* (*fig.* 57), which is the ſame ſection as B O A H (*fig.* 58): but theſe dimenſions are ſuited to thoſe of the ſecondary cryſtal, and here occaſion no difficulty, becauſe we may ſuppoſe that the primitive form has been extended more in one direction than in another; for this form, as I have already remarked, is only a convenient *datum* for the explanation of the ſtructure, and the cryſtal conſiſts merely in an aſſemblage of ſimilar moleculæ; ſo that it is the dimenſions of theſe moleculæ which remain invariable.

This being premiſed, we ſhall find, by comparing the figures 56 and 57; 1ſt, that the plane *f a b n k l i h* (*fig.* 56) and its oppoſite, which correſpond to *m n*, *d g*, (*fig.* 57), are parallel to two of the planes of the nucleus, viz. G O A D, B R N H (*fig.* 58), and conſequently do not reſult from any law of decrement; 2d, that the plane P *o m* N, and its oppoſite (*fig.* 56), which correſpond to *a o*, *e g* (*fig.* 57), are alſo parallel to two of the planes of the nucleus, viz. B O A H, R G D N (*fig.* 58); 3d, that the plane *o n k m* and its oppoſite (*fig.* 56), which correſpond to *o n*, *e g*, (*fig.

(*fig.* 57) reſult from a decrement by two ranges parallel to the ridges A O, N R (*fig.* 58); 4th, that the plane *c f g h* and its oppoſite (*fig.* 56), which correſpond to *m y*, *d c* (*fig.* 57), reſult from a decrement by four ranges parallel to the ridges G D B H (*fig.* 58); 5th, that the plane *c t* F *g* and its oppoſite (*fig.* 56), which correſpond to *f y*, *c a* (*fig.* 57), reſult from a decrement by two ranges parallel to the ſame ridges G D, B H (*fig.* 58), which decrement takes place on the other ſide of theſe ridges. It may be ſeen by what has been already ſaid, that decrements different in their meaſure give riſe to planes ſimilarly ſituated, ſuch as *o n k m* and *c f g h* (*fig.* 56), which is a conſequence of the particular figure of the moleculæ.

With regard to the faces of the ſummit, the heptagon *p* G *t c d e z* (*fig.* 56) is ſituated parallel to the baſe B R G O (*fig.* 58). The enneagon B *s r* P *o n b e z* (*fig.* 56) is produced in conſequence of a decrement by one range on the angle O B R (*fig.* 58), or parallel to the diagonal O R; which decrement does not attain to its full extent, and leaves ſubſiſting the neighbouring heptagon parallel to the baſe B R G O. It may be readily conceived, after what has been ſaid on the poſition of the diagonal O R, why the line *e z* (*fig.* 56), which ſeparates the two large faces of the ſummit, is ſituated horizontally, ſuppoſing that the planes have a vertical poſition.

The trapeziums *d a f c*, A *p* G C, reſult from a decrement by one range on the ridges G O, B R, (*fig.* 58). The facet *d e b a* (*fig* 56) ariſes from a decrement by two ranges, parallel to the ridge B O (*fig.* 58). With regard to the other facet A B *z p*, which has the ſame poſition as the preceding, in regard to the oppoſite part of the cryſtal, it reſults from an intermediary law by a range of double moleculæ on the angle O B R (*fig.* 58). The rhombuſes *b c l h*, *k l ſ u* (*fig.* 59), repreſent the horizontal ſections of two of theſe double moleculæ, taken in the ſame range, and whoſe relation to the reſt of the aſſortment will become ſenſible by comparing

comparing the rhombuses in question with those marked by the same letters (*fig.* 57).

The crystals of this variety are subject to a change of dimensions, which is, that the faces *pGtcdez*, *fabnklih*, and their opposites, which are at right angles to each other, are stretched out, in the direction of their breadth, in such a manner that they exhibit the appearance of a quadrilateral rectangular prism, the summits of which would be formed by the faces situated towards the ridges PN, F*t*.

This variety is found in opake crystals, and of a whitish, yellowish, and sometimes reddish colour, in the granites of Auvergne, and of different countries. There are some of them in groups and some single, but the latter are uncommon.

[*To be concluded in the next Number.*]

XII. *Description of the Apparatus employed by* LAVOISIER *to produce Water from its component Parts, Oxygen and Hydrogen.*

THE discovery made by Mr. Cavendish of the composition of water having effected a complete revolution in the theory of chemistry, it will no doubt gratify many of our readers to see some account of the principal apparatuses which have been contrived to exhibit this phenomenon.

Fig. 1, Plate X. is that used by Mr. Lavoisier. A is a balloon holding about 30 pints, having a large opening, to which is cemented the plate of copper B pierced with four holes, in which four tubes terminate. The first tube H*h* is intended to be adapted to an air-pump, by which the balloon may be exhausted of its air. The second tube *gg* communicates by its extremity MM with a reservoir of oxygen gas, from which the balloon is to be filled. The third tube *d*D*d* communicates by its extremity *d*NN with a reservoir of hydrogen gas. The extremity *d* of this tube terminates in a capillary opening, through which the hydrogen gas contained in in the reservoir is forced, with a moderate degree of quickness, by the pressure of a column of one or two inches of water. The fourth tube, G L, contains a metallic wire, having a knob at its extremity L, intended for transmitting an electrical spark from L to *d*, on purpose to set fire to the hydrogen gas: this wire is moveable in the tube, that the operator may be able to move the knob L to or from the extremity *d* of the tube D*d*.

The three tubes *d*D*d*, *gg*, and H*h*, are all provided with stop cocks.

That the hydrogen gas and oxygen gas may be as much as possible deprived of water, they are made to pass, in their way to the balloon A, through the tubes M M, N N, of about an inch diameter; and these are filled with salts, which, from their deliquescent nature, greedily attract the moisture of the gas: such are the acetite of potash, and the muriat or nitrat of lime. These salts must only be reduced to a coarse powder, that they may not run into lumps, and prevent the gases from passing through their interstices.

Being provided with a sufficient quantity of the oxygen and hydrogen gases (the latter in the proportion of 2 to 1 of the former), and having adjusted every thing properly, as above directed, the tube H *h* must be adapted to an air-pump, and the balloon A exhausted of its air. Next admit the oxygen so as to fill the balloon, and then by means of pressure force a stream of hydrogen through the tube D *d*, to which set fire by an electrical spark sent down the wire contained in the tube G L. By means of the above described apparatus the mutual combustion of these two gases may be continued for a long time, as the operator has the power of supplying them to the balloon from their reservoirs, in proportion as they are consumed *. It appears from the most accurate experiments, that 100 parts of water contain 85 parts of oxygen and 15 of hydrogen by weight.

* In a future number we shall give a plate of the apparatus contrived by Dr. Higgins for the same purpose.

XIII. *De-*

XIII. *Description of the Apparatus contrived by Mr.* CAVALLO *for containing Gas of any Kind, and transferring it to Bottles, Bladders, &c.*

FIG. 6, Plate X, shews a section of the vessel A, which may be of glass or tin; B, a funnel, into which is fastened a bent glass tube C; D, is a tube soldered to the funnel, and which with it passes through the cork *a*; E, represents a tube of tin, wood, or other materials, to one end of which a bladder or oiled silk bag is fastened; the other is inserted in the tube D.

The vessel A being filled with the required gas *, whenever it may be necessary to transfer any quantity to a bottle, bladder, &c. an equal quantity of water is to be poured through the funnel B, which will displace the gas, and force it through D into E.

The bent part of the tube C, by always containing some water, prevents the gas from escaping through the funnel; but when the apparatus is to be set by, both the funnel, and the tube D, must be close stopped with corks.

XIV. *Cursory View of some of the late Discoveries in Science.*

[Continued from the last Number, p. 212.]

SENSIBILITY OF PLANTS.

THE cause of this sensibility is still little known. The following is the explanation given of it by Lamark †: "In my opinion, there exist in the articulations of many

* This is done by taking out the cork with the funnel, &c. filling the vessel with water, and inverting it with its opening under water. Thus, if a tube leading from the apparatus whence the gas is produced, be brought under the mouth of the vessel, the gas will ascend and displace the water till it be full.

† *Memoires de Physique*, p. 288.

 plants,

plants, and in certain parts of them, particular veſicles which, eſpecially in warm weather, become filled with elaſtic and very ſubtle excretory vapours. Theſe vapours, which are accumulated and retained to a certain degree in the veſicles, ſwell them out, and make them produce an extenſion in all the moveable parts where they are ſituated; but on the leaſt ſhock or agitation the elaſtic and ſubtle vapours which fill theſe veſicles eſcape, and are exhaled into the atmoſphere. The veſicles being then emptied ſhrink; and the vegetable part, which is not preſerved in its extended ſtate, ſhrinks alſo, and falls back into the articulation where the veſicle was placed. Soon after the veſicle becomes filled again, though in an inſenſible manner, and ſtill produces an extenſion of the leaf-ſtalk or petiole, which a cauſe like the former may deſtroy.

"In the *hedyſarum gyrans*, the veſicles of the bottom of the ſmall leaves being filled to a certain degree, then empty themſelves inſenſibly, become filled again as before, and re-empty themſelves in the like manner, without any other determining cauſe than the effect of their plenitude. But this continued alternation of repletion and evacuation keeps in conſtant movement the ſmall leaves of the plant, which, when the weather is warm, riſe and fall alternately, but in a ſlow manner."

Shade, or the abſence of light, by the coolneſs reſulting from it, cauſes that evacuation or ſhrinking of the veſicles juſt mentioned. Hence the cloſing up in the evening of certain parts of plants, eſpecially of the leguminous families, to which botaniſts have given the name of *their ſleep*.

It is by theſe cauſes, or others analogous, that all the movements of theſe plants ought to be explained. A great number of plants experience particular movements in the ſexual parts at the time of their fecundation. Theſe movements muſt be produced by the *aura ſeminalis* *.

IRRITA-

* It may not, perhaps, be improper to take notice here of the following curious circumſtance reſpecting a *conferva* never before found in France, and

IRRITABILITY OF THE ANIMAL FIBRE.

Notwithſtanding the many reſearches made reſpecting the cauſe of this irritability, much is ſtill wanting. Girtanner aſcribes it chiefly to oxygen: but the proofs which he gives in ſupport of his opinion do not appear ſatisfactory; ſince the air does not ſeem to have a direct influence on the irritability of the heart. For example, if the vein of an animal be opened, and if a bubble of vital air or oxygen gas can be introduced into it, by means of a ſmall tube, as ſoon as the air reaches the heart the animal ſends forth a cry of pain and expires. Bichet, who made this experiment *, repeated it with atmoſpheric air, azot, hydrogen, and the carbonic acid gas, and the animal periſhed in the like manner; but cold water injected into a vein does not produce the like effect. Bichet concludes, that the death of the animal is occaſioned by the interception of the air between the columns of the arterial and venal blood. But, in this caſe, we may reſt aſſured that oxygen gas deſtroys the animal.

Dr. Menzies obſerved, that the irritability of the heart preſerved itſelf longer in animals ſtrangled or drowned than in thoſe which periſhed in gas. He thence concludes, that the particular ſtate which the blood acquires in paſſing through the lungs, and which gives it thoſe ſenſible qualities that

and the ſame repreſented by Muller in his *Flora Danica*, under the name of *conferva jugalis*, which was communicated, not long ago, to the Philomatic Society at Paris. Citizens Charles and Romain Coquebert having collected ſome of this *conferva*, in the neighbourhood of Paris, aſcertained by means of an excellent microſcope, conſtructed by Nairne and Blunt, that in this ſpecies there are male and female filaments, which unite by an actual copulation; that certain globules contained in the male filaments paſs into the interior part of the female filaments; and that by this union there are formed in the latter ſeeds, or, if we may uſe the expreſſion, ſmall *ova*, which reproduce the ſpecies. This is the firſt inſtance in the vegetable kingdom of a reproduction abſolutely analogous to that which we find among animals. EDIT.

* Société Philom. page 18.

distinguish the arterial from the venal blood, is not the real cause which gives play to the irritability of the heart, but that its action is particularly owing to the *effect of heat combined with humidity.*

Van Marum, Hildebrant, and other philosophers think that there is a real *irritability* in plants, and particularly in those which have spontaneous kinds of movement. It has thence been asserted, that oxygen has the same effect upon those plants called sensitive, such as the humble plant (*mimosa pudica*), the *hedysarum gyrans*, &c. as upon animals.

Peschier has made several experiments to ascertain whether this opinion was well founded; but oxygen never appeared to him to produce any effect upon these plants. He afterwards examined whether these movements of those plants called sensitive are owing to *real irritability*, like that of animals. The numerous experiments which he made on this subject gave him reason to conclude, that *no real irritability could be ascribed to these plants*, and that all the movements they experience, by the simple touch or otherwise, are merely mechanical; and indeed plants have neither nerves nor muscles, nor any organs analogous to those which, in animals, appear to be the seat of irritability.

This difference in the organization of animals and vegetables cannot be denied; but on the other hand it is equally certain, that what is called *irritability* in animals is owing to mechanical causes. The movement of the muscular fibre in animals is altogether as mechanical as the shrinking of a sprig of the sensitive plant when it is touched. That of the muscular fibre is owing to an efflux of the nervous fluid; that of the sensitive to the efflux of another fluid, which is as little known. But it may here perhaps be said, The animal fibre, such as the heart, is still irritable a long time after it has been separated from the rest of the body, which is not the case with the vegetable fibre. This is true: but it does not prove that it is not always a mechanical cause which acts in these circumstances; its action only is of longer duration;

duration; for, in whatever manner the action of this muscular fibre be considered, it cannot be moved but by physical causes. The question then will be, to discover what are these physical causes.

It appears very certain that the cause of muscular movement is owing to the nerves, since a part in which the nerves are palsied, or confined by a ligature, has no longer any movement. But how does the nerve move? Some philosophers have compared its movement to the oscillations of an extended cord which is struck: But, 1. The nerves are not extended: 2. They are enveloped on all sides; whereas the cord has no points of contact but at its two extremities.

It appears more probable to others to consider the nerve as one or more vessels constructed almost like the lymphatic vessels; that is to say, composed of a series of vesicles in which flows a fluid called the nervous fluid. I have supposed that this nervous fluid is of a nature analogous to that of the *aura seminalis*. Others have sought for the cause of irritability in electricity, and the experiments on Galvanism seem to give some weight to this opinion.

[*To be continued.*]

XV. *On the Effects of Oxygen in accelerating Germination. From the* Journal de Physique, 1798.

MR. HUMBOLDT discovered, in 1793, that simple metallic substances are unfavourable to the germination of plants, and that metallic oxydes favour it in proportion to their degree of oxydation. This discovery induced him to search for a substance with which oxygen might be so weakly combined as to be easily separated, and he made choice of oxygenated muriatic acid gas mixed with water. Cresses (*lepidium sativum*) in the oxygenated muriatic acid shewed germs at the end of six hours, and in common water at the end of 32 hours. The action of the first fluid on the vegetable fibres is announced by an enormous quantity of air bubbles which cover the seeds, a phenomenon not exhibited by water till at the end of from 30 to 45 minutes. These experiments announced in Humboldt's *Flora Subterranea Fribergensis*, and in his Aphorisms on the chemical physiology of Plants, have been repeated by others *. They were made at a temperature of from 12 to 15 Reaumur. In the summer of 1796, Humboldt began a new series of experiments, and found that by joining the stimulus of caloric to that of oxygen he was enabled still more to accelerate the progress of vegetation. He took the seeds of garden cresses (*lepidium sativum*), peas (*pisum sativum*), French beans (*phaseolus vulgaris*), garden lettuce (*lactuca sativa*), mignonette (*reseda odorata*); equal quantities of which were thrown into pure water and the oxygenated muriatic acid at a temperature of 88° F. Cresses exhibited germs in three hours in the oxygenated muriatic acid, while none were seen in water till the end of 26 hours. In the muriatic, nitric † or sulphuric acid, pure or mixed with water, there was no germ at all: the oxygen seemed there to be too intimately united with bases of azot or sulphur, to be disengaged by the affinities presented by the fibres of the vegetable. The author announces that his discoveries may one day be of great benefit in the cultivation of plants. His experiments have been repeated with great industry and zeal by several distinguished

* See Uslar's Fragments of Phythology, Plenck's Physiology, Villdenow's Dendrology, and *Dictionnaire de Physique* par Gehler.

† The nitric acid, however, diluted with a great deal of water, accelerates germination also, according to the experiments of Candolle, a young naturalist, who has applied with great success to vegetable physiology. This phenomenon is the more interesting, as chemistry affords other analogies of the oxygenated muriatic acid and the nitric acid. Professor Pfaff, at Kiel, by pursuing Humboldt's experiments, has found that frogs suffocated in oxygenated muriatic acid gas increase in irritability, while those which perish in carbonic acid gas are less sensible of Galvanism.

philo-

philoſophers. Profeſſor Pohl at Dreſden cauſed to germinate in oxygenated muriatic acid the ſeed of a new kind of *euphorbia* taken from Bocconi's collection of dried plants, 110 or 120 years old. Jacquin and Vander Schott at Vienna threw into oxygenated muriatic acid all the old ſeeds which had been kept 20 or 30 years at the botanical garden, every attempt to produce vegetation in which had been fruitleſs, and the greater part of them were ſtimulated with ſucceſs. Even the hardeſt ſeeds yielded to this agent. Among thoſe which germinated were the yellow bonduc or nickar tree (*guilandina bonduc*), the pigeon cytiſus or pigeon pea (*cytiſus cajan*), the *dodonæa anguſtifolia*, the climbing mimoſa (*mimoſa ſcandens*), and new kinds of the *homæa*.—There are now ſhewn at Vienna very valuable plants which are entirely owing to the oxygenated muriatic acid, and which are at preſent from five to eight inches in height. Humboldt cauſed to germinate the *cluſia roſea*, the ſeeds of which had been brought from the Bahama iſlands by Booſe, and which before had reſiſted every effort to make them vegetate. For this purpoſe he employed a new proceſs, which ſeems likely to be much eaſier for gardeners who have not an opportunity of procuring the oxygenated muriatic acid: He formed a paſte by mixing the ſeeds with the black oxyde of manganeſe, and then poured over it the muriatic acid diluted with water. Three cubic inches of water were mixed with half a cubic inch of the muriatic acid. The veſſel which contains this mixture muſt be covered, but not cloſely ſhut; elſe it might readily burſt. At the temperature of 95° the muriatic acid becomes ſtrongly oxydated; the oxygenated muriatic gas which is diſengaged paſſes through the ſeeds; and it is during this paſſage that irritation of the vegetable fibres takes place.

XVI. *On the Invention of the Telegraph, with a Description of that proposed by Dr.* HOOKE.

THE idea of conveying intelligence by means of signals, both during the day and in the night-time, is of very great antiquity, as appears by the testimony of several ancient authors; and there is reason to believe that some sort of telegraph was in use even among the Greeks. The destruction of Troy was certainly known in Greece very soon after it took place, and before any person had returned from it. A Greek play begins with a scene, in which a watchman descends from the top of a tower in Greece, and gives information that Troy is taken: "I have been looking out these ten years," says he, "to see when that would happen, and this night it has been done." A night telegraph is also expressly mentioned by Polybius *, who in his tenth book gives a very circumstantial account in what manner the letters of the alphabet may be expressed by means of torches.

It does not appear, however, that this or any other method of the ancients was ever brought into general use, or that any of the moderns had thought of such a machine as the telegraph till the year 1663, when the Marquis of Worcester in his Century of Inventions affirmed, that "he had discovered a method by which, at a window, as far as the eye can discover black and white, a man might hold discourse with his correspondent without noise made, or notice taken; being according to occasion given or means afforded, *ex re nata*, and no need of provision before hand, though much better if foreseen, and course taken by mutual consent of parties." This could be effected only by a telegraph, which in the next sentence is declared to have been rendered so perfect, that by means of it the correspondence could be carried on "by night as well as by day, though as dark as pitch is black."

* Lib. x. cap. 40.

Forty

Forty years after, M. Amontons, an ingenious French mechanic, born at Paris in 1663, and who died in 1705 at the age of 42, propofed the following method: " Let there be people placed in feveral ftations, at fuch a diftance from one another, that by the help of a telefcope a man in one ftation may fee a fignal made in the next before him: he muft immediately make the fame fignal, that it may be feen by perfons in the ftation next after him, who are to communicate it to thofe in the following ftation, and fo on. Thefe fignals may be as letters of the alphabet, or as a cypher, underftood only by the two perfons who are in the diftant places, and not by thofe who make the fignals. The perfon in the fecond ftation making the fignal to the perfon in the third, the very moment he fees it in the firft, the news may be carried to the greateft diftance in as little time as is neceffary to make the fignals in the firft ftation. The diftance of the feveral ftations, which muft be as few as poffible, is meafured by the reach of a telefcope." Amontons tried this method on a fmall tract of land, before feveral perfons of the higheft rank at the court of France.

Whether the telegraph be a French invention, as that nation afferts *, or whether Amontons' plan for conveying intelligence was founded on the hint thrown out by the Marquis of Worcefter, we fhall not here examine; but it is certain that the idea of a telegraph, upon a fimilar conftruction to thofe ufed at prefent, was fuggefted by Dr. Hook towards the end

* In *Rapport general des Travaux de la Societé Philomatique*, p. 35, the author, fpeaking of the papers read before the fociety, fays: " Citizen Chappe has at different times given you an account of his experiments, and of the refult of thofe labours by which he has been able to bring the telegraph to its prefent degree of perfection. At firft his difcoveries were doubted, and foon after they were carried into execution it was pretended that traces of this invention were to be found in the works of feveral ancient authors. Experience, however, has already done juftice in regard to the firft affertion; time will do the fame in regard to the fecond; and *the glory of this invention will remain to its author, and to the nation to which he has had the honour of prefenting it.*"

of

of the laſt century, and that he gave the firſt complete deſcription of ſuch a machine, as appears by the following extract from a paper of his, read before the Royal Society on the 21ſt of May 1684*. "I propoſed (ſays he) ſome years ſince, a method of diſcourſing at a diſtance, not by ſound, but by ſight. I ſay that it is poſſible to convey intelligence from any one high and eminent place to any other that lies within ſight of it, though 30 or 40 miles diſtant, in as ſhort a time almoſt, as a man can write what he would have ſent; and as ſuddenly to receive an anſwer as he that receives it hath a mind to return it, or can write it down on paper. Nay, by the help of 3, 4, or more of ſuch eminent places, viſible to each other, lying next in a ſtraight-line, 'tis poſſible to convey intelligence almoſt in a moment, to twice, thrice, or more times that diſtance, with as great a certainty as by writing.

"For the performance of this, we muſt be beholden to a late invention, which we do not find any of the ancients knew; that is, the eye muſt be aſſiſted with teleſcopes, that whatever characters are expoſed at one ſtation, may be made plain and diſtinguiſhable at the other.

"1ſt, For the ſtations: if they be far diſtant, it will be neceſſary that they ſhould be high, and lie expoſed to the ſky, that there be no higher hill, or part of the earth beyond them, that may hinder the diſtinctneſs of the characters, which are to appear dark, the ſky beyond them appearing white. By which means, alſo, the vapours near the ground will be paſſed over and avoided.

"Next, in chuſing of theſe ſtations, care muſt be taken, as near as may be, that there be no hill that interpoſes between them, that is almoſt high enough to touch the viſible ray; becauſe, in ſuch caſes, the refraction of the air of that hill will be very apt to diſturb the clear appearance of the object.

† The whole paper may be ſeen in "Philoſophical Experiments and Obſervations of the late eminent Dr. Robert Hooke," publiſhed by Mr. Derham. London, 1726.

"The

"The ſtations being found convenient, the next thing to be conſidered, is, what teleſcopes will be neceſſary for each ſtation. One of theſe teleſcopes muſt be fixed at each extreme ſtation, and two of them in each intermediate; ſo that a man, for each glaſs, ſitting and looking through them, may plainly diſcover what is done in the next adjoining ſtation; and with his pen write down on paper the characters there expoſed, in their due order; ſo that there ought to be two perſons at each extreme ſtation, and three at each intermediate; that, at the ſame time, intelligence may be conveyed forwards and backwards.

"Next, there muſt be certain times agreed on, when the correſpondents are to expect; or elſe there muſt be ſet at the top of the pole, in the morning, the hour appointed by either of the correſpondents for acting that day.

"Next, there muſt be a convenient *apparatus* of characters, at leaſt, as many diſtinct characters as there are neceſſary letters in the alphabet made uſe of, (as is expreſſed in Plate X. fig. 5.) And thoſe muſt be either day characters, or night characters: if they are to be made uſe of in the day time, they may all be made of deals, and of bigneſs convenient for the ſeveral diſtances. Any one of which characters may ſignify any one letter of the alphabet, and the whole alphabet may be varied 10,000 ways; ſo that none but the two extreme correſpondents ſhall be able to diſcover the information conveyed. If the characters are for the night, then they may be made with links or other lights, diſpoſed in a certain order, which may be covered and uncovered according to the method agreed on. There will be alſo requiſite ſeveral other characters, which may, for expedition, expreſs a whole ſentence; ſuch as, 'I am ready to communicate,' 'I am ready to obſerve,' &c.

"I could inſtance a hundred ways of facilitating the method of performing this deſign with the more dexterity and quickneſs, and with little charge; but that, I think, will be needleſs at preſent, ſince, whenſoever ſuch a way of correſpondence

ſhall

ſhall be put into practice, thoſe, and many more than I can think of at preſent, will of themſelves occur; ſo that I do not in the leaſt doubt, but that with a little practice, all things may be made ſo convenient, that the ſame character may be ſeen at Paris within a minute after it hath been expoſed at London; and that the characters may be expoſed ſo quick after one another, that a compoſer ſhall not much exceed the expoſer in ſwiftneſs; and this not only at the diſtance of one ſtation, but of a hundred; for, ſuppoſing all things ready at all thoſe ſeveral ſtations for obſerving and expoſing, as faſt as the ſecond obſerver doth read the characters of the firſt expoſer, the ſecond expoſer will diſplay them to the obſerver of the third ſtation, whoſe expoſer will likewiſe diſplay them for the fourth obſerver, as faſt as his obſerver doth name them to him, or write them down.

"There may be many objections brought againſt this way of communication, becauſe it has not yet been put in practice; but hardly any that may not be eaſily anſwered and obviated." Dr. Hook illuſtrates his invention thus:

"Let A B C (Plate X. fig. 4.) repreſent three very long maſts or poles erected; E, the top-piece, that joins them all together; D, a ſcreen, behind which all the deal-board characters hang upon certain rods or lines, and may, by the help of ſmall lines connected with each of them, be expoſed at F, or drawn back again behind D, as occaſion ſhall require."

XVII. *Propoſitions reſpecting the Mechanical Power of the Wedge, by Mr.* Peter Nicholson *of Newman-ſtreet. Communicated by the Author.*

WRITERS on mechanics, in treating of the wedge, have frequently drawn falſe concluſions reſpecting the proportion which exiſts between the impelling power applied to the head, and the reſiſting powers oppoſed to the ſides; and

thoſe

thoſe concluſions have reſulted from falſe opinions concerning the directions of the reſiſting powers.

It is evident, that when wood or other ſubſtance is ſplit by a wedge which does not fill the cleft, that is, when the angle of the cleft is more acute than that of the wedge, the power or action of each ſide of the wedge, equal and oppoſite to the reſiſtance of the cleft, muſt be reſolved into two; the one in the direction of the ſide of the cleft, which tends to thruſt it forward; and the other perpendicular to that direction, which tends to tear it aſunder. It is by not attending to the above reſolution that writers on this ſubject have been led into miſtakes; for, inſtead of conſidering the powers which act in thoſe two directions, they have imagined a ſingle power only as acting obliquely on each ſide. But if the ſides of the wedge are perfectly poliſhed, as we muſt here conſider them, no ſingle permanent power can be applied to impel any one of them, unleſs its direction be perpendicular to the plane of the ſide to which it is applied: therefore two oblique powers, applied on oppoſite ſides of the ſame point, are at leaſt neceſſary to ſuſtain each other and the action of the plane; and in the caſe of the wedge above mentioned, the directions of thoſe two oblique powers will always be perpendicular to each other, as will appear obvious from the two following propoſitions.

PROP. I. Let ABC (Fig. 3, Plate X.) be a vertical ſection paſſing through the centre and at right angles to the head and ſides of any iſoſceles wedge; alſo in the plane of this ſection, and at right angles to its ſides AB, BC, and CA, let three powers be applied, ſuch, that their directions may all mutually interſect in the axis, and their efforts ſuſtain the wedge in equilibrio; I ſay, that theſe three powers are as AB, BC, and CA reſpectively.

Let LM, KI, ED be the directions of theſe three powers, which produced, interſect each other and the axis in O. Since, by hypotheſis, theſe three powers directed to the ſame point are in equilibrio, and the three ſides of the triangle ABC are at right angles to their directions; therefore, by a well

well known ftatical principle, the intenfities of thefe powers are as AB, BC, and CA refpectively.

Prop. II. When an impelling power applied to the head of an ifofceles wedge is in equilibrio with the refifting power of a cleft, the angle of which is more acute than that of the wedge inferted, then univerfally,

The impelling power applied to the head,
The action of the wedge on either fide of the cleft,
The part thereof which tends to thruft it forward,
And the remaining part, which tends to tear it afunder,

Are

As twice the fine of half the vertical angle of the wedge,
The radius,
The fine of the angle contained by the fides of the wedge and cleft,
And the co-fine of that angle refpectively, the fame radius being common.

Let Fig. 2, Plate X. reprefent a vertical fection of the wedge and cleft, fimilar in pofition to that defcribed in Propofition 1; alfo let the two fides of the cleft DH, DH be equal, and in contact with the fides of the wedge AC, AC at equal diftances DC, DC from the vertex C, in which cafe the fides of the wedge make equal angles with thofe of the cleft. Through either point D, draw DF at right angles, and equal to AC; alfo through D, draw DE, at right angles to DH, and complete the parallelogram DEFG. Then by Propofition 1, the line AA reprefents in quantity the impelling power applied to the head, and the line DF reprefents in quantity and direction the whole action of the fide of the wedge on that of the cleft, which by hypothefis is balanced by its refiftance; but the power DF is refolved into two, reprefented in quantity and direction by DG, DE refpectively: the one, being in the direction of the cleft, tends to thruft it forward; and the other, being at right angles thereto, tends to tear it afunder.

Therefore the powers mentioned in the Propofition are as AA, DF, DG and DE refpectively; but AC = DF being radius, thefe lines are refpectively equal to

Twice

Twice the fine of half the vertical angle of the wedge,

The radius,

The fine of the angle contained by the fides of the wedge and cleft,

And the co-fine of that angle. Hence the propofition is manifeft.

XVIII. *Report of the Commiffioners appointed by the National Inftitute to repeat the Experiments which have been made on Galvanifm: read in the Name of the Commiffion by Cit.* HALLE. *From the* Bulletin des Sciences, par la Société Philomathique, Thermidor, An VI.

THE commiffion was not fatisfied with repeating a great part of the experiments already made: they claffed them, and rendered them complete by the addition of others which were wanting.

I. The phenomenon of Galvanifm, taken in general, is as follows: A communication is eftablifhed between two points of a feries of nervous or mufcular organs by means of certain determined fubftances. At the moment when this communication is made, there take place in the ftate of the organs changes, the nature of which is ftill unknown; but which are manifefted by fenfations more or lefs lively, or contractions more or lefs violent. Thefe mufcular contractions take place even in feparated parts of the body, and with as much force as when produced by the moft effectual means of irritation. The feries of mufcular or nervous organs is called the *animal arc;* the other fubftances form the *exciting arc.* The compofition of both may be varied many different ways.

II. Among the effects refulting from the different compofitions of the animal arc, the following are the moft remarkable: A ligature made on a nerve does not intercept Galvanifm, unlefs it be made in the part furrounded with flefh. If the nerve

nerve be cut, and its two ends be in contact, Galvanism takes place; but if they are only brought near to each other, without contact, it is intercepted.

III. Among the effects resulting from the different compositions of the exciting arc, we shall remark the following: The most favourable composition is when it consists of three pieces, each of which is a different metal. One must touch the nerve, and the other the muscle: these are called the *supports*, or *armatures*. The third forms the communication. This is called the *communicator*. But one or two of these may be omitted. Animal bodies, or water, may be placed between them; or other substances, either metallic combinations, or all other metals, &c. may be substituted in their stead. It has not yet been possible to determine exactly what are the most ineffectual combinations; but they have been already classed to a certain point, according to the degree of their efficacy. Gold, silver, zinc and tin, are the metals most favourable to Galvanism, when introduced into the exciting arc.

In general a single metal does not act, except when all other circumstances are favourable; but in that case it has been often seen to act. Error, however, may readily here arise; for, if one of the ends of the arc be alloyed, in a proportion ever so little different, the arc acts as if there were two metals. By rubbing one end with a different metal, sometimes even with the fingers, or by breathing upon it, efficacy may be communicated to it, under circumstances where it would not otherwise have possessed any.

Oxydes act less efficaciously, *cæteris paribus*, than their metals. Dry carbon acts as an actual metal. It is not intercepted by water and moist substances, nor by the fingers if wet; but this is not the case if the fingers be dry. The energy of Galvanism is not intercepted or diminished by pieces of dead flesh. The effects of it are sensibly checked by the epidermis; and they are incomparably greater in flayed

flayed animals, or in parts of the human body from which the epidermis has been removed.

It cannot be ſaid that Galvaniſm is intercepted by all idio-electric bodies; but, on the other hand, it is intercepted by all ſubſtances which are ſtrong conductors of electricity. Such are flame, very dry animal bones, the ſteam of water, glaſs brought to a red heat, &c.

IV. Galvaniſm is influenced alſo by ſeveral circumſtances foreign to the compoſition of the two arcs. Such as, 1. The ſtate of the parts which are ſubjected to the operation: the freſher they are, the ſtronger are the effects. 2. The longer or ſhorter exerciſe of Galvaniſm: ſuſceptibility of Galvaniſm is in general excited by exerciſing it; is exhauſted by continuance, and renewed by repoſe. 3. The ſucceſſion of various experiments. A diſpoſition of metals which at firſt had been ineffectual, has become effectual after a different diſpoſition. Two uncertain experiments are hurtful to each other, and become ſtill more ſo if made in ſucceſſion. 4. The ſtate of the atmoſphere. The atmoſphere electric; the animal on which the operation is performed charged and inſulated, the effect is the ſame. The whole apparatus placed under water, the effect remains the ſame.

V. There are various artificial means to weaken or revive the ſuſceptibility of Galvaniſm. Thus, a frog exhauſted and brought near to a charged electrophorus reſumed its ſuſceptibility. Alcohol, on the other hand, weakens and even extinguiſhes it ſo as never to return. Potaſh produces the ſame effect, only ſlowly. According to M. de Humboldt, this ſuſceptibility is in many caſes reſtored by oxygenated muriatic acid gas. The commiſſioners did not obſerve this circumſtance; but they propoſe to reſume the ſubject, and to repeat ſeveral other experiments of that learned philoſopher.

They have already repeated thoſe on the action of Galvaniſm on the heart, and have obſerved, as he did, that its action is the ſame as on the voluntary muſcles, and that it accelerates their movement.

XIX. *Of an Attempt to make the Maple Sugar above an hundred Years ago. Communicated by Dr.* THORNTON, *Lecturer on Medical Botany at Guy's Hospital, &c.*

IT appears, by the following correspondence between Dr. Robinson and Mr. Ray, that the property of the American maple of yielding a saccharine juice was known above a century ago, and that attempts were even made to produce sugar from it:

Dr. ROBINSON *to Mr.* RAY.

"Dear Sir, *London, March* 10, 1684.

"I have enclosed you some sugar of the first boiling got from the juice of the wounded maple: Mr. Ashton, Secretary to the Royal Society, presented it to me. 'Twas sent from Canada, where the natives prepare it from the said juice; eight pints yielding commonly a pound of sugar. The Indians have practised it time out of mind; the French begin now to refine it, and to turn it to much advantage. If you have any of these trees by you, could you not make the rial, proceeding as with the sugar cane?"

Answer to Dr. ROBINSON.

"*Black Netley, April* 1, 1684.

"Yours of the 10th instant I received, and therein an enclosed specimen of the Canada sugar, a thing to me strange and before unheard of. It were well worth the experiment you mention. I therefore engaged a friend and neighbour of mine, an ingenious apothecary, whom I employed yesterday to boil the juice of the greater maple, a tree which grows freely half a mile off from my residence. Having made an extract, he found a whitish substance, like to brown sugar, and tasting very sweet, immersed in a substance of the colour and consistency of molosses. Upon curing, I have no doubt it will make perfect sugar. When it is cured, I will give you a farther account of it."

Here

Here the matter ended; and after the paper given you on the American maple (see p. 182), I hope the subject will be again pursued with ardour in this country, and this curious investigation turn of profit to this nation.—I shall send you, for your next number, a paper on the mulberry tree, and the rearing of silk-worms.

INTELLIGENCE.

LEARNED SOCIETIES.

DENMARK.

THE Royal Society of Copenhagen has this year proposed a gold medal, value 100 rix-dollars, for the best answer to each of the following questions.

I. HISTORY.

Quænam gentes ante Norvægicos Americam invenerint, et itinera per mare in hanc terræ regionem instituerint? Quousque detecta Norvægicorum in America præsertim Austrum versus extensa fuerint? Quæ hac de re constitui poterunt, argumentis et conjecturis ex scriptis, monumentisve, v. c. munimentis, ædificiis, linguis, traditionibus Americanis probanda sunt.

" What nations discovered America, and kept up an in-" tercourse by sea with that country before the Norwegians? " How far did the discoveries of the Norwegians in America " extend towards the South? The proofs and grounds of " conjecture must be drawn partly from written documents " and partly from monuments, such as fortifications, edi-" fices, languages and traditions still existing in America."

II. IN THE MATHEMATICS.

Invenire functionem omnium quantitatum quæ conjunctim determinant magnitudinem effectus calorifici, cujuscunque materiæ igni accipiendo aptæ in re familiari usitatæ, tam ligni, quam cespitis caminarii et lithantracis, seu carbonum fossilium cujuscunque speciei.

Æquatio quæſita ad minimum determinanda eſt pro quatuor diverſis caſibus. 1*mo*, Si lignum vel ceſpes caminarius ſeu carbones foſſiles in fornace deuruntur, ut ſpatium aëris incluſum, e. gr. cubiculi calefieri poſſit. 2*do*, Si in foco fluido cuicunque coquendo inſervient. 3*tio*, Si materiæ molli indurandæ, e. gr. in camino laterario lateribus coquendis. 4*to*, Si materiis duris liquefaciendis, e. gr. metallis ſive in clibano ſive in uſtrina fundendis inſervient.

Singulæ æquationes experientia duce ita analyſis ope detegendæ et inſtituendæ ſunt, ut ex ipſis computari poſſit ratio effectus calorifici æque ac uſus œconomici cujuſcunque ſpeciei ligni, ceſpitis caminarii et carbonum foſſilium.

"To diſcover the functions of all thoſe quantities which "conjointly determine the degree of the effect of heat pro- "duced by every combuſtible ſubſtance employed for econo- "mical purpoſes, whether wood, turf, foſſil, or pit-coal of "whatever ſpecies.

"The required equation muſt be determined for four "different caſes. 1*ſt*, When the wood, turf, or pit-coal is "burnt in a ſtove, that the incloſed quantity of air, for "example of a chamber, may be ſufficiently heated. 2*dly*, "When they are employed as fuel for boiling any liquid. "3*dly*, When they are employed for hardening any ſoft "ſubſtance, for example, in a brick-kiln for baking bricks. "4*thly*, When employed for melting hard ſubſtances, ſuch, "for example, as fuſing metals either in an eſſaying furnace "or a melting furnace.

"Each of theſe equations muſt be ſo deduced from ex- "periment, by the help of analyſis, that they may ſerve for "computing the ratio of the effects of the heat and the "economical advantages of each ſpecies of wood, turf, and "pit-coal."

III. IN PHYSICS.

Experimentis invenire maximum caloris gradum quem calefacti vapores aquei cum aliis corporibus communicare poſſunt? An ea pars aquæ in olla Papiniana, quæ non in

vapores

vapores calore mutata eſt majorem, quam 212° Fahren. temperaturam habere poteſt?

"To determine, by experiments, what is the higheſt de-"gree of heat which can be communicated to other bodies "by the ſteam of water? Can that part of the water in "Papin's digeſter which is not in the form of vapour ac-"quire a higher degree of heat than 212° of Fahrenheit?"

IV. IN PHILOSOPHY.

Quinam ſunt notabiliores gradus per quos philoſophia practica, ex quo tempore ſyſtematice tractari cœpit, in eum, quem hodie obtinet, ſtatum pervenerit?

"What are the moſt remarkable ſteps in the progreſs "which practical philoſophy has made, from the time it was "brought into a regular ſyſtem down to the preſent period?"

The anſwers to theſe queſtions muſt be tranſmitted, poſt paid, before the end of June 1799, to Profeſſor Abildgaard, ſecretary to the ſociety. All men of letters, the members of the ſociety alone excepted, are invited to this competition, and their anſwers may be written in Daniſh, German, French or Latin. The authors are requeſted not to inſert their names in the title of the papers, but to diſtinguiſh them by a motto, which muſt be inſcribed alſo on a ſealed note containing their name and place of reſidence.

SPAIN.

The Royal Academy of Practical Medicine at Barcelona has propoſed the following queſtion as the ſubject of a prize:

To determine whether cold baths, adminiſtered as a preſervative or as a remedy to thoſe attacked with diſorders of the breaſt, are uſeful or prejudicial; and what may be their effects and advantages according to circumſtances?

The prize will be a gold medal, value 375 rials; and the memoirs muſt be tranſmitted, with the uſual formalities, to the ſecretary of the academy, in the courſe of the month of October 1799.

NEW AGRICULTURAL SOCIETY.

A Society for promoting agriculture and manufactures has lately been eſtabliſhed in Finland. It will publiſh its tranſactions monthly, a thouſand copies of which are to be printed in the Finniſh, and a thouſand in the Swediſh language.

FRANCE.

The following prize queſtions were propoſed by the French National Inſtitute of the Arts and Sciences, in the public ſitting of Meſſidor 15th, year VI.

GEOGRAPHY.

To determine what are the grand revolutions which have taken place on the globe, and which are either indicated or proved by hiſtory?

The prize will be a gold medal of the weight of five hectogrammes, and will be adjudged in the public ſitting of the 15th of Nivoſe, in the year VIII.

MORAL SCIENCE.

The Claſs of the Moral and Political Sciences had propoſed, for the ſubject of a prize for the year VII, the following queſtion:

What are the inſtitutions beſt calculated to found the morals of a people?

The eſſays tranſmitted on this ſubject not having anſwered the required conditions, the claſs propoſes the ſame ſubject again, and in the public ſitting of Vendemiaire the 15th, in the year VII, will publiſh in a new programme ſome illuſtrations of this important queſtion. The prize will be five hectogrammes of gold ſtruck into a medal, which will be adjudged in the public ſitting of Nivoſe the 15th, in the year VIII. No anſwers will be received after the 15th of Vendemiaire, the ſame year.

CLASS

CLASS OF THE MATHEMATICAL AND PHYSICAL SCIENCES.

PHYSICS.

This clafs had propofed, in the year IV, as the fubject of a prize to be adjudged in the public fitting of Vendemiaire of the year VII, the ufes of the liver in the different claffes of animals. This fubject fo important, which the academy of fciences had propofed in 1792, and which the Inftitute thought it its duty to continue to hold forth to the examination of the learned, was not treated in the manner it expected. It received only one memoir, in which the queftion was not in the fmalleft degree illuftrated; and of which the author had wandered into the wide field of the ancient hypothefes, without availing himfelf of the anatomical and chemical refources pointed out by the Inftitute in its programme.

This paucity of memoirs, on a fubject which concerns one of the nobleft and moft ufeful branches of phyfics, induced the Inftitute to fuppofe that the magnitude and extent of the queftion; the feries of the refearches neceffary for treating it in a proper manner; and above all, the difficulty of finding united in one man the chemical and anatomical knowledge requifite for folving it, were the caufes which had deterred competitors from coming forwards. Without abandoning the idea of prefenting to the zeal of philofophers a queftion of fo much importance, the Inftitute has thought proper to divide it into two branches, and to make it the fubject of two prizes, by adding to the medal which was to have been adjudged in the year VII, for the whole queftion, that which it has at its difpofal for the prefent year. It propofes, therefore, as the fubject of two prizes, to determine the functions of the liver, feparating what relates to the anatomical ftructure of the hepatic fyftem, from what relates to the chemical examination of the liquids and folids belonging to that fyftem.

The object of the firft of thefe prizes will be: the form, fituation, fize, comparative weight, and defcription of the tissue of the vessels, ducts and appendages of the liver, considered in the principal classes of animals, from man down to insects, moluscæ and worms.

The object of the second will be: an analysis of the hepatic or cystic bile in the different classes of animals as above mentioned.

The memoirs of those who intend to be candidates for one or other of these prizes or for the whole in one essay, must be transmitted, post paid, to the secretary of the class of the mathematical and physical sciences, before the first of Nivose in the year VIII.

The prize for each question will be a gold medal of the weight of a kilogramme; and will be adjudged in the sitting of Germinal 15th, in the year VIII. The memoirs may be written in French or in Latin, or in whatever language the authors choose.

Notice of the Labours of the Class of the Physical Sciences during the preceding three Months. By Cit. LASSUS, *Secretary.* Read on the 15th Messidor (July 3d.)

In the class of the Physical Sciences during the last three months, several memoirs were read relating to chemistry, natural history, rural œconomy and medicine, as applicable to animals as well as man. Cit. Guyton, in treating of the anomalies in affinities, shewed that these apparent deviations open to chemists a vast field for new researches. He examined why there is no combination between the azot and oxygen which exist so abundantly in the atmosphere, and in a state of expansion generally so favourable to an union. He likewise pointed out the means of producing it in an apparatus capable of supporting nine or ten times the weight of the atmosphere.

The same chemist employed himself also in the reciprocal decomposition of salts, at a temperature below freezing; a phenomenon, the observation of which is of so much importance

portance in ſalt works. He diſcovered the cauſe of it in the diſengagement of caloric, which becomes a diſaggregative power. Since chemiſts have extended their reſearches to the matter of heat, it is well known that carbon is one of the weakeſt conductors of it. Pyrometrical experiments have proved to Cit. Guyton, that a body encloſed in carbon does not receive from the ſame fire but two thirds of the heat received by a ſimilar body placed in ſiliceous ſand. The conſequences to be drawn from this fact will ſerve to improve the proceſſes employed in reduction and fuſion.

Chemiſts have hitherto been checked in many of their experiments, by not being able to increaſe the intenſity of fire. The application of an hydraulic principle to the conſtruction of Macquer's furnace, furniſhed Cit. Guyton with the means of increaſing heat to ſuch a degree, that a crucible of platina began to melt; a circumſtance never before obſerved.

Profeſſor Klaproth, at Berlin, had announced that the colouring matter of the emerald was iron; but the laſt analyſes of Cit. Vauquelin prove that the emerald is compoſed of ſiliceous alumine, a particular earth which has been called glucine, and the calx or oxyde of chrome; ſo that the emerald as well as the beryl or aigue-marine are two ſtones perfectly ſimilar, and compoſed of the ſame principles, the colouring matter excepted. (See p. 204.)

By an accurate application of chemical knowledge to the art of dyeing, Cit. Chaptal has diſcovered a ſimple and eaſy proceſs for communicating to cotton a darker or lighter chamoy yellow *(jaune chamois)*. By uniting alumine to the oxyde of iron, this chemiſt has been able above all to give to his colours a ſoft and velvety appearance, which they can never acquire when that oxyde is employed alone. He has examined the different methods of combining that oxyde with the red of madder, to form a violet colour, and has reduced to ſimple principles, operations which were exceedingly complicated. He has ſhewn the reaſons why no other aſtringents, whatever be the doſe employed, can be ſubſtituted for gall-nuts in dyeing cotton.

To give to the ſame ſtuffs that beautiful red colour, known under the name of the Turkiſh or Adrianople red, dyers employ ſoda, oil, gall-nuts, ſumach, madder, the ſulphate of alumine, and ſeveral other ſubſtances. Cit. Chaptal has examined what is the action of the three principal mordants, oil, gall-nuts, and alum, employed in dyeing cotton; and by deſcribing the moſt complex and obſcure operations in dyeing, he has ſhewn what chemiſtry can do towards improving the arts, when the practice of it is directed by a ſimple and clear theory *.

The employment of ſoda is not confined to the dyeing of cotton; that brought from Spain is of great uſe alſo in ſoap manufactories, glaſs-houſes for making white glaſs, and in bleaching. As France expends annually the ſum of four millions for that foreign article, it was of importance to encourage the cultivation of the plant which furniſhes the ſoda of Alicant. In this reſpect Cit. Chaptal and Teſſier have been of great ſervice: the firſt, in proving by the experience of many years, that the plant which furniſhes the ſoda of Alicant may be ſucceſsfully cultivated on the ſouthern coaſts of France; and that the ſoda it produces is abſolutely of the ſame quality as that of Spain; and the ſecond, by giving all the neceſſary inſtructions reſpecting the cultivation, and burning of the plant in order to convert it into ſoda.

Some years ago Cit. Clouet, a member of the Inſtitute, had ſhewn the poſſibility of converting iron into caſt ſteel, without having recourſe to previous cementation. This proceſs, which he has brought to perfection, is the more valuable to the arts which require caſt ſteel, as it may be produced without cementation or natural ſteel in every place where there is good iron, a mixture of alumine and ſiliceous earth, and chalk.

It is well known that the goodneſs of artillery depends, in an eſſential manner, on the operations which relate to the mixture and fuſion of the metal. Tin, which forms a part

* See Chaptal's Paper on this ſubject, page 274.

of

of its compoſition, is expoſed ſometimes to ſo great heat while the piece is uſed, that it becomes fuſed, which gradually renders the cannon defective. To remedy this inconvenience, Cit. Baumé propoſes to harden the copper with nickel, or with what was formerly called regulus of antimony, neither of them being ſo fuſible as tin.

Experiments made at Rambouillet, and in different parts of France, have already ſhewn the poſſibility of propagating and preſerving in all their purity ſheep of the Spaniſh breed. Cit. Gilbert has communicated on this important point of rural economy the fulleſt inſtructions, and given the beſt founded hopes that theſe valuable animals may be reared in the territorities of the republic, without ever degenerating.

The conqueſts of our army of the North, by augmenting the riches of the Muſeum of Natural Hiſtory at Paris, have given Cit. Lamarck an opportunity of pointing out with preciſion the diſtinctive characteriſing marks of the common cuttle fiſh (*ſepia officinalis*), the calmar or ſea ſleeve (*ſepia loligo*), and poulpe or eight armed cuttle (*ſepia octopus*), which had been confounded and claſſed in one genus. He has rectified an error received among ſome naturaliſts, who conſidered as the animal which forms the argonauta or paper ſailor, a poulpe which is accuſtomed to lodge itſelf in that ſhell, in the ſame manner as the crab called the hermit takes up its lodging in different kinds of ſhells.

Cit. Cuvier, in a very long memoir on the organs of the voice, ſhews that the greater part of birds, independently of the inferior glottis, which is the principal organ of their voice, have a ſuperior larynx, by which mechaniſm they are the more enabled to vary their tones, as by its means they can more eaſily change the ſtate of their glottis, the length of their trachea, and the aperture of their upper larynx. It reſults from this organiſation, that the graveſt tones, and the harmonics of theſe tones, are produced by a prolongation of the tracheal artery and the greateſt relaxation of the glottis; while by a ſhortening of the trachea, and a contrac-

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tion of the glottis, the bird produces tones ſo much higher as the trachea is ſhorter, and all the harmonics beſides which correſpond to that degree of contraction.

Obſervations which confirm the utility of the muriate of mercurius dulcis in the cure of the ſmall pox, by Cit. Deſeſſarts, as well as the profound reſearches of Cit. Huzard on a malady which affects the organs of generation in horſes, engaged likewiſe the attention of the claſs.

Several of its members have made it their particular care to confirm, by repeated experiments, the phenomena of Galvaniſm. (See Report of the Commiſſion appointed to examine this phenomenon, p. 319.)

PRODUCTION OF SOUNDS BY DIFFERENT GASES.

J. F. Jacquin, profeſſor of chemiſtry at Vienna, in a letter to M. Delametherie, gives the following account of ſome curious experiments which he made lately on this ſubject: " Profeſſor Chladni at Wittemberg, already celebrated by ſeveral diſcoveries in the theory of the phenomena of ſound, induced me, during his reſidence at Vienna, to make experiments on the property of different gaſes conſidered as ſonorous bodies; and particularly on that gas which conſtitutes our atmoſphere, and ſerves as the organ of voice. We took a glaſs bell furniſhed at the top with a braſs cock, ſuch as that uſed for filling bladders with gas, and made the internal aperture of the cock to communicate with a ſmall tin flute, about ſix inches in length. This bell being placed in the pneumatic tub, and filled with gas of any kind, a bladder with a cock, and filled with the ſame gas as the bell, was fitted to the cock of the bell, and by preſſing the bladder gently the flute was made to ſound. Comparative experiments were repeated in this manner with atmoſpheric air, oxygen gas, hydrogen, the carbonic acid, and nitrous gas. The ſtrength of the ſound was always the ſame: but, compared with that in atmoſpheric air, the oxygen gas gave half a tone lower; azotic gas, prepared different ways, gave almoſt always a ſemi-tone lower; hydrogen gas gave nine or eleven tones higher; the carbonic acid gas a third lower; and the nitrous gas almoſt the ſame: a mixture of oxygen gas and azotic gas, in the proportion of atmoſpheric air, gave again the tone of the laſt mentioned air, that is to ſay, a ſemi-tone higher than each of the compound gaſes alone. As long as the two gaſes were not uniformly mixed there was a frightful diſcord. Chladni has promiſed to publiſh a full account of theſe intereſting experiments, which differ entirely from thoſe of Dr. Prieſtley.

EXPERIMENTS ON ATMOSPHERIC AIR.

On the 14th inſtant, at 7 o'clock in the evening, Cit. Garnerin and Cit. Beauvais aſcended in a balloon from the garden d'Apollon, at Paris. At the height of nearly 400 toiſes Cit. Garnerin let fall a cage, attached to a parachute, and containing a cat, which fell very gently near the Port-au-Bled. After 20 minutes the balloon deſcended at Nanteuil, diſtant from Paris three leagues. At that place, Cit. Beauvais, aide-de-camp to General Moulins, quitted Cit. Garnerin, who departed at half paſt three in the morning to complete his aërial voyage, by taking a long flight. Cit. Frederic Humboldt, a celebrated philoſopher, had begged Cit. Garnerin to fill with air a ſmall flaſk with a ground ſtopper. Cit. Garnerin emptied the water which it contained at the height of 669 toiſes (1303 metres) above Paris. Cit. Beauvais brought back the bottle, filled with atmoſpheric air, to Cit. Humboldt, who was deſirous to know if the carbonic acid gas aſcends to ſuch elevated regions.

The obſervations of Sauſſure, made on the ſummit of Mount Blanc (at the height of 2.480 toiſes), announced its exiſtence there; but this philoſopher was in an atmoſphere modified by the proximity of rocks. Cit. Humboldt found in the air brought back by Cit. Beauvais, which had not been under the like influence, between 8 and 10 milliemes of carbonic air. Here then is a very heavy aëriform fluid carried to the moſt elevated regions of the atmoſphere.

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The air of Paris, collected on the following midnight, and analysed by means of the nitrous gas and sulfate of iron, was found to contain 0,276 of oxygen gas. The air collected by Cit. Garnerin contained only 0,259 of oxygen. The first was at 103 degrees, the second at 108 of the eudiometer. The air of the high regions was consequently 5 degrees, or 0,017 (almost equal to 0,02) more impure than the air at the earth's surface *. This difference is very considerable, when we reflect that the greatest or least purity of the atmosphere does not differ near the earth's surface but 0,03 of oxygen.

MINERALOGY.

Mr. DONALD STEWART, who has been employed for several years past as travelling mineralogist to the Dublin Society, has lately arrived at Belfast, after having passed over, in his last journey, the counties of Meath, Cavan, Fermanagh, Donegall, Derry, and Antrim. He had before explored the greatest part of the South and West of Ireland. He has made many new and curious observations, and collected numerous specimens, illustrating the natural history, and affording materials for the arts, manufactures, and agriculture of that kingdom.

Though not educated to those pursuits, he has been indefatigable in his researches, and successful in his discoveries; and indeed he appears to be the first person who ever attempted making any general survey of that island with a view to its mineralogy.

Some imperfect accounts of the native plants of Ireland have been published by Rutty, Wade, and some other gentlemen, who, during the residence of Lord Chesterfield as viceroy,

* It is easy to account for the atmosphere containing more oxygen near the earth than in the higher regions; the vegetables which grow on its surface being the principal agents employed by nature to restore the purity of the atmosphere: but it is not so easy to account for the presence of carbonic acid gas at so great a height. EDIT.

viceroy, formed a ſociety in Dublin under his patronage: but the mines are not deſcribed in their eſſays, nor are there any catalogues of their foſſile productions publiſhed.

Mr. Stewart has been upwards of twenty years engaged excluſively in this purſuit, and has already depoſited 1300 different mineral ſpecimens in the cabinet of the Dublin Society. But as few of his obſervations have hitherto been laid before the public, the following extract from his notes may prove acceptable to our readers:

"I was enabled," ſays Mr. Stewart, "by diſcovering rich quarries of limeſtone and marle, in ſeveral eſtates where they were never before known either to tenant or landlord, to be acceſſary to the fertilization of the moſt barren lands. In the eſtates of Lord Palmerſton and Ormby Jones, Eſq. in the county of Sligo, I afforded the greateſt pleaſure and advantage to the poor inhabitants, by demonſtrating to them that the great rocks, which they called Serpent Rocks, and which they were gazing at with ſtupid or ſuperſtitious admiration for ages, contained moſt excellent lime. Theſe quarries are at their doors; whereas formerly they carried the ſcanty pittance of lime they were able to procure from nine or ten miles diſtance. Having turf at home in abundance, they are now ſupplied with lime at as cheap a rate as any people in Europe.

"I obſerved to the prieſt who accompanied me to the Serpent Rocks, that this muſt have been the place to which my countryman (St. Patrick) had collected all the ſerpents of the kingdom. The cliffs extend a mile in front, dip towards the ſea weſtward, and run to an indeterminate length into the country. No block can be raiſed in theſe cliffs that is not replete with petrifactions; and the fiſh appear to lie promiſcuouſly as if thrown out of a net. There may be about one-twentieth of the whole rock compoſed of thoſe petrified fiſh or ſerpents. The ſtrata or beds are very regular, and of different thickneſs. They contain alſo ſome large round ſhells as yellow as gold; ſo that if chimney-pieces were

were wrought here they would be very valuable, as the fish and shells would afford very lively and interesting objects upon the polished surface. The Cobham marble is reckoned of great value, from the representation of ruins and landscapes which sometimes appear upon it; but it would fall far short, in my opinion, of the singular and surprising figures with which these rocks abound."

Two small blocks of this stone are deposited at the Dublin Society.

BOTANICAL EXPEDITION.

The following is a list of the objects of natural history, and other curiosities, brought home by Captain Baudin, commander-in chief of the botanical expedition, in the flute *La Belle Angelique*:—One hundred and ninety casks, containing about 3,500 living plants, and in a state of vegetation; four boxes of zoophites and lithophites; a box containing the horns of quadrupeds, and other objects; a box containing vases of porcelain, and other objects; a box of paintings; a box of bows and arrows, and other objects; two boxes of madrepores; two boxes of stuffed birds; two boxes of specimens of wood; a box of quadrupeds and fishes in spirits; two boxes of insects and quadrupeds in spirits; four boxes of plants in spirits; a box of crustaceous animals and polypes; four boxes of seeds; four double boxes of insects; three casks of shells; a cask of melocacti in spirits; living birds; three apes; a crab-eater (*chien crabier*); eleven planks, and one log of mahogany; a box of miscellaneous articles; a cask of minerals; four boxes of petrifactions and eagle-stones (*geodes*); a box of bitumen, &c.

THE

PHILOSOPHICAL MAGAZINE.

SEPTEMBER 1798.

I. *Observations on the Account of the supposed Orang Outang of the East Indies, published in the Transactions of the Batavian Society in the Island of Java. By* DE GEOFFROY, *Professor of Zoology at the Museum of Natural History. From the* Journal de Physique, 1798.

BARON VON WURMB, the author of this account*, supposing that the object of his examination was that wonderful being, so much celebrated in Europe, by means of which naturalists imagine they can trace out, through shades almost insensible, the gradation from man to animals, made no hesitation to give to his ape the name of the *large orang outang* or *pongo*. But, instead of having an opportunity to observe this singular species, which had occupied so long and in so vague a manner the attention of naturalists and philosophers, and with which, it is said, Maupertuis would have preferred two hours conversation to that of the most learned societies in the world, Wurmb did not even see an ape of the species of the orang outang. His observations, however, are no less valuable, since the object of them is not only a new species, but a species of a peculiar form,

* For Wurmb's description of this animal see page 225.

in which are united,, beſides the characteriſing marks proper to it, and which are not to be found in any other of the mammalia, ſome others very extraordinary which belong to animals extremely diſſimilar. To bring forward then to public notice a diſſertation almoſt unknown, and on an animal, which, though deſcribed ſome time ago, has not yet been comprehended in the catalogues or ſyſtems of natural beings, is rendering a real ſervice to ſcience. But this is not enough: it is neceſſary to prevent that confuſion of names which is always followed by a confuſion of ideas; for the deſcription of Wurmb, which is not ſufficiently ample, and which beſides is unaccompanied by a figure, does not afford naturaliſts the means of aſcertaining whether the animal deſcribed be rather a new ſpecies than the *pongo*; and I have been able to determine this point only by comparing the ſkeleton of Wurmb's ape with thoſe of different orang outangs preſerved in the collection of the Muſeum of Natural Hiſtory. This ſkeleton of Wurmb's ape, one of the moſt curious and moſt valuable in the national collection, will furniſh us with very important obſervations, that may ſerve to give a better idea of the ſpecies in queſtion, than a deſcription of the external parts. (*See Plate* XI.)

This animal, in the ſcale of beings, occupies almoſt the laſt rank in the numerous family of the apes. The ſingular conformation of its head places it between the mandrils (*ſimia maimon et mormon* L) and the allouates (*ſimia ſeniculus*). However, if, without fixing on this characteriſing mark, though of great importance, we adhere to thoſe according to which ſyſtematic authors have formed for apes *genera* and *diviſions*, the want of a tail will make it an animal nearly related to the gibbons and orang outangs. But I do not think it neceſſary to endeavour to prove that the latter mark is very inſufficient to point out the real affinity of beings. A tail is a ſuperfluous appendage, and almoſt foreign to the bodies of animals. This organ can in no caſe have any influence on their economy, nor even on

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their habits. We might as well fay that fome fpecies of the genera of the *lemur, cavia, erinaceus*, &c. which have no tail, are fimilar to the orang outangs; which would be an abfurdity. On the contrary, in a family like that of the apes, where all the principal organs exhibit no remarkable numerical difference, and where the teeth, fingers and tongue have a perfect refemblance, the form of the cranium is the moft important confideration in examining the real affinity of thefe animals, and may ferve as a bafis for their generic divifions; fince it appears that the fize and convexity of the cranium indicate fenfibility, as the prolongation and fize of the muzzle indicate brutality.

But what is moft ftriking in the fkull of Wurmb's ape is the exceffive prolongation of the muzzle; and as this muzzle acquires fuch a bulk only at the expence of other neighbouring parts, it happens that there is no apparent forehead; that the offeous box which inclofes the brain is very fmall, and that the occipital foramen is fituated in the pofterior part of the head. The muzzle, the fize of which feems to form the principal characterifing mark of this fpecies, is remarkable not only for the enormous thicknefs of the jaw-bones, but alfo for the extraordinary bulk of the incifive and canine teeth with which it is armed. The incifive exceed in fize thofe of the lion; and the canine, in that refpect, are not much different: fo that, though thefe incifive and canine teeth, except in bulk, have a near refemblance to thofe of other apes, we are tempted to confound the head of the one in queftion with that of the moft carnivorous animals. Another confideration feems in fome manner to fupport this affinity. The occiput rifes to a point, and forms a pretty large and thick quadrilateral protuberance, from which arife three offeous ridges, no lefs apparent and no lefs folid than thofe of the lion: two of thefe ridges proceed in a lateral direction to the auricular apertures, and have from four to five lines of elevation; another proceeds to the vertex, then divides itfelf above the forehead, like that of the lion,

lion, into two lateral branches, and continues to the external ſide of the upper edge of the orbits. Theſe ſmall ridges are more diſtinct in the ape of Wurmb, and form, with the upper edge of the ſockets of the eye, an equilateral triangle. But theſe characteriſing marks, already ſo ſingular in this ape, will aſtoniſh us ſtill more by their combination with others at leaſt equally ſtrange. The head has the form of half a pyramid, and the auricular apertures are placed far above the os palatinus; ſo that a line let fall from the auricular apertures to the internal edge of the os palatinus would form, at the point of its interſection with the horizontal line, an angle of 25°. This has been already obſerved in the allouate, where ſuch a ſingular conformation is neceſſary on account of an extraordinary ſwelling of the os hioides.

The anatomical reader will, no doubt, be perſuaded, after what I have ſaid, that the ape of Wurmb can in no caſe ſupport itſelf on its two hind legs, but that it muſt always go on all-fours. It is, indeed, on the poſition of the occipital foramen, according to the learned obſervations of Daubenton, that the greater or leſs degree of aptitude for walking upright chiefly depends. In man, whoſe occipital foramen is nearly in the centre of the baſe of the cranium, the head is placed on the vertebral column in an almoſt perfect equilibrium; but if the occipital foramen is removed backwards, and particularly to that point where it is obſerved in the ape of Wurmb, the equilibrium is deſtroyed; the weight of the head carries with it the body, and obliges the animal to uſe for its ſupport, and for walking, thoſe anterior extremities which in man ſerve only for graſping.

Before we can draw any concluſion on this point, in regard to the ape of Wurmb, and before we affirm, that, according to the poſition of its occipital foramen, it cannot walk on two legs, let us conſider it in its whole organiſation. We are not yet acquainted with all the immenſe reſources of nature. We do not yet know to what degree it can enlarge, and render uſeful, organs the rudiments of which only exiſt

exiſt in the greater part of animals to compenſate for others which ſhe may have rendered too prominent. But, indeed, all the reſt of the organiſation of the ape of Wurmb announces a biped animal. Its pelvis is not completely parallel to the ſpine; its os calcaneum has a flat part, upon which, like man, it may find a ſolid ſeat; and, in the laſt place, its arms have an immoderate length like thoſe of the gibbon, ſince they reach almoſt to the external malleolus. This laſt characteriſing mark, to which no attention has hitherto been paid, appears to me one of the ſureſt indications of a biped walk. Apes muſt take advantage of the great length of their anterior extremities, by extending them in all directions; they muſt make uſe of them as of a balancing pole to keep themſelves in equilibrium, or to reſtore themſelves to it when they have been expoſed to a fall which obliges them to make only a gentle inclination of the body.

In a word, a particular organiſation rectifies the diſadvantages which reſult, in walking erect, from the length of the muzzle, and the poſition of the occipital foramen being removed farther back. In all the known mammalia, the ſpinal apophyſes of the cervical vertebræ are ſhorter than thoſe of the lumbar and dorſal vertebræ. The caſe is the reverſe in the ape of Wurmb; and, according to the judicious remark of Cuvier, theſe apophyſes of the cervical vertebræ have this great length, to form more powerful and more numerous bonds with the large muſcles of the neck which proceed on the occipital ridges. Thus nature by another mechaniſm has provided for the ſupport of the head of Wurmb's ape on the ſpinal column; and by theſe means it can keep itſelf erect, and run in that poſture.

I ſhall not purſue any farther an explanation of the characteriſing marks which it exhibits to naturaliſts. I have ſaid enough to prove that it is not the orang outang or pongo, but that it ought to be conſidered as a ſpecies unknown before the publication of Wurmb's memoir. I am far from reproaching that obſerver for his miſtake. At the time when he wrote his defcription the natural hiftory of the orang outangs was involved in fuch obfcurity, that he muft naturally have confidered his ape to be the fame animal as the large orang outang or pongo of Buffon. Naturalifts were then far from being convinced that this animal, fuch as it is defcribed in the immortal work of that celebrated author, is an imaginary being to which Buffon has affigned a form and characterifing marks, by confounding, under the fame name, and in the fame defcription, fix different fpecies of apes defcribed by travellers.

II. *Account of the Methods employed in Japan and China to prepare Soy, with fome Obfervations on the Bean from which it is produced. By Profeffor* BECKMANN.

THIS article, which is a brown faline liquor, imported to Europe from the Eaft Indies, is employed for feafoning various kinds of difhes, and improving the tafte of different fauces. It is brought from Japan in fmall wooden veffels, and alfo from China and other parts of India in glafs flafks, feveral of which are packed together in a wooden box. The ufe of it has been long general in the Eaft Indies; where it is placed on the table at each meal, inftead of falt, for the purpofe of dipping in it flefh, fifh, and other kinds of food.

The Japanefe are faid to be the inventors of this article; and, at prefent, their foy is preferred to any other; though it is afferted by connoiffeurs that this preference arifes more from the price than the goodnefs. In my opinion, it was firft introduced in the European commerce in the prefent century; for it is not to be found in the old catalogues of goods; in Saavary's or Ludovici's dictionaries, nor in the old books on cookery. The firft account of the method of preparing it after the Japanefe manner was publifhed by Kempfer.

Before

Before I give a deſcription of this method, it may not be improper to inform the reader that the people in India, inſtead of our common kidney beans, cultivate and uſe as food another ſpecies of a ſimilar kind, called in botany *dolichos*, and which comprehends ſeveral ſpecies. Among theſe there is one called *dolichos ſoya.* This plant is all over rough; and its weak ſtem riſes to the height of a man. Its flowers, which are ſmall, ſcarcely appear above the calyx, and are of a blueiſh or almoſt violet colour. The rough huſks contain for the moſt part only two ſeeds, which in form, ſize and taſte differ very little from our garden peaſe, except that they are flatted, ſhaped ſomewhat like an egg, and have a black ſpeck at the place where they begin to germinate*.

Theſe ſeeds form the principal component part of ſoy. In Japan they are firſt boiled, and then mixed with the ſame quantity of barley or wheat meal (the latter is for the purpoſe of giving the ſoy a darker colour); and the mixture, being covered up, is depoſited for twenty-four hours in a warm place, where it ferments. The ſame quantity of common ſalt, with the like quantity and half as much water, is thrown over it; and the whole maſs, for the ſpace of two or three months, is ſtirred round daily with a chocolate ſtick, and cloſely covered immediately after. At the expiration of that period it is ſtrained or ſqueezed through a linen cloth, and the liquor, which is preſerved in wooden veſſels, becomes always clearer and better the longer it is kept. The maſs which remains is again ſubjected to a like proceſs by having water poured over it, and, being ſtirred round for ſome days, as before, is then ſtrained.

* *Hilum fuſcum.* The firſt deſcription and figure of this plant was given by Kempfer in his *Amœnitat. exot.* p. 837, 838. Both theſe, however, were improved and rendered more complete by Bergius in *Abhandlungen der Schwediſch. Akad.* xxvi. p. 281. The lateſt deſcriptions are thoſe of Thunberg in his *Flora Japonica*, p. 282; and Jacquin in *Collectanea ad botanicam et hiſt. nat.* vol. i. p. 46.

Of the preparation in China the following account has been given by Eckberg, a Swede*: Thirty-five pounds of theſe beans, clean waſhed, are boiled for a few minutes with water in a covered veſſel, until they can be eaſily preſſed together between the fingers. They are then put into a ſieve; and when they are ſtill moiſt, after the water has run off, they are ſtirred round in fine meal, made of the ſame beans, until they are completely covered by it. They are then put into ſmall ſieves, or laid upon ſmooth mats to the height of an inch and a half above each other, and are depoſited in a baſket covered with mats, where they are ſuffered to remain three or four days till they begin to grow mouldy. They are then firſt expoſed to the air, and afterwards dried in a ſtrong ſun-heat, or in a warm place, until they can bear the ſtroke of a hammer; when they are rubbed between the hands, and in that manner freed from the meal and mouldineſs with which they are covered. They are then thrown into earthen veſſels, and a pickle compoſed of 20 pounds of ſalt and 100 pounds of ſpring water is poured over them. Theſe earthen veſſels are expoſed open during the day to the ſun, but at night they are covered; or they are put in ſome warm place, for the ſpace of ſix weeks, until their whole ſubſtance be well extracted. When it is obſerved that the pickle has become thick and of a dark brown colour, it is poured off, and boiled ſeveral times in order to render it thicker. Some, during theſe boilings, add to it ſugar, ginger and other ſpices according to pleaſure, leaving the whole to ſtand for a few days; after which it is ſtrained.

From what has been above ſaid, it may be readily perceived that the preparation of ſoy in Europe would be attended with no difficulty if it were poſſible to cultivate the beans. Bergius, however, gives his countrymen little hope that this can be done; and chiefly for this reaſon, that the plant blows ſo late in green-houſes, that the ſummer is gone before the fruit can ripen. But this is often the caſe with

* Abhandlungen der Schwediſchen Acad. xxvi. p. 40.

exotics

exotics which are reared by our gardeners in hot-houses. As they only begin to blow when their nourishment decreases and occasions a stoppage of their growth, the same thing may happen too late in too fertile a soil, or when they have a superfluity of nourishment. On the other hand, when they are transplanted into soil somewhat poorer, and into an open place where they have less shelter, they do not grow so quick and so long; but they blow earlier. And hence it happens, that many exotics planted in the open air produce ripe seeds, which could never be obtained from them while they were preserved as curiosities and favourites of the gardener in green-houses. I consider it, therefore, as an experiment worth making, to plant these beans in the open fields; and I am inclined to think that in many summers they would produce ripe seeds, especially as Jacquin says expressly that they throve well at Vienna in the open air.

Should my conjecture, however, be not realised, this would not, at any rate, be the case with that of Bergius, who is of opinion that a kind of soy might be obtained from our peas and beans by the same or a similar process; but indeed it would have this great fault, that it would be too cheap, and too soon become common.

III. *Comparative View of the expansive Force of the Steam of Water and that of Alcohol. By R. PRONY. From the* Journal de l'Ecole Polytechnique.

THE experiments from which the following tables are deduced have been described by Bettancourt, their author, in a memoir published in 1790. I gave the results of them, together with a short description of the apparatus used, in the first volume of my *Architecture Hydraulique,* in treating on the general theory of the application of steam to the movement of machines; but in the second volume, which contains a complete description of steam-engines from the first

 invention

invention of them down to the most recent discoveries, I recur to the labours of Bettancourt, which I have explained at full length, as well as the application that may be made of it to physics and the arts *. I refer those, who may be desirous of being thoroughly acquainted with the subject, to that work, and shall here content myself with giving an idea of the apparatus.

The fluid with which the experiments were made was confined in a very strong boiler made of copper, being eight inches at its greatest diameter, and fourteen inches in height. The upper part of it was closed by a cover made of copper also, through which passed three tubes. The first served to introduce the fluid into the boiler, and could be closely shut by means of a screw. The second was occupied by a thermometer, having its ball about two inches above the bottom of the boiler, and the scale, which was on the outside, contained from 0 to 110° of Reaumur. To the third was adapted a bent barometric tube, having two lines of internal diameter, the ascending branch of which was 110 inches in length.

By means of a lateral cock a communication was established between the boiler and an air pump, which served to make a vacuum before a fire was kindled in the furnace below the apparatus. This circumstance of evaporation in a vacuum, forms an essential difference between the experiments of Bettancourt and those made before by Ziegler, and renders them applicable to the theory of the steam-engine, where the vapour acts in a space freed from air.

* In this second volume will be found experiments made on the same object, and communicated to me by their author John Henry Ziegler. They were published at Basle in 1769, in a memoir entitled: *Specimen physico-chemicum de digestore Papini, ejus structurâ, effectu et usu, primitias experimentorum novorum circa fluidorum à calore rarefactionem et vaporum elasticitatem exhibens.* Bettancourt, who did not see them till he had finished his own, mentions them in his memoir. It will be perceived, by the account I have given of them, that they deprive him of none of that glory which he has a right to expect from his labours.

A va-

A vacuum having been made in the boiler, the mercury brought as nearly as poſſible to a level in the two branches of the barometric tube, and the thermometer reduced to zero by means of ice, the ice was removed, and a fire was kindled, which was excited gently and with much equality, in ſuch a manner that the barometer paſſed over about a degree per minute. One perſon then ſtood by to obſerve the barometer, and another to obſerve the thermometer, and each kept a regiſter from degree to degree of the preſſure and correſponding temperatures; the preſſure being expreſſed by the height in (French) inches of the columns of mercury, which roſe above the level in the long branch of the barometer.

It was exceedingly difficult to prevent either the introduction of air into the boiler, or the extravaſation of vapour, according as the internal preſſure was leſs or greater than the weight of the atmoſphere: means, however, were found to obviate theſe inconveniencies; but they are too long to be detailed here, and muſt be read in the works before mentioned.

The obſervations of the expanſive force of the ſteam of water furniſh 110 reſults, proceeding from degree to degree of the thermometer, and beginning at zero. Theſe reſults are contained in the annexed table, where the degrees of preſſure are expreſſed in (French) inches of mercury, and the temperatures denoted according to Reaumur's ſcale *.

The experiments on the expanſive force of the ſteam of alcohol were made by the ſame proceſſes, and with the ſame apparatus, as thoſe employed with the ſteam of water. The object of them, independently of their general utility in phyſics, was to make known the relative expences which would be occaſioned by theſe fluids, when uſed to produce moving forces in ſteam-engines. This object of reſearch is

* For the convenience of our readers, we have added another column to the table, in which we have given the correſponding degrees of Fahrenheit's thermometer. EDIT.

both

both important and new. The expence of movement in a ſteam engine is compounded of the price of the fluid evaporated and that of the fuel. The uſe of water requires no farther expence than that of the ſubſtance employed as fuel; but it is poſſible that ſome other fluid, much dearer in itſelf, may nevertheleſs have ſuch expanſion, that with an equality of preſſure the ſaving in fuel may be greater than the price of the fluid. If the reſults from the ſteam of alcohol be compared with thoſe from the ſteam of water, it will be ſeen that, at the ſame temperature, the expanſive force of the ſteam of the former is always more than double that of the latter. Much leſs fuel then will be neceſſary to produce in a ſteam-engine the ſame effect by alcohol; and if the apparatus were diſpoſed in ſuch a manner as not to loſe the condenſed liquor, which would be attended with no great difficulty, it might be uſed with much advantage in certain caſes, and in engines of ſmall dimenſions. But, according to every appearance, there are other fluids leſs expenſive than alcohol, which may have an equal or even a greater expanſion; and it would be a very uſeful object of reſearch to determine the mechanical effect of which ſteam is ſuſceptible, and to give tables on that ſubject, ſimilar to that here preſented in regard to water and alcohol.

The reſults given by experiments, of the expanſive force of the ſteam of alcohol at different temperatures, are expreſſed in the ſame manner in the following table, as thoſe given by the experiments on the ſteam of water.

TABLE

Table of the Expansive Force of the Steam of Water and of Alcohol.

Temperature.		Pressure.		Temperature.		Pressure.	
Reaum.	Fahr.	Water.	Alcohol.	Reaum.	Fahr.	Water.	Alcohol.
0	32	0,00	0,00	56	158,00	7,85	18,85
1	34,25	0,00	0,00	57	160,25	8,40	20,00
2	36,50	0,00	0,00	58	162,50	8,85	21,20
3	38,75	0,00	0,05	59	164,75	9,35	22,30
4	41,00	0,02	0,09	60	167,00	9,95	23,70
5	43,25	0,02	0,12	61	169,25	10,40	24,80
6	45,50	0,05	0,18	62	171,50	11,00	26,10
7	47,75	0,07	0,25	63	173,75	11,70	27,40
8	50,00	0,10	0,32	64	176,00	12,40	28,90
9	52,25	0,12	0,38	65	178,25	13,20	30,60
10	54,50	0,15	0,45	66	180,50	13,80	32,00
11	56,75	0,18	0,50	67	182,75	14,50	33,50
12	59,00	0,22	0,62	68	185,00	15,25	35,10
13	61,25	0,27	0,72	69	187,25	16,10	37,20
14	63,50	0,30	0,82	70	189,50	16,90	39,40
15	65,75	0,35	0,93	71	191,75	17,80	41,30
16	68,00	0,40	1,02	72	194,00	18,70	43,50
17	70,25	0,45	1,12	73	196,25	19,50	46,00
18	72,50	0,52	1,25	74	198,50	20,60	48,10
19	74,75	0,58	1,38	75	200,75	21,75	50,20
20	77,00	0,65	1,52	76	203,00	22,90	52,60
21	79,25	0,75	1,65	77	205,25	24,15	55,30
22	81,50	0,82	1,80	78	207,50	25,50	57,90
23	83,75	0,90	1,95	79	209,75	26,67	61,00
24	86,00	0,97	2,10	80	212,00	28,00	63,80
25	88,25	1,05	2,32	81	214,25	29,60	66,90
26	90,50	1,12	2,52	82	216,50	31,30	69,80
27	92,75	1,22	2,75	83	218,75	33,00	73,40
28	95,00	1,32	2,95	84	221,00	34,60	76,90
29	97,25	1,42	3,20	85	223,25	36,45	79,60
30	99,50	1,52	3,40	86	225,50	38,10	83,60
31	101,75	1,65	3,70	87	227,75	40,00	87,10
32	104,00	1,78	4,00	88	230,00	42,20	90,80
33	106,25	1,90	4,30	89	232,25	44,30	95,00
34	108,50	2,00	4,60	90	234,50	46,40	98,00
35	110,75	2,15	4,95	91	236,75	48,40	
36	113,00	2,27	5,28	92	239,00	50,50	
37	115,25	2,45	5,55	93	241,25	53,00	
38	117,50	2,57	6,00	94	243,50	55,30	
39	119,75	2,75	6,45	95	245,75	57,80	
40	122,00	2,92	6,90	96	248,00	60,50	
41	124,25	3,10	7,35	97	250,25	63,40	
42	126,50	3,27	7,82	98	252,50	66,20	
43	128,75	3,47	8,37	99	254,75	69,00	
44	131,00	3,70	8,92	100	257,00	71,80	
45	133,25	3,95	9,48	101	259,25	75,00	
46	135,50	4,25	10,15	102	261,50	78,20	
47	137,75	4,45	10,80	103	263,75	81,00	
48	140,00	4,75	11,50	104	266,00	84,00	
49	142,25	5,00	12,20	105	268,25	86,80	
50	144,50	5,35	12,35	106	270,50	89,00	
51	146,75	5,70	13,75	107	272,75	91,30	
52	149,00	6,05	14,60	108	275,00	93,50	
53	151,25	6,50	15,50	109	277,25	95,60	
54	153,50	6,90	16,40	110	279,50	98,00	
55	155,75	7,32	17,65				

IV. *An Analysis of the Waters of two Mineral Springs at Lemington Priors, near Warwick; including Experiments tending to elucidate the Origin of the Muriatic Acid. By* WILLIAM LAMBE, *M. A. late Fellow of St. John's College, Cambridge. From the* Memoirs of the Literary and Philosophical Society of Manchester, *Vol. V. Part I.*

[Concluded from p. 269.]

XI. FURTHER PROPERTIES OF THE OXYGENATED MURIAT OF IRON.

THE facts I have related are unquestionable: it was in the latter end of 1795 that I first made the observation on the effect of hepatised water upon iron: since then I have verified it repeatedly, and particularly in the month of December 1796, with some very pure iron, and in the presence of two gentlemen, very competent judges, one of whom assisted at every part of the process. Still it has been asked, How is it possible that this solution can contain muriatic acid, seeing that nitrat of silver, that most delicate test of this acid, is hardly affected by it? To this it might perhaps be a sufficient reply, that it is unreasonable to oppose a mere analogy to the direct evidence of the senses; particularly in a new case, where we have found some of the analogies best established in chemistry to fail. But let us recur once more to experiment.

I formed again some oxygenated muriat of iron. I suffered the acid to remain on the oxyde about 24 hours; then poured off the liquor, and evaporated the salt to dryness to expell the superfluous acid: the salt, which deliquesces instantly on cooling, was re-dissolved in a little distilled water. 1. I tried the solution with the acetite of lead: not the smallest cloud was produced. 2. The solution was then tried with the nitrat of silver: a little white curdy matter was formed. 3. A tea-spoonful of the solution was diffused through two or three ounces of distilled water, and then tried with the nitrat of silver: a very slight cloud was formed, and a minute purple precipitate fell, but not till after some hours. The appear-

ance

ance was not ſo ſtrong, nor the precipitate ſo copious, as when nitrat of ſilver is dropped into ordinary rain water.— Theſe experiments evince, that this ſalt either does not decompoſe the ſalts of lead and ſilver, or that the new compounds are ſoluble in water. The firſt is abſolutely conclusive: as to the ſmall appearance of decompoſition in Exp. 2 and 3, be it conſidered how difficult it is to prevent a minute quantity of common acid from paſſing over in the diſtillation of the oxygenated acid; and how readily this acid itſelf is decompoſed: add to this the imperfect oxydation, perhaps, of the iron. If theſe circumſtances are duly weighed, it ſeems probable, that this ſalt, when quite pure, would not at all ſenſibly decompoſe nitrat of ſilver. A ſlight impurity cannot be detected by acetite of lead, as a ſmall quantity of muriat of lead is ſoluble in water.

XII. FURTHER CONSIDERATIONS ON THE HEPATISED SOLUTIONS.

Beſides the oxygenated ſalts, I think it probable, that theſe ſolutions retain ſome ſulphur; but under what form, or in what combination, it is not eaſy to ſay. The reſiduum, after evaporation, has a peculiar ſmell, whereas the pure ſalts are inodorous. The ſtain left upon ſilver by the reſiduum ought, perhaps, to be attributed to this cauſe. Alſo, the white matter formed by the decompoſition of oxygenated muriat of mercury ſeems to be a combination of ſulphur and mercury. In proof of this it may be remarked, that the precipitate of this ſalt diſſolved in ſimple hepatiſed water is white. Further, it is doubtleſs true, that if hepatiſed water have a ſmall quantity of acid mixed with it, the ſolution of iron ſtrikes a purple colour with galls. To point out the origin of this colour, mix iron filings and ſulphur not waſhed, and form them into a paſte with a little water, and let them remain together for ſome hours: put the paſte into water, and filtrate: this water now ſtrikes a purple colour

with

with galls. Now, common ſulphur is always contaminated with a little ſulphuric acid; and, as neither hepatic gas nor oxygenated ſalt is here concerned, the effect muſt be attributed to the acid and the ſulphur. If this water be evaporated, it leaves a matter which does not deliqueſce; but which emits the ſame ſmell as the reſiduum of the hepatiſed ſolutions. To ſhew that the acid is neceſſary to the production of the purple colour, let the ſulphur be well waſhed with diſtilled water before it is mixed with the iron; and it will be found that no ſuch colour can be now produced. The following fact ſeems to prove that ſulphur may be retained in water, in the form neither of ſulphur nor of hepatic gas: it is an additional proof how eſſentially the oxygenated differs from all the common ſalts of iron. I ſaturated a diluted ſolution of oxygenated muriat of iron, which ſcarcely affected nitrat of ſilver, with hepatic gas. A white precipitate fell, but ſo minute that it was impoſſible to collect it, nor did it deſtroy the tranſparency of the water: hence I think it probable that, if the ſalt were quite perfect, it would not be ſenſibly affected by hepatic gas. I now boiled the liquor, to expell the gas, till it wholly loſt its hepatic ſmell. The liquor was again tried with nitrat of ſilver; and there was a copious depoſition, but of a dark browniſh colour. It ſeems certain, then, that ſome ſulphur is retained by the ſolution, which cannot be expelled by boiling.

XIII. THE NEUTRAL SALTS OF THE WATER: MURIAT OF MAGNESIA, MURIAT OF SODA, SULPHAT OF SODA.

A gallon of the water was evaporated to dryneſs; the deliqueſcent ſalts were ſeparated from the non-deliqueſcent; and each of the ſalts which were thus obtained was carefully examined. Thus, by proceſſes which are ſufficiently known, it was found that the gallon of water contains of muriat of magneſia 11.5 grains nearly; muriat of ſoda 430 grains; ſulphat of ſoda 152 grains.

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The triple compound of which I have treated, is mixed with the deliquefcent falt of magnefia, but not wholly; for it may be difcovered with the non-deliquefcent falts, though thefe have been feparated carefully by fpirit of wine. The tartrite of potafh indicates it in both. Oxalic acid does the fame thing, feparating a white powder with fome cryftalline grains which are the oxalat of manganefe. (See Bergman, Differt. viii. 24.)

XIV. THE RESIDUUM OF DIFFICULT SOLUTION.

After thefe falts had been feparated there remained a large refiduum, which was not foluble except in a great quantity of water. This has a cryftalline form like fulphat of lime; and the ufual reagents fhewed it, in fact, to contain both lime and fulphuric acid. But the weight of this refiduum, from a gallon of water, was no lefs than 112 grains: a larger quantity than could be diffolved in a gallon of water, if it were pure fulphat of lime. If it be confidered that the water requires fome evaporation before thefe cryftals begin to feparate, the proportion is ftill more increafed. There muft be, therefore, fomething peculiar in the compofition of the falt, or in the foluble powers of the water. Other experiments fhew the fame thing. 1. Sulphuric acid dropped into the water precipitates copioufly fulphat of lime. This cannot be effected by the decompofition of the muriat of lime; fince we have already feen that no fuch falt is to be found (XIII.). Indeed it cannot exift in the fame folution with fulphat of foda, as thefe falts decompofe each other*. 2. Sometimes a more unexpected appearance than this

* It is aftonifhing that this fact fhould have been neglected, and that in recent publications. Mr. Schmeiffer, in his analyfis of the waters of Kilburn Wells (Phil. Tranfac.), has joined together fulphat of foda, fulphat of magnefia, and muriat of lime, as being contained in thefe waters. Dr. Garnett has alfo put into the compofition of the fulphur-well at Harrowgate fulphat of magnefia and muriat of lime; an error the more unaccountable, as Bergman has exprefly remarked this decompofition in his Differtation on the Analyfis of Waters. See Differt. ii. 7. M.

takes place. It is, that a precipitate, seemingly like the former, has been made by the addition of the muriatic acid: but by the addition of more acid the precipitate is re-dissolved. Sometimes, indeed most commonly, I have not been able to effect this appearance.

It was natural to expect the solution of any further uncommon observation in the same matter that had already explained so much. 3. I accordingly digested sulphat of lime in the hepatised solutions of iron and manganese; and I found that the latter had a very strong solvent power. After the liquor had been filtered, sulphat of lime was plentifully precipitated by sulphuric acid. The solution of iron seems to have something of a similar property; but as it is very small, and as iron has almost always a little manganese united with it, it is at least uncertain whether the whole effect ought not to be attributed to manganese.

It remains to compare this remark with the effects of the artificial oxygenated salts; and thus to confirm, if confirmation were needed, the analogy which I have laboured to establish. 4. Sulphat of lime was digested with the oxygenated muriat of manganese and distilled water by a gentle heat: after 24 hours the clear liquor was separated: into this I dropped a little sulphuric acid; by degrees a large quantity of sulphat of lime was separated. Muriatic acid was dropped into the same liquor, but it did not separate any thing. The oxygenated muriat of iron possessed the same property, but in so small a degree, that here again I am inclined to attribute this power to a little manganese attached to the iron. It follows from these facts, that the large quantity of sulphat of lime is kept in solution by the salt of manganese. And a further examination of the residuum itself shews that it contains the triple salt of manganese and iron. 5. Some of the residuum was perfectly edulcorated, and sulphuric acid was dropped upon it; the vapours of muriatic acid arose, and were rendered evident by paper moistened with ammoniac or with simple water. To the sulphuric

acid,

acid, which was ufed in this experiment, was added fome diftilled water, and the liquor was filtrated: it was then faturated with an alkali; a fmall precipitate fell, which was proved (by the ufual methods) to contain both manganefe and iron.

6. I have noticed a variation (2.) in the effect of muriatic acid when added to the water. I have obferved a fimilar variety in the refiduum itfelf; which is, that fometimes it has been found foluble in the muriatic acid: when this happens, the addition of an alkali precipitates the refiduum in its original cryftalline form; and this it does before the acid is faturated. But moft commonly the muriatic acid does not diffolve it at all. Further, it has been faid above (VII. I.) that the acids precipitate a cryftalline fubftance from oxygenated muriat of iron. This fubftance I have found to contain manganefe. But what belongs to this place to obferve is, that it is not always, indeed it is but rarely, that this effect can be produced in any great degree: in a very fmall degree it may always be obferved; but, when I firft remarked it, the precipitate was very copious, fo that enough was readily collected for examination by the blow-pipe. The falt of manganefe does not fhew this appearance in the fmalleft degree. It depends, therefore, on fome peculiarity of the iron ruft, but precifely on what I cannot take upon me to determine.

As the oxygenated falts unite with all the other falts of the water, and confequently cannot be feparated by fpirit of wine, I have found it impoffible to determine the quantity of them.

I had concluded from the experiment (1.) that this water contained muriat of lime; and the following remark confirmed me in my error: I mention it, as I think it probable that others have been led into miftakes from the fame caufe. I reduced fome of the water, by evaporation, to about two ounce-meafures; taking for granted that by this procefs nearly the whole of the sulphat of lime was separated. By adding sulphuric acid to this liquor, 20 grains of sulphat of lime were precipitated. I concluded, therefore, that this must have proceeded from the decomposition of muriat of lime: in truth, this sulphat was dissolved in the two ounce-measures of water, and was separated by the decomposition of the oxygenated salt.

ON THE WATER OF THE OLD BATHS.

The spring which supplies these baths was discovered in 1786, in which year a cold and a warm bath were constructed. Upon sinking the well, a rock was found at the depth of eighteen feet; and the water rises from about the depth of three feet within the rock.

XV. THE GASEOUS FLUIDS.

I could obtain very little gas from this water, not more than three cubic inches from a gallon. It was azotic. An hepatic smell is perceptible when the water is fresh. To the hepatic gas, doubtless, it is owing, that no oxygen is found in this water or in that of the other spring. Dr. Garnett has so well explained the cause of this circumstance, that it is needless for me to enter upon it. (See Dr. G. on the Mineral Waters of Harrowgate, p. 74, &c.)

XVI. THE SPONTANEOUS PRECIPITATE.

This water is pellucid when it first rises from the spring; in small quantities it does not lose its transparency: a very small sediment is deposited by boiling, so small indeed that sufficient cannot be collected in this way for examination. However, when the bath has been newly filled, in some hours the transparency of this large body of water is destroyed by exposure to the atmosphere, and it contracts a whitish colour. I collected a large quantity of this precipitate from the bottom of the bath, where it by degrees accumulates. 1. I first attempted its analysis by acids, but was disappointed. It is hardly soluble in in any of the mineral acids: they all take up a little of it, make a brisk effervescence, and excite heat when first applied; but neither by a long digestion, nor by boiling, could I saturate the acids; nor, by putting a very small quantity of the powder into a large quantity of acid, could I completely dissolve the powder.

2. But by the use of the blow-pipe it readily appeared that this sediment is no other than the oxydes of the two metals so frequently mentioned, iron and manganese. It may be made magnetic; it gives the hyacinthine colour to borax; the colour is destroyed by continuing the fusion, and may be renewed by removing the globule to a silver spoon: fused with soda and nitre it makes a blue or a green globule. As the sediment may be procured in sufficient quantity, I repeated the last experiment on a larger scale: some nitre being mixed with it, the mass was pulverised, and fused in a crucible; when taken out of the fire it was green, and dissolved in water, to which also it imparted a fine green colour: in a day or two a yellow ochre was deposited, when the solution became blue; from this liquor a powder subsided by exposure to the air, which was manganese. (See Scheele's Essay on Mang. xxxvi. B.

3. Pursuing the observations of the effects of the mineral acids confirms this conclusion. I mixed some of the sediment with powdered charcoal, and exposed the mixture to a strong red heat: it became of a light brown colour, and now proved to be readily soluble in all the mineral acids. (See Scheele's Essay on Manganese, xxxviii. A.) With the muriatic and nitric it formed a gelatinous compound. The sulphuric acid, diluted, was soon saturated; the liquor was evaporated, and deposited white crystals, the form of which is rhomboidal. This is a triple salt, the base of which is iron and manganese. If there be a small excess of acid, the taste is very like that of sulphat of argill. The same salt may be obtained by boiling the sulphuric acid with the sediment itself, and continuing the boiling till the mass is be-

come dry: the salt may then be procured by lixiviating the dry mass, and crystallising the solution.

XVII.

Neither sulphat of argill nor oxygenated muriat of mercury is at all decomposed by this water.

XVIII. THE METALLIC SALTS.

All the appearances which demonstrate the existence of peculiar metallic salts in the waters of the new baths are also to be found in this: as, the oxydation and solution of metals and a copious precipitate by galls, while the prussiat of potash is not affected (IV.): and the same experiments were repeated to shew the presence of the oxygenated salts of iron and manganese (V. VII. &c.) with the same result, and authorise the same conclusions. Still I believe there is some difference in regard to these salts between the two waters. 1. I have already observed (XVII.) two points of distinction; and, as the second of those experiments is probably an indication of sulphur, this water seems to be without it. This is confirmed by evaporating the water in a silver vessel, to which it communicates no stain. However, 2. Its action on copper is very strong, so that, if it be boiled in a copper vessel for a long time, a blue oxyd of copper is separated from the vessel. But here, again, there is a difference between this and the former water; for, though copper is dissolved in it, none can be precipitated on iron in its metallic form, as we have seen (IV. 1.). The iron in this water does not seem to be in that high degree of oxygenation that it is in the other. This I infer, because, 3. the precipitate formed by tincture of galls is of a much darker colour, even when the water has been much evaporated; sometimes, when the water has been reduced to half its original bulk, I have remarked even a very slight green tinge communicated by prussiat of potash, but not till it has been added to it many hours.

As the oxygenated ſalts are formed by the action of hepatic gas on the metals, it cannot be doubted that they are very common. Bergman (Diſſert. VII. 6.) obſerves, "that cold martial waters, when freſh, almoſt always have an hepatic ſmell:" it ſeems very probable then that this ſalt of iron may be found in almoſt all ſuch waters. I doubt not that it has been frequently miſtaken for muriat of lime, to which in its properties it approaches very nearly.

Though I have purpoſely avoided all medical diſcuſſion in this eſſay, I cannot abſtain from beſtowing a moment's conſideration on one very obvious queſtion. What, it will be aſked, are the medical properties of mangaueſe? Is it uſeful? Is it innocent? Is it noxious? That it is innoxious I certainly know. Dr. John Johnſtone (Eſſay on Mineral Poiſons, page 134.) has ſhewn that it may be taken in large doſes without injury; and he has informed me, that he has ſince confirmed the ſame fact frequently. I wiſh I could as well anſwer the firſt queſtion; but what the medical virtues of this ſubſtance may be, is a ſubject which ſtill remains in a great meaſure unexplored. It is certainly well worth the attention of men of ſcience. To thoſe who are inclined to labour in this field I take leave to ſuggeſt, that they ſhould uſe either the carbonat or ſome other ſalt of mangaueſe: the black oxyde, I apprehend, muſt be hardly ſoluble in the human fluids.

XIX. THE NEUTRAL SALTS.

Theſe are the ſame as of the other water, but in different quantities. The gallon contains of muriat of magneſia 58; —muriat of ſoda 330;—ſulphat of ſoda 62 grains.

XX. THE RESIDUUM.

A ſtill larger reſiduum is obtained, after the ſeparation of the neutral ſalts, from this than from the other water. The gallon leaves 146 grains. Its properties are the ſame as of that already deſcribed (XIV.).

It is to be obferved, that both thefe fprings are affected by rainy weather; and that, confequently, their contents vary confiderably according to the feafons.

SYNOPTICAL TABLE OF SUBSTANCES CONTAINED IN THE TWO SPRINGS.

Gafeous fluids contained in a wine-gallon in cubic inches.

	WATER OF THE NEW BATH.	WATER OF THE OLD BATH.
Hepatic gas - - - -	too fmall to be meafured.	too fmall to be meafured.
Azotic gas - - -	3·5	·3
Carbonic acid gas - -	·5	

Solid contents of a wine-gallon in grains.

Carbonat of iron - -	·75	
Oxyds of iron and manganefe - - -		too fmall to be weighed.
Oxygenated muriat of iron and manganefe	unknown, but very fmall.	unknown, but very fmall.
Sulphur - - -	unknown, but very fmall.	
Muriat of magnefia -	11.5	58
Muriat of foda - -	430	330
Sulphat of foda - -	152	62
Sulphat of lime - -	112	146

Extract of a letter from Dr. HOLME, *dated Sept. 25th* 1797.

" In the analyfis of the waters of the new baths I have conjectured that the decompofition of oxygenated muriat of mercury is occafioned by a minute portion of fulphur, attached to fome of the fubftances diffolved in the water (111.). I have attempted to verify this conjecture, and not without fuccefs. Wifhing to collect fome quantity of the precipitate, I evaporated a gallon of the water to half its bulk; but found, that now the falt of mercury was diffolved without decompofition. I added, therefore, the falt to the water without boiling; and fuffered the precipitate to fubfide. By this procefs, I could collect no more than a grain from a gallon of water. I threw this upon alkali heated to rednefs; but the

the whole inftantly evaporated with a denfe fmoke. I mixed, therefore, another portion (procured in the fame manner) with alkali, and heated them in a crucible: ftill I failed to collect any fulphur from the alkali (as I had hoped); but I now perceived that, as the crucible became hot, the matter burnt away with a blue flame, as fulphur does.

"Sulphat of argill is not decompofed by this water when it has been reduced by evaporation: however, it gradually feparates fome of the abundant fulphat of lime; which is probably caufed by its attracting the water which held it in folution.

"I think it right here to obferve, that I have recently met with this water in fuch a condition that it caufed a permanent decompofition of fulphat of argill. This precipitate is extremely minute: I have not as yet determined the caufe of it, but I fufpect it to be carbonat of magnefia."

V. *Second Memoir on the Metal contained in the Red Lead of Siberia. By Cit.* VAUQUELIN. *From the* Annales de Chimie, *Vol. XXV.* 1798.

I HAVE already fhewn in my firft memoir * on the red lead of Siberia, that this mineral contains a particular metal, which I promifed to examine with more attention. The Council of Mines having furnifhed me with a pretty large quantity of the red lead, confidering its fcarcity, I have been able to make a feries of experiments fufficient to determine its principal properties, of which I fhall now give an account; but it will firft be neceffary to recapitulate, in a few words, the fubftance of my former memoir, in order that what I have to fay at prefent may be rendered more intelligible.

1. I fhall obferve, that on boiling the red lead reduced to a powder with two parts of the carbonat of potafh, the lead

* See page 279.

combined

combined itself with the acid of the carbonat; and that the alkali was afterwards united with a particular acid, which gave it an orange-yellow colour, and the property of producing crystals of the same colour.

2. That this new combination was decomposed by mineral acids; and that on causing the liquor, in which the decomposition had been effected, to evaporate, there was obtained, on the one hand, the salt formed by the mineral acid which had been added; and on the other, the acid of the red lead, under the form of elongated prisms of a ruby colour.

3. That the combination of the acid of the red lead with potash formed, with the nitrat of mercury, a precipitate of a cinnabar red colour; with the nitrat of lead, an orange-yellow sediment; with the nitrat of copper, a precipitate of a chestnut-red, &c.

4. That this acid alone became green by the contact of light, by a solution of tin and of the greater part of metals.

5. That the same acid, either free or in a state of combination, combined itself with borax, microcosmic salt, and glass; and communicated to them a beautiful emerald-green colour.

Such, in a few words, are the principal properties of the acid of the new metal contained in the red lead, as announced in my first memoir. I shall now proceed to examine the other characterising marks of this substance; and shall enlarge chiefly on those which ought to make us consider it as a particular metal, and on those which distinguish it from other bodies of the same class.

Exp. I. *Action of Acids on the Red Lead.*

If one part of the muriatic acid, mixed with as much water, be poured over the red lead, reduced to powder, there will be formed muriat of lead, which deposits itself under the form of white crystals, and the liquor assumes a very beautiful orange colour.

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In this operation the muriatic acid, as is evident, combines with it in virtue of a greater affinity to the lead, from which it ſeparates the natural acid, which is then diſſolved in the water of the muriatic acid. When ſuitable proportions of the acid, water, and lead have been employed, if the liquor be evaporated by a gentle heat and without the contact of light, you may obtain cryſtals of the acid of a ruby red colour. But if too great a quantity of the acid be uſed, or an acid too much concentrated; and, above all, if heat has been employed in the proceſs; inſtead of a red acid you will obtain a dark green liquor, which is then a combination of the oxyde of the new metal with the muriatic acid. It will be ſeen hereafter what are the cauſes of theſe eſſential differences: at preſent it is ſufficient to mention them.

The ſulphuric acid decompoſes alſo the red lead, by laying hold of the oxyde; but I did not employ it to extract the acid, becauſe, if ever ſo little a quantity more than is neceſſary be added, it is very difficult to ſeparate it.

The nitric acid does not produce any change in the nature of the red lead, only that when aided by the action of heat it effects its ſolution; but on cooling, the greater part of the red lead ſeparates itſelf with all its properties.

Exp. II. *Action of Alkalies on the Red Lead.*

Cauſtic alkalies do not ſeem to decompoſe the red lead, for they diſſolve it entirely, and form with it a kind of triple combination; the properties of which I did not examine minutely.

Alkaline carbonats, on the contrary, decompoſe the red lead completely; and there is formed, on the one hand, carbonat of lead; and on the other, a ſoluble ſalt compoſed of the metallic acid and of the baſe of the carbonat employed.

The ſalts formed by this acid with alkalies cryſtalliſe into priſms, or into laminæ of a golden yellow colour, the forms of of which I have not been able to determine accurately, on account of the ſmall quantity I could make.

Theſe ſalts have a ſlight metallic taſte: they diſſolve with efferveſcence, and aſſume a green colour: they are decompoſed by acids and alkaline earths, which form orange yellow precipitates.

Exp. III. *Action of Acids on the Acid of the Red Lead.*

Among the mineral acids, the muriatic is the only one which acts in a remarkable manner on that of the red lead. Indeed, whether the red lead be diſtilled, or its acid with the muriatic acid a little concentrated, there is ſoon diſengaged oxygenated muriatic acid, and the liquor aſſumes a very beautiful green colour. The cauſe of this may be readily conceived: the muriatic acid takes from that of the lead a part of its oxygen, and reduces it to the ſtate of a green oxyde, which is held in ſolution by another portion of the muriatic acid.

As this experiment announced to me that the oxygen does not adhere ſtrongly to that metal, I was deſirous to know whether its acid mixed with the muriatic acid would diſſolve gold: I therefore put into this mixture a piece of gold leaf, which was diſſolved in a little time by the help of a gentle heat, and the ſolution had a yellowiſh-green colour. This acid then produces the ſame effect as the nitric acid in aqua-regia, in regard to the ſolution of gold.

The ſulphuric acid, cold, produces no effect upon this acid; but when warmed it makes it aſſume a blueiſh green colour, by favouring, no doubt, the diſengagement of a portion of its oxygen, as it does in regard to the oxyde of manganeſe and the acids of tungſten and molybdena.

The ſulphurous acid lays hold of a part of the oxygen of this acid, becomes ſulphuric acid, and reduces that of the lead to the ſtate of an oxyde, which it diſſolves.

Exp.

Exp. IV. *Reduction of the Oxyde of the Red Lead.*

An experiment which could not but excite my curiofity was, to know whether the acid of the red lead, treated in a fuitable manner, could be reduced to a metallic ftate. For this purpofe I put 72 parts of this acid, extracted by the muriatic acid in the manner before mentioned, into a crucible of charcoal, which I placed in another crucible of earth filled with charcoal duft. Having then heated it for half an hour in a forge fire, I found in the charcoal crucible a metallic mafs of a whitifh grey colour, in the form of needles interwoven through each other, and which weighed 24 parts. The refult of this operation fhews that the acid of the red lead contains a large quantity of oxygen, fince of 72 parts employed, 24 only, which make one third, were converted into metal.

Exp. V. *Properties of the Metal.*

The fmall maffes with which I was obliged to make my experiments did not allow me to difcover a great number of properties in this metal. The few, however, which I obferved are fufficient to characterife it, and to induce me to affign it a particular place among the metallic fubftances.

1. It is white, greyifh, exceedingly brittle, infufible, fixed and cryftallifed into needles.

2. Expofed to the heat of the blow-pipe it becomes covered with a lilac-coloured cruft, which, on cooling, turns green.

3. Heated by the fame apparatus with borax it does not melt; but a part after being oxydated diffolves in that falt, and communicates to it a very beautiful green colour.

4. The action of acids upon it is exceedingly weak. The nitric acid is the only one which makes it undergo any remarkable change. By diftilling five or fix times fucceffively to drynefs 20 parts of this acid, concentrated, upon one of the metal, I was able to convert it into an orange yellow powder, which at firft was green.

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This powder is acid; diſſolves in water; combines itſelf with alkalies, from which it diſengages the carbonic acid and precipitates metallic ſolutions, exactly with the ſame phenomena as the acid of the natural red lead. It therefore appears to me, beyond a doubt, that I have made here, in every reſpect, the particular acid, ſuch as it exiſts in the red lead of which it forms one of the elements.

My experiments, and the phenomena they gave riſe to, as mentioned in this memoir, authoriſe me to conſider the ſubſtance which mineraliſes the lead in the red lead of Siberia not only as a metal, but as a particular metal, which, with the general properties of the metals already known, poſſeſſes very diſtinct characteriſing marks that belong to no other. What metallic ſubſtance, indeed, is there, which, converting itſelf into an acid of a ruby red colour, has the property, in that ſtate, of becoming green by the light, by caloric and metallic ſubſtances, and of precipitating the nitrate of mercury of a cinnabar red colour; lead of an orange yellow colour; nitrat of copper of a cheſtnut red colour; of diſſolving gold conjointly with the muriatic acid; of precipitating the tanning principle of a brown colour, and alkaline pruſſiats green? Without doubt there is none.

On account of theſe properties, and by the advice of Cit. Fourcroy and Hauy, I propoſe to call this metal *chrome*, which ſignifies colour; becauſe its combinations are, indeed, all more or leſs coloured. I however muſt confeſs that this appellation is not ſuited to the metal itſelf, ſince it has no particular colour; and that, beſides, each metal has one peculiar to itſelf, more or leſs different. I am not, therefore, attached to this name more than to any other that may be given it, provided it expreſs any of its moſt ſtriking and moſt characteriſtic qualities.

The brittleneſs and infuſibility of this metal do not give us reaſon to think that it can be applied to very many uſeful purpoſes; but we may ſtill hope that, if it can be found hereafter in larger quantities, the combinations of its acid

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with metallic oxydes, and of its oxyde with vitreous ſubſtances, will furniſh very beautiful and durable colours for the art of painting and enamelling. This hope appears to me ſo much better founded, as I have already diſcovered the oxyde of this metal in the emerald, in which it forms the colouring principle. I have alſo found it in the matrix of the red lead, in the ſtate of a green oxyde combined with the lead; and I have no doubt that it may be found in many other combinations, when minerals ſhall be examined with more care than they have hitherto been.

It reſults then that *chrome* is a peculiar metal before unknown; that this metal, infuſible and cryſtalliſable, has little affinity with oxygen, from which it derives however two thirds of its weight; that this acid of a red colour diſſolves in water and combines with alkalies, earths and metals, to which it communicates different colours, but more or leſs analogous to its own; that it readily loſes a part of its oxygen either by light, caloric, or the contact of certain metals, and the greater part of combuſtible ſubſtances, by paſſing through all theſe circumſtances to the ſtate of a green oxyde; and hence it is that this acid and all its combinations yield, by heat, a certain quantity of oxygen, and communicate to glaſs a beautiful green colour.

VI. *Propoſal for a new Hygrometer. By* Mr. HOCHHEIMER. *From* Economiſche Heſte.

VARIOUS hygrometers have been invented, but they are all in ſome degree imperfect: 1ſt, becauſe they do not determine with accuracy in what proportion water is diſſolved in the atmoſphere; and 2dly, becauſe they do not ſuffer the moiſture they have imbibed to eſcape from them in the ſame proportion as that in which they attracted it. I ſhall, therefore, mention in a brief manner only a few of them, and then propoſe a new method of conſtructing a hygrometer; though I muſt, at the ſame time, remark, that I by no means offer it it as a perfect and complete instrument. I wish merely to communicate my ideas on the subject, and to give others an opportunity of examining it farther, and of perhaps producing something that may be better calculated to answer the intended purpose. It is, indeed, much to be wished, that an accurate hygrometer could be invented; as it may be readily conceived that such an instrument would be of the utmost utility, not only to naturalists, but also to farmers and others.

The most common hygrometer, known under the name of a weather-house, is founded on the property of several twisted substances to untwist themselves in a moist atmosphere, and then to twist themselves back when the weather is dry. The substances chiefly employed are cat-gut; and, when required on a large scale, hempen ropes. Cassebois, a Benedictine monk, at Metz, proposed another hygrometer, which consists of the gut of a silk-worm. When that insect is ready to spin, there are found in it two vessels proceeding from the head to the stomach, to which they adhere, and then bend towards the back, where they form a great many folds. The part of these vessels next the stomach is of a cylindric form, and about a line in diameter. These vessels contain a gummy sort of matter from which the worm spins its silk; and, though they are exceedingly tender, means have been devised to extract them from the insect, and to prepare them for the above purpose. When the worm is about to spin, it is thrown into vinegar, and suffered to remain there twenty-four hours; during which time the vinegar is absorbed into the body of the insect, and coagulates its juices. The worm being then opened, both the vessels, which have now acquired strength, are extracted; and, on account of their pliability, are capable of considerable extension. That they may not, however, become too weak, they are stretched only to the length of about fifteen or twenty inches. It is obvious that they must be kept sufficiently extended till they are completely dry. Before they attain to that state they must be freed, by means of the nail of the finger, from a slimy substance which adheres

adheres to them. Such a thread will fuftain a weight of fix pounds without breaking; and may be ufed for an hygrometer in the fame manner as cat-gut. Paper, parchment, wood, ivory, hair, and the beard of wild oats, &c. have been employed for hygrometers on the fame principle.

Another fort of hygrometer is founded on the increafe of weight which certain bodies acquire by the moifture they attract from the atmofphere. Thus, for example, if a fponge which has been dipped in a folution of fal ammoniac, and again dried, be fufpended in the open air at the end of a balance, the variation of its gravity marked by a weight placed at the other end will fhew the temperature of the atmofphere in regard to drought and moifture.

Mr. Lowitz found at Dmitriewfsk in Aftracan, on the banks of the Wolga, a thin blueifh kind of flate which attracted moifture remarkably foon, but again fuffered it as foon to efcape. A plate of this flate weighed, when brought to a red heat, 175 grains, and, when faturated with water, 247: it had therefore imbibed, between complete drynefs and the point of complete moifture, 72 grains of water. Lowitz fufpended a round thin plate of this flate at the end of a very delicate balance, faftened within a wooden frame, and fufpended at the other arm a chain of filver wire, the end of which was made faft to a fliding nut that moved up and down in a fmall groove on the edge of one fide of the frame. He determined, by trial, the pofition of the nut when the balance was in equilibrio and when it had ten degrees of over-weight, and divided the fpace between thefe two points into ten equal parts, adding fuch a number more of thefe parts as might be neceffary. When the ftone was fufpended from the one arm of the balance, and at the other a weight equal to 175 grains, or the weight of the ftone when perfectly dry, the nut in the groove fhewed the excefs of weight in grains when it and the chain were fo adjufted that the balance ftood in equilibrio. A particular apparatus on the fame principles as a vernier, applied to the nut, fhewed the excefs of weight to ten parts of a grain. Lowitz remarked that this hygrometer in continued wet weather gave a moifture of more than 55 grains, and in a continued heat of 113 degrees of Fahrenheit only $1\frac{1}{2}$ degree of moifture.

In my opinion, it would not be neceffary, in order to conftruct fuch a hygrometer, to procure argillaceous flate from Aftracan, as feveral other argillaceous kinds of flate, as well as ftones and other fubftances, poffefs in an equal degree the fame property. If a perfon, for example, preffes with the finger on a marble flab, a grey free-ftone or a piece of glafs, it will immediately attract the infenfible perfpiration, and become tarnifhed.

The hygrometer thus invented by Lowitz was however attended with this fault, that it never threw off the moifture in the fame degree as the atmofphere became drier. It was alfo fometimes very deceitful, and announced moifture when it ought to have indicated that drynefs had again begun to take place in the atmofphere. To avoid thefe inconveniencies, I would propofe the following method:

1. Take a fquare bar of fteel about two lines in thicknefs, and from ten to twelve inches in length, and form it into a kind of balance, one arm of which ends in a fcrew. On this fcrew let there be fcrewed a leaden bullet of a proper weight, inftead of the common weights that are fufpended.

2. Take a glafs plate about ten inches long and feven inches in breadth, deftroy its polifh on both fides, free it from all moifture by rubbing it over with warm afhes, fufpend it at the other end of the balance, and bring the balance into equilibrium by fcrewing up or down the leaden bullet.

3. Mark now the place to which the leaden bullet is brought by the fcrew, as accurately as poffible, for the point of the greateft drynefs.

4. Then take away the glafs-plate from the balance, dip it completely in water, give it a fhake that the drops may run off from it, and wipe them carefully from the edge.

5. Apply

5. Apply the glass-plate thus moistened again to the balance, and bring the latter into equilibrium by screwing the leaden bullet. Mark then the place at which the bullet stands, as the highest degree of moisture.

6. This apparatus is to be suspended in a small box of well-dried wood*, sufficiently large to suffer the glass-plate to move up and down. An opening must be made in the lid, exactly of such a size as to allow the tongue of the balance to move freely. Parallel to the tongue apply a graduated circle, divided into a number of degrees at pleasure from the highest point of dryness to the highest degree of moisture. The box must be pierced with small holes on all the four sides, to give a free passage to the air; and to prevent moisture from penetrating into the wood by rain, when it may be requisite to expose it at a window, it must either be lackered or painted. To save it at all times from rain, it may be covered, however, with a sort of roof fitted to it in the most convenient manner. But all these external appendages may be improved or altered as may be found necessary.

VII. *Method employed in Spain for making the Alcarrazas, or Vessels used there for cooling Water. By Cit.* LASTEYRIE. *From the* Journal des Mines, *No. XXXIV.* 1798.

ALCARRAZAS are a kind of vessels used in Spain for cooling water intended for drinking. As they are exceedingly porous, the water oozes through them on all sides; the air which comes in contact with it, by making it evaporate, carries off the caloric contained in the water in the vessel, and by these means renders it remarkably cool †. These

* We would recommend a glass case. EDIT.

† It is a principle, universally admitted, that a liquid, passing to a state of vapour, appropriates to itself a quantity of caloric, which it takes from those bodies with which it is in contact. The more volatile a liquid is, the more rapid will be this effect; and it is on this principle that chemists,

Thefe veffels, which are of different forms and fizes, are manufactured in various parts of Spain, and are generally of a greyifh white colour. The moft celebrated place for this fpecies of pottery, and that from which all the veffels of this kind ufed at Madrid are brought, is Anduxar in Andalufia. The earth employed for making them is procured on the banks of a rivulet called Tamuforo, which is fituated at the diftance of a quarter of a league from the above town.

The ufe of thefe vafes was introduced into Spain by the Arabs. They are ftill ufed in Egypt, as well as in different parts of Africa; and are known in the Eaft Indies, Syria, Perfia, China, and other parts of Afia.

It is aftonifhing that thefe vafes were never introduced by the Arabs into Sicily. I never faw any of them in any part of that ifland. This fingular fact proves, that the fimpleft and moft beneficial ufages are rarely imitated by

mifts, during the heats of fummer, caufe, in fome minutes, the congelation of water inclofed in a fmall glafs ball covered with a cloth dipped in ether, care being taken to renew it in proportion as it evaporates. It is well known that coldnefs may be effected by liquors much lefs volatile than ether, either by expofing the vafe, the furface of which has been moiftened with them, to a current of air, or by fwinging it round a point of fufpenfion, which by moving it through the air ferves to favour the folution of the vapour in the atmofphere. From thefe principles it will be readily conceived on what depends the property of the alcarrazas above mentioned. On being expofed to the open air, or rather to a current of air, the water they contain becomes cool in a little time, and to fuch a fenfible degree, that in fummer, when the thermometer ftood at $99\frac{1}{2}$° F. in the fhade, at Madrid, the water has been known to defcend to the temperature of water preferved a confiderable time in a cellar. Thefe vafes, however, cannot be long ufed, unlefs care be taken to fill them only with very pure water, and fuch as is little charged with the fulphat of lime (*felenite*). Turbid water foon clofes up the pores even of filtering paper; and the fame effect will be produced by water that holds in folution fulphat of lime, becaufe the water abandons it in proportion as it unites with the air in a ftate of vapour. To open the pores, clofed up by earthy falts, it will be fufficient to keep thefe vafes for fome moments in boiling water. EDIT.

other

other nations, unless recommended by some favourable incident.

Though France is so near to Spain, and though there has always been great intercourse between these two countries, no traveller has ever yet given an account of the process employed in the fabrication of the above vases. The introduction of them into France would, in my opinion, be attended with great advantage; for, besides the pleasure of drinking cool water during the great heats, we ought to take into consideration the benefit that would arise from them in regard to the health. I have, therefore, procured correct information respecting the manner in which these vases are made in Spain; and I have brought alcarrazas to France, as well as the earth employed in the fabrication of them.

Cit. Darcet was desirous of analysing this white marly earth; and, by employing all the precision necessary for that purpose, he found that 100 grains of it contained 60 of calcareous earth mixed with alumine and a little oxyd of iron difficult to be dissolved, and $36\frac{1}{2}$ of siliceous earth also mixed with alumine and the same oxyd*. The quantity of iron may be estimated at almost a grain. The process for fabricating the alcarrazas is very simple; and, as the earth employed abounds in France, it will be easy, by the method which I shall explain, to establish manufactories of this kind; the expences of which will be trifling, and the profits certain, if the public do not refuse to adopt a useful practice.

The preparation given to the earth may be reduced to three principal operations.

1st Preparation. Suppose it were necessary to manufacture 150 pounds of earth: after it has been dried, and divided into portions of the size of a walnut, it is macerated in a bason or tub, by proceeding in the following manner: The

* A French journal states the result of Cit. Darçet's analysis thus: "About one third part of calcareous earth; one third alumine; one third lex—mixed with a very small portion of iron." EDIT.

workman takes three or four *celemins* of earth*, which are ſpread out equally in the baſon, and water is poured over it; he then throws in three or four *celemins* more of earth, which are watered as before; and this operation is repeated until the tub be ſufficiently full. In pouring on the laſt water, care is taken not to add more than may be neceſſary to cover the whole maſs. The earth is ſuffered to remain in this ſtate for twelve hours; after which it is worked and kneaded with the hands, in the tub, until it is reduced to the conſiſtence of a tough paſte. The earth is then depoſited on a ſmooth platform covered with brick, kept exceedingly clean, and over which is ſtrewed a little ſifted aſhes. It is formed into a cake about ſix inches in thickneſs, which is ſmoothed on the ſurface as well as at the ſides. It is left in that ſtate until it begins to crack; after which it is freed from the aſhes adhering to it, and removed to another tiled place made exceedingly clean.

2d Preparation. To this earth the workman adds ſeven pounds of ſea ſalt, if he wiſhes to make *jarras*, and only the half if it is deſtined for the fabrication of *botiſas* or *cantaros*. This difference ariſes from the greater or leſs capacity intended to be given to the vaſes. The larger the vaſe is, its ſides muſt be ſo much thicker, in order that it may have the neceſſary degree of ſtrength; but the earth, at the ſame time, muſt be more porous, otherwiſe the water would not filter through with eaſe; and, for this reaſon, the workman adds a greater quantity of ſalt when he wiſhes to make *jarras*, which are much larger than the *botiſas* and *cantaros*. The earth is kneaded with the feet, adding the ſalt gradually; and this labour is repeated, at leaſt three times, without the neceſſity of adding more water, as the moiſture retained by the earth is ſufficient.

3d Preparation. The earth, after being ſubjected to theſe different preparations, is fit to be applied to the lath. The

* The *celemin* is a meaſure of capacity, which contains about ſeven pounds of grain.

man

man who is employed for this work ought to knead it well with his hands, taking care to extract the ſtones, even the ſmalleſt which he may meet with, as well as every other foreign body. He then forms it into lumps, which he applies to the lath to be made into vaſes or jars.

The alcarrazas may be baked in any kind of furnace uſed by potters. Thoſe employed in Spain are eighteen feet ſquare in the inſide; and five feet three inches in height. The flame enters by a hole, one foot four inches in diameter, ſituated in the centre. Such a furnace will contain 800 pieces of different ſizes, including 500 *jarras*. Pottery of much greater ſtrength than the alcarrazas may be baked in the ſame furnace, if care be taken to keep up the fire for one or two hours longer. The alcarrazas, which require to be only half baked, remain there ten or twelve hours, according to the temperature of the air, or the greater or leſs quantity of fuel employed.

Proceſſes different from that which I have here deſcribed, are purſued in ſome of the potteries in Spain; but they all depend on the ſame principles. After the earth has been pounded, it is ſuffered to macerate in a tub for twenty-four hours; the whole is ſtirred round with a ſtick, and it is freed from the ſtraws or other foreign bodies that float on the ſurface. The ſtones and coarſer parts of the earth fall to the bottom of the veſſel, and the finer is drawn off by a hole four inches above it. The earth is then left to dry to a certain degree requiſite; and it is afterwards depoſited in a moiſt place, to be employed as may be found neceſſary. In other manufactories, the earth, when dry, is ground below a roller; after which it is ſifted, and, the proper quantity of ſalt and water being added, it is then kneaded. The proportion of ſalt is not every where the ſame. In ſome places the ſame quantity of earth requires a half leſs of ſalt. Care is always taken to chooſe earth of a proper quality, without ever having occaſion to add to it a mixture of ſand. The ſame earth is employed alſo for common pottery; the only dif-

 ference

ference is, that ſalt is added to the clay uſed for the alcarrazas, and that they are only half baked.

There is not a ſingle family in Madrid where theſe veſſels are not uſed. They are filled with water, which is expoſed for ſeveral hours to a current of air, in order that the evaporation may be more rapid, and that the water conſequently may become cooler.

A kind of red veſſels called *bucaros*, employed likewiſe to cool water, are made alſo at a place called Salvatierra in Eſtramadura; but the earth being leſs porous, it is not ſo proper for the intended purpoſe. Beſides, theſe vaſes communicate to the water a diſagreeable argillaceous taſte. They are, however, in great requeſt among the ladies of Madrid; ſome of whom pound fragments of them, and mix the powder with ſnuff. Young girls have a particular fondneſs for this kind of pottery, and eat it when they are troubled with the chloroſis.

Vaſes of a ſimilar kind to thoſe above deſcribed, are employed in Portugal for moiſtening ſnuff. They are plunged into water, after being filled with this article; and the water which filters inſenſibly through them communicates to it, at the end of ſome hours, the neceſſary degree of humidity.

VIII. *On the Theory of the Structure of Cryſtals, by the Abbé* HAUY. *From Vol. XVII. of the* Annales de Chimie.

[Concluded from p. 303.]

III. *Number of primitive Forms.*

In the examples before mentioned I have choſen a parallelopipedon for nucleus, on account of the ſimplicity of its form. I have hitherto found that all the primitive forms may be reduced to ſix, viz. the parallelopipedon, in general, which comprehends the cube, the rhomboid, and all the

ſolids

ſolids terminated by ſix faces parallel two and two; the regular tetraedron; the octaedron with triangular faces; the hexagonal priſm; the dodecaedron with rhomboidal planes; and the dodecaedron with iſoſceles triangular planes.

Among theſe forms, there are ſome found as nucleus, which have the meaſure of their angles different in different kinds of minerals. This will appear leſs ſurpriſing when we conſider that theſe nuclei are compoſed in the firſt inſtance of elementary moleculæ, and that it is poſſible the ſame form of nucleus may be produced in one kind by elements of a certain nature, and in another kind by different elements; as we ſee integral moleculæ, ſome cubic and others tetraedral, produce ſimilar ſecondary forms, in conſequence of different laws of decrement. But, it is worthy of remark, that all the forms, hitherto met with as nuclei, in the different ſpecies, are among the number of thoſe which have a particular character of perfection and regularity, as the cube, the regular octaedron, the regular tetraedron, and the dodecaedron with equal and ſimilar rhombuſes for its planes. Theſe forms are a ſort of limits at which nature arrives by different routes, while each of the forms, placed between theſe limits, ſeems to be attached to one unique kind, at leaſt as far as can be judged by the preſent ſtate of our knowledge on this ſubject,

IV. *Forms of the integral Moleculæ.*

The primitive form is that obtained by ſections made on all the ſimilar parts of the ſecondary cryſtal; and theſe ſections, continued parallel to themſelves, conduct to a determination of the form of the integral moleculæ, of which the whole cryſtal is an aſſemblage. This requires certain conſiderations that relate to the moſt delicate point of the theory, which I ſhall now explain, with as much preciſion as the narrow limits to which I am obliged to confine myſelf will allow.

There

There is no cryſtal from which a nucleus in the form of a parallelopipedon may not be extracted, if we confine ourſelves to ſix ſections parallel two and two. In a multitude of ſubſtances this parallelopipedon is the laſt term of the mechanical diviſion, and conſequently the real nucleus. But there are certain minerals where this parallelopipedon is diviſible, as well as the reſt of the cryſtal, by farther ſections made in the different directions of the faces; and there thence neceſſarily reſults a new ſolid, which will be the nucleus, if all the parts of the ſecondary cryſtal, ſuperadded to this nucleus, are ſimilarly ſituated. When the mechanical diviſion conducts to a parallelopipedon, diviſible only by ſections parallel to its ſix faces, the moleculæ are parallelopipedons ſimilar to the nucleus; but, in all other caſes, their form differs from that of the nucleus. This I ſhall illuſtrate by an example.

Let *a c b s n o* (*fig.* 60.) be a cube, having two of its ſolid angles *a*, *s*, ſituated on the ſame vertical line. This line will be the axis of the cube; and the points *a* and *s* will be its ſummits. Suppoſe this cube to be diviſible by ſections, each of which, ſuch as *a b n*, paſſes through one of the ſummits *a*, and by two oblique diagonals *a b*, *a n*, contiguous to this ſummit. This ſection will detach the ſolid angle *i*; and as there are ſix ſolid angles, ſituated laterally, viz. *i*, *b*, *c*, *r*, *o*, *n*, the ſix ſections will produce an acute rhomboid, the ſummits of which will be confounded with thoſe of the cube. Figure 61 repreſents this rhomboid exiſting in the cube, in ſuch a manner that its ſix lateral ſolid angles *b*, *d*, *f*, *p*, *g*, *e*, correſpond to the middle of the faces *a c b i*, *c r s b*, *b i n s*, &c. of the cube. But geometry ſhews that each of the angles, at the ſummits *b a g*, *d s f*, *p s f*, &c. of the acute rhomboid, are equal to 60°, from which it follows that the lateral angles *a b f*, *a g f*, &c. are equal to 120 degrees.

Beſides, it is proved by theory, that the cube reſults from a decrement which takes place by a ſingle range of ſmall rhomboids,

rhomboids, ſimilar to the acute rhomboid, on the ſix oblique ridges *a b*, *a g*, *a e*, *s d*, *s f*, *s p*. This decrement produces two faces, one on each ſide of each of theſe ridges, which makes in all twelve faces. But as the two faces, which have the ſame ridge for their line of departure, are on the ſame plane by the nature of the decrement, the twelve faces will be reduced to ſix, which are ſquares; ſo that the ſecondary ſolid is a cube. This reſult is analogous to that of the very obtuſe calcareous ſpar before mentioned.

Let us now ſuppoſe that the cube (*fig.* 60.) admits, in regard to its ſummits *a*, *s*, two new diviſions ſimilar to the preceding ſix, that is to ſay, one of which paſſes through the points *c*, *i*, *o*, and the other through the points *b*, *n*, *r*. The firſt will paſs alſo through the points *b*, *g*, *e*, and the ſecond through the points *d*, *f*, *p*, (*fig.* 61 *and* 62.) of the rhomboid; from which it follows, that theſe two diviſions will detach each a regular tetraedron *b a g e* or *d s f p* (*fig.* 62.), ſo that the rhomboid will be found converted into a regular octaedron *e f* (*fig.* 63.), which will be the real nucleus of the cube; ſince it is produced by diviſions ſimilarly made, in regard to the eight ſolid angles of the cube.

If we ſuppoſe the ſame cube to be diviſible, throughout its whole extent, by ſections analogous to the preceding, it is clear that each of the ſmall rhomboids of which it is the aſſemblage, will be found, in like manner, ſubdivided into an octaedron, with two regular tetraedra applied on the two oppoſite faces of the octaedron.

By taking the octaedron for nucleus, we may conſtruct around this nucleus a cube by regular ſubtractions of ſmall complete rhomboids. For example, if we ſuppoſe decrements by a ſingle range of theſe rhomboids, having *b* for their point of departure, and made in a direction parallel to the inferior edges *g f*, *e g*, *d e*, *d f*, of the four triangles, which unite to form the ſolid angle *b*, there will reſult four faces, which will be found on a level, and, like the octaedron with ſix ſolid angles, ſimilar decrements around the other five

five angles will produce twenty faces, which, taken four and four, will be equally on a level, which will make, in the whole, ſix diſtinct faces, ſituated as thoſe of the cube (*fig.* 60.); ſo that the reſult will be preciſely the ſame as in the caſe of the rhomboid conſidered as nucleus.

In whatever manner we proceed to ſubdivide either the cube, the rhombus, or the octaedron, we ſhall always have ſolids of two forms, that is to ſay, octaedra and tetraedra, without ever being able to reduce the reſult of the diviſion to unity. But the moleculæ of a cryſtal being neceſſarily ſimilar, it appeared to me probable that the ſtructure was as it were interſperſed with a multitude of ſmall vacuities, occupied either by the water of cryſtalliſation or by ſome other ſubſtance; ſo that, if it were poſſible to carry the diviſion to its limits, one of the two kinds of ſolids in queſtion would diſappear, and the whole cryſtal would be found compoſed only of moleculæ of the other form.

This idea is the more admiſſible, as each octaedron being enveloped by eight tetraedra, and each tetraedron being equally enveloped by four octaedra, whichever of the forms we imagine to be ſuppreſſed, the ſolids that remain will join exactly by their edges; ſo that, in this reſpect, there will be continuity and uniformity throughout the whole extent of the maſs. The manner in which each octaedron is enveloped by eight tetraedra may be readily conceived, if we take care that in dividing the cube (*fig.* 60.) only by the ſix ſections given by the rhombus, we may depart at pleaſure from any two, *a, s*; *o, b*; *c, n*; *i, r*, of the eight ſolid angles, provided that theſe two angles be oppoſite to each other. But if we depart from the angles *a, s*, the rhomboid will have the poſition ſhewn *fig.* 62. On the other hand, if we depart from the ſolid angles *o, b*, theſe angles will become the ſummits of a new rhomboid (*fig.* 64.) compoſed of the ſame octaedron as that of *fig.* 63, with two new tetraedra applied on the faces *b d f*, *e g p* (*fig.* 64.), which were unoccupied on the rhomboid of *fig.* 62. Figures 65 and 66 repreſent, one, the caſe in which the two tetraedra repoſe on the faces *d b e*, *f g p*, of the octaedron; the other, that in which they would reſt on the faces *b f g*, *d e p*. It is thence ſeen, that whatever may be the two ſolid angles of the cube aſſumed for the points of departure, we ſhall always have the ſame octaedron, with two tetraedra contiguous by their ſummits to the two ſolid angles in queſtion; and as there are eight of theſe ſolid angles, the central octaedron will be circumſcribed by eight tetraedra, which will reſt on its faces. The ſame effect will take place if we continue the diviſion always parallel to the firſt ſections. Each face of the octaedron, then, however ſmall we may ſuppoſe that octaedron to be, adheres to a face of the tetraedron, and reciprocally. Each tetraedron then is enveloped by four octaedra.

The ſtructure I have here explained is that of ſparry fluor. By dividing a cube of this ſubſtance we may, at pleaſure, extract rhomboids, having the angles formed by their planes equal to 120° or regular octaedra, or tetraedra, equally regular. There are a ſmall number of other ſubſtances, ſuch as rock cryſtal *, carbonate of lead (ſparry lead), &c. which being mechanically divided beyond the term at which we ſhould have a rhomboid or parallelopipedon, give alſo parts of various different forms aſſorted together in a manner even more complex than in ſparry fluor. Theſe mixt ſtructures neceſſarily occaſion uncertainty reſpecting the real figure of the integral moleculæ which belong to the ſubſtances in queſtion. I have, however, obſerved that the tetraedron is always one of thoſe ſolids which concur to the formation of ſmall rhomboids or parallelopipedons that would be drawn from the cryſtal by a firſt diviſion. On the other hand, there are ſubſtances, which, being divided in all poſſible directions, reſolve themſelves only into tetraedra. Of this number are garnet, blend, and tourmaline. I ſhall ſoon give examples of this reſult of the mechanical diviſion.

* Mémoires de l'Acad. des Sciences, An 1786, p. 78.

In

In ſhort, ſeveral minerals are diviſible into right triangular priſms. Such as the apatite, the primitive form of which is a regular right hexaedral priſm, diviſible parallel to its baſes and its planes, from which neceſſarily reſult right priſms with three planes, as may be ſeen by inſpecting *fig.* 68, which repreſents one of the baſes of the hexaedral priſm divided into ſmall equilateral triangles, which are the baſes of ſo many moleculæ, and which, being taken two and two, form quadrilateral priſms with rhombuſes for their baſes.

By adopting then the tetraedron in the doubtful caſe of which I have ſpoken, we ſhould reduce, in general, all the forms of integral moleculæ to three, remarkable by their ſimplicity; viz. the parallelopipedon, the ſimpleſt of all the ſolids which have faces parallel two and two; the triangular priſm, the ſimpleſt of all priſms, and the tetraedron, which is the ſimpleſt of pyramids. This ſimplicity may furniſh a reaſon for the preference given to the tetraedron in ſparry fluor, and the other ſubſtances of which I have ſpoken. I ſhall, however, forbear deciding on this ſubject, as the want of accurate and preciſe obſervations leaves to theory nothing but conjectures and probabilities.

But the eſſential object is, that the different forms to which the mixt ſtructures in queſtion conduct, are aſſorted in ſuch a manner, that their aſſemblage is equivalent to a ſum of ſmall parallelopipedons, as we have ſeen to be the caſe in regard to ſparry fluor; and that the laminæ of ſuperpoſition, applied on the nucleus, decreaſe by ſubtractions of one or more ranges of theſe parallelopipedons; ſo that the baſis of the theory exiſts independently of the choice which might be made of any of the forms obtained by the mechanical diviſion.

By the help of this reſult, the decrements to which cryſtals are ſubject, whatever be their primitive forms, are found brought back to thoſe which take place in ſubſtances where this form, as well as that of the moleculæ, are indiviſible paral-

parallelopipedons; and theory has the advantage of being able to generaliſe its object, by connecting with one fact that multitude of facts which by their diverſity ſeem to be little ſuſceptible of concurring in a common point.

What has been here ſaid will be better illuſtrated by a few examples of the manner in which we may reduce to the theory of the parallelopipedon that of the forms different from thatſolid.

Cryſtals, the moleculæ of which are tetraedra with iſoſceles triangular faces.

Garnet.

1. Primitive garnet (*fig.* 68.) *Grenat à douze faces.* Daubenton *Tab. Miner.* edit. 1792, p. 5. *Grenat dodecaèdre à plans rhombes.* De l'Iſle *Cryſtallographie*, tom. ii. p. 322. var. 1.

Geomet. charact. Reſpective inclination of any two of the faces of the dodecaedron 120°. Angles of the rhombus C L G H, C or G = 109° 28′ 16″; L or H = 78° 31′ 44″.

Though garnets of the primitive form be in general vitreous on the fractures, there are perceived on them, however, laminæ ſituated parallel to the rhombuſes which compoſe their ſurface. Let us ſuppoſe the dodecaedron divided in the direction of its laminæ, and, for the greater ſimplicity, let us make the ſections paſs through the centre. One of theſe ſections, viz. that which will be parallel to the two rhombuſes D L F N, B H O R, will concur with a hexagon which would paſs through the points E, C, G, P, I, A, by making the tour of the cryſtal. A ſecond ſection parallel to the two rhombuſes G L F P, B E A R, will coincide with another hexagon ſhewn by the points D, C, H, O, I, N. If the diviſion be continued parallel to the other eight rhombuſes, taken two and two, we ſhall find that the planes of the ſections will be confounded with four new hexagons analogous to the preceding. But by reſuming all theſe hexagons it is ſeen that their ſides correſpond, ſome of them with the

the ſmall diagonals of the rhombuſes of the dodecaedron, viz. thoſe which would be drawn from C to G, from A to I, from C to B, &c. and others would correſpond with the different ridges E C, G P, P I, E A, &c.

1. The planes then of the ſections paſſing through the ſides and through the ſmall diagonals of the twelve rhombuſes will ſubdivide the whole ſurface into 24 iſoſceles triangles, which will be the halves of theſe rhombuſes. 2. Since the planes of the ſections paſs alſo through the centre of the cryſtal, they will detach 24 pyramids with three faces, the baſes of which, if we chooſe, will be the external triangles that make a part of the ſurface of the dodecaedron, and of which the ſummits will be united in the centre.

Moreover, if we take, for example, the ſix tetraedra which have for external faces the halves of the three rhombuſes C E D L, C L G H, C E B H, theſe ſix tetraedra will form a rhomboid repreſented by *fig.* 69, and in which the three inferior rhombuſes D L G S, G H B S, D E B S, reſult from three diviſions which paſs, one through the hexagon D L G O R A (*fig.* 68.); the ſecond through the hexagon GHBANF, and the third through the hexagon BEDFPO. *Fig.* 69 repreſents alſo the two tetraedra, the baſes of which make part of the rhombus C L G H. One of theſe is marked by the letters L, C, G, S, and the other by the letters H, C, G, S. By applying what has been ſaid to the other nine rhombuſes, which are united three and three around the points F, A, H (*fig.* 69.), we ſhall have three new rhomboids; from which it follows, that the 24 tetraedra, conſidered ſix and ſix, form four rhomboids; ſo that the dodecaedron may be conceived as being itſelf immediately compoſed of theſe four rhomboids, and in the laſt analyſis of 24 tetraedra.

I ſhall here obſerve, that the dodecaedron having eight ſolid angles, each formed by three planes, we might have conſidered them as being the aſſemblage of the four rhomboids, which would have for exterior ſummits the four angles

G,

G, B, D, A; from which it reſults that any one of the faces, ſuch as C L G O, is common to two rhomboids, one of which would have its ſummit in C, and the other in G, and which would themſelves have a common part in the interior of the cryſtal.

It may be farther remarked, that a line G S (*fig.* 69.), drawn from any one G (*fig.* 68.) of the ſolid angles compoſed of three planes, as far as the centre of the dodecaedron, is, at the ſame time, the axis of the rhomboid, which would have its ſummit in G, and one of the edges of that which would have its ſummit in C (*fig.* 68 *and* 69.). The compoſing rhomboids then have this property, that their axis is equal to the ſide of the rhombus. With a little attention it will be eaſily ſeen, that in each tetraedron, ſuch as C L G S (*fig.* 69.), all the faces are equal and ſimilar iſoſceles triangles.

If we ſhould continue the diviſion of the dodecaedron by ſections paſſing between thoſe which we have ſuppoſed to be directed towards the centre, and which ſhould be parallel to them, we ſhould obtain tetraedra always ſmaller, and arranged in ſuch a manner, that, taking them in groupes of ſix, they would form rhomboids of a bulk proportioned to their own.

The tetraedra, which would be the term of the diviſion, were it poſſible for us to reach it, ought to be conſidered as the real moleculæ of the garnet. But we ſhall ſee, that, in the paſſage to the ſecondary forms, the laminæ of ſuperpoſition, which envelop the nucleus, really decreaſe by ranges of ſmall rhomboids, each of which is the aſſemblage of ſix of theſe tetraedra.

The ſulphure of zinc or blend has the ſame ſtructure as the garnet. I have divided by very clean ſections fragments of this ſubſtance, in ſuch a manner as to obtain ſucceſſively the dodecaedron, the rhomboid, and the tetraedron.

2. Trapezoidal Garnet (*Fig.* 70.).

Grenat à 24 faces. Daubenton *Tab. Miner.* edit. 1792, p. 5. *Grenat à 24 facettes trapézoidales.* De l'Iſle *Cryſtallographie*, tom. ii. p. 327.

Geomet. charact. Reſpective inclination of the trapezoids united three and three around the ſame ſolid angle D, C, G, &c. 146° 26′ 33″; of the trapezoids united four and four around the ſame ſolid angle *u*, *x*, *r*, &c. 131° 48′ 36″. Angles of any one of the trapezoids *m* D *u* L, L = 78° 27′ 46″; D = 117° 2′ 8″; *m* or *u* = 82° 15′ 3″. The value of the angle L is the ſame as that of the acute angle of the nucleus of calcareous ſpar.

This variety reſults from a ſeries of laminæ decreaſing at the four edges, on all the faces of the primitive dodecaedron. For the more ſimplicity, let us firſt conſider the effect of this decrement in regard to the rhombus C L G H (*fig.* 68.). We have juſt ſeen that this rhombus was ſuppoſed to belong in common to two rhomboids, which ſhould have for ſummits, one, the point C, and the other, the point G. Let us ſuppoſe that the laminæ applied on this rhombus decreaſe towards their four edges by ſubtractions of a ſingle range of ſmall rhomboids, in ſuch a manner that, in regard to the two edges C L, C H, circumſtances are the ſame as if the rhombus belonged to the rhomboid which has its ſummit in C; and that, in regard to the other two edges G L, G H, the effect is the ſame as if the rhombus belonged to the rhomboid having its ſummit in G. This diſpoſition is admiſſible here, in conſequence of the particular ſtructure of the dodecaedron, which permits us to obtain ſmall rhomboids, ſome of which have their faces parallel to the faces of that with its ſummit in C, and the reſt to that having its ſummit in G*.

The

* Theory has conducted me to another reſult, which is, that the ſum of the nucleus and laminæ of ſuperpoſition, taken together in proportion

as

The reſults of the four decrements being thus perfectly ſimilar to each other, the laminæ of ſuperpoſition, applied on the rhombus C L G H, and on each of the other rhombuſes of the dodecaedron, will form as many right quadrangular pyramids, which will have for baſes theſe ſame rhombuſes. In *fig.* 71 may be ſeen the pyramids which reſt on the three rhombuſes C L D E, C E B H, C G H B (*fig.* 68.), and which have for ſummits the points *m*, *e*, *s* (*fig.* 71.); but on account of the decrement by a ſimple range, the adjacent triangular faces, ſuch as E *m* C, E *s* C of the two pyramids that belong to the rhombuſes C L D E, C E B H, are on a level, and form a quadrilateral E *m* C *s*. But we had twelve pyramids, and conſequently forty-eight triangles. · Dividing by two, we ſhall then have twenty-four quadrilaterals, which will compoſe the ſurface of the ſecondary cryſtal. But becauſe the rhomboidal baſes of the two pyramids extend more, in proceeding from L to E or from H to E, than in proceeding from D to C or from B to C, the ſides *m* E, E *s* of the quadrilateral will be longer than the ſides C *m*, C *s*. Moreover, we ſhall evidently have *m* E equal to E *s*, and C *m* equal to C *s*. The quadrilaterals will then be trapezoids, which will have their ſides equal two and two.

I am acquainted with no cryſtalline form where the ſtriæ, when they exiſt, point out, in a more ſenſible manner than in this, the mechaniſm of the ſtructure. We may here ſee the ſeries of decreaſing rhombuſes which form each of the pyramids C L D E *m*, C E B H *s*, &c. (*fig.* 71.), and ſometimes the furrows are ſo deep that they produce a kind of ſtair, the ſteps of which have a more particular poliſh and brilliancy than thoſe of their facets, which are parallel to the faces C E D L, C H B E, &c. of the nucleus.

as the latter are applied one upon the other, is always equal to a ſum of rhomboids, though at firſt view it does not appear that this ſhould be the caſe, according to the figure of theſe laminæ, which repreſent riſing pyramids. See *Memoires de l'Acad.* 1789, p. 525.

If the decrements ſtop abruptly at a certain term, ſo that the pyramids are not terminated, the twenty-four trapezoids will be reduced to elongated hexagons, which will intercept twelve rhombuſes parallel to the faces of the nucleus. This is the variety to which I have given the name of *intermediary garnet*..

In the ſulphure of zinc the regular octaedron reſults from a decrement by a range around the eight ſolid angles, compoſed of three planes, viz. C, B, O, G, F, D, A, I (*fig.* 68.). The ſame ſubſtance aſſumes alſo the figure of a regular tetraedron, by the help of a decrement by one range on four only of the eight ſolid angles before mentioned, ſuch as C, O, F, A. This tetraedron is remarkable by its ſtructure, which preſents an aſſemblage of other tetraedra with iſoſceles faces.

Cryſtals the Moleculæ of which are triangular Priſms.

Oriental.

I give this appellation to a kind of gem known under the names of the *ruby*, *ſapphire*, *oriental topaz*, according as it is red, blue or yellow. It is ſo rare to find cryſtals of this gem which do not exhibit marks of a precipitate formation, or which have not been rolled, that hitherto we have had no accurate deſcription of its different varieties, nor any preciſe indication of the nature of the particular angles of each variety. The cryſtals which enabled me to eſtabliſh the following reſults were of a form ſufficiently well characteriſed.

1. *Primitive Oriental.*

It cryſtalliſes in the form of a regular hexaedral priſm diviſible parallel to its baſes. Theory points out other joinings, parallel to the planes, from which it follows, that the molecula is an equilateral triangular priſm. The height of this priſm, ſuch as given by theoretic calculation, is a little leſs than three times the height of the triangle of the baſe.

2. *Elon-*

2. *Elongated Oriental* (*fig.* 72.).

De l'Iſle *Cryſtallographie*, tom. ii. p. 215. A.

Geomet. charact. Reſpective inclinations of the triangles I A S, I B S, 139° 54′. Angles of the triangle I A S, A = 22° 54′, I or S = 78° 48′.

This form is the effect of a decrement by a ſimple range of ſmall quadrangular priſms on all the edges of the baſes of the nucleus. Let *q d* (*fig.* 67.) be the ſuperior baſe, ſubdivided into ſmall triangles, which repreſent the analogous baſes of ſo many moleculæ. The edges of the laminæ of ſuperpoſition will correſpond ſucceſſively to the hexagons *b i l m n r*, *e k u x y v*, &c.; from which it evidently follows, that the ſubtractions take place, as I have ſaid, by ranges of ſmall parallelopipedons or quadrangular priſms, compoſed each of two triangular priſms.

3. *Minor Oriental.*

Geomet. charact. Dodecaedron formed of two right pyramids leſs elongated than thoſe of the preceding variety. The triangles which correſpond to I A S, I B S, are inclined to each other 122° 36′. In each of theſe triangles the angle of the ſummit is 31°, and each of the angles at the baſe is 74° 30′.

The law from which this variety reſults differs from that which produces the preceding, as it determines a mixed decrement by three ranges in breadth and two ranges in height.

4. *Enneagonal Oriental* (*fig.* 73.).

Geomet. charact. Inclination of each ſmall triangle, ſuch as *c q i* to the adjacent baſe *a c i p l b g e d*, 122° 18.

It is the elongated oriental the ſummits of which are replaced by two faces, parallel to the baſes of the nucleus, with the addition of ſix ſmall iſoſceles triangles *c q i*, *l b f*, *v z m*, &c. the three ſuperior of which are alternate in poſition with the three inferior. Theſe triangles reſult from a decrement by three ranges of ſmall quadrangular priſms on the three angles of the ſuperior baſe of the nucleus, ſuch as *b*, *d*, *g*, (*fig*. 67.), and on the intermediate angles of the inferior baſe. It may be readily conceived, that in the decrement which takes place, for example, on the angle *g*, the three ranges, which remain unoccupied between that angle and the correſponding edge of the firſt lamina of ſuperpoſition, are, 1ſt, the ſmall rhombus *g o i p*, which alone forms the firſt range; 2d, the two rhombuſes *o s t i*, *p z d i*; 3d, the three rhombuſes ſituated on the ſame line behind the two preceding.

Cryſtals of the oriental are found particularly in the kingdom of Pegu. There are alſo in France ſapphires called the ſapphires of Puy. They are found at the diſtance of a league from Velai, on the banks of a rivulet near the village of Expailly, where they are mixed with garnets and hyacinths. Theſe ſapphires have all the characters of the ſtone called *oriental ſapphire*.

V. *Difference between Structure and Increment.*

In what I have hitherto ſaid reſpecting the decrements to which the laminæ of ſuperpoſition are ſubjected, my only view was to unfold the laws of ſtructure; and I am far from believing that, in the formation of a dodecaedral cryſtal, or one of any other form having a cube for nucleus, the cryſtalliſation has originally produced that nucleus ſuch as it is extracted from the dodecaedron, and made it afterwards paſs to the figure of that dodecaedron, by the ſucceſſive application of all the laminæ of ſuperpoſition by which it is covered. On the contrary, it ſeems proved, that from the firſt moment the cryſtal is already a very ſmall dodecaedron, containing a cubical nucleus proportioned to its ſmall ſize, and that the cryſtal afterwards increaſes by degrees without changing its form, by new layers which envelop it on all ſides, ſo that the nucleus increaſes alſo, always preſerving the ſame relation with the whole dodecaedron.

Let

Let us make this more ſtriking by an example taken from a plane figure. What I am going to obſerve reſpecting this figure may be eaſily applied to a ſolid, ſince we may always conceive a plane figure as a ſection of a ſolid. Let E R F N then (*fig.* 74.) be an aſſortment of ſmall ſquares, in which the ſquare A B C D, compoſed of forty-nine partial ſquares, repreſents a ſection of the nucleus, and the extreme ſquares R, S, G, A, I, L, &c. that of the kind of ſtair formed by the laminæ of ſuperpoſition. It may be readily conceived that the aſſortment began by the ſquare A B C D; and that different files of ſmall ſquares were afterwards applied on each of the ſides of the central ſquare, for example, on the ſide A B, firſt the five ſquares comprehended between I and M, next the three ſquares comprehended between L and O, and then the ſquare E. This increment correſponds with that which would take place if the dodecaedron began by being a cube, proportioned to its bulk, and which increaſed afterwards by the addition of continually decreaſing laminæ.

But, on the other hand, we may conceive that the aſſortment was at firſt like that repreſented by fig. 76, in which the ſquare *a b c d* is compoſed of only nine moleculæ, and bears upon each of its ſides only one ſquare *e*, *n*, *f*, or *r*; and that afterwards, by means of the application of new ſquares, arranged around the former, the aſſortment has become that of figure 75, where the central ſquare $a' b' c' d'$ is formed of twenty-five ſmall ſquares, and bears on each of its ſides a file of three ſquares, plus a terminating ſquare e', n', f' or r', and that, in ſhort, by a farther application the aſſortment of fig. 75 is converted into that of fig. 74. Theſe different tranſitions will give an idea of the manner in which ſecondary cryſtals may augment in bulk, yet retain their form; from which it is ſeen that the ſtructure is combined with that augmentation of bulk, ſo that the law, according to which all the laminæ applied in the nucleus of the cryſtal, when arrived at its greateſt dimenſions, ſucceſſively decreaſe, in departing from this nucleus, exiſted already in the riſing cryſtal.

The theory I have explained, ſimilar in this to other theories, ſets out from a principal fact, on which it makes all facts of the ſame kind to depend, and which are only as it were corollaries. This fact is the decrement of the laminæ ſuperadded to the primitive form; and it is by bringing back this decrement to ſimple and regular laws, ſuſceptible of accurate calculation, that theory arrives at reſults the truth of which is proved by the mechanical diviſion of cryſtals, and by obſervation of their angles. But there ſtill remain new reſearches to be made, in order to aſcend a few ſteps farther towards the primitive laws to which the Creator has ſubjected cryſtalliſation; and which are nothing elſe themſelves than the immediate effects of his ſupreme will. The object of one of theſe reſearches would be to explain how theſe ſmall polyedra, which are, as it were, the rudiments of cryſtals of a ſenſible bulk, repreſent ſometimes the primitive form, without any modification; ſometimes a ſecondary form produced in virtue of a law of decrement; and to determine the circumſtances which produce decrements on the edges, and thoſe which give riſe to decrements on the angles. I have already paid attention to the ſolution of this problem, as delicate as it is intereſting; but hitherto I have only had conjectures, which, before they deſerve to be publiſhed, require to be verified by more attentive labour and more profound meditation.

IX. *On the Principles of Equilibrium, and the Stability of floating Bodies applied to River and Canal Boats of different Forms. By Mr.* JOHN GEORGE ENGLISH, *Teacher of Mathematics and Mechanical Philosophy. Communicated by the Author.*

THE principles of dynamics in general, and of ſtatics in particular, have already been ſo fully explained by ſome of the ableſt mathematicians in Europe, that little or nothing of conſequence is farther to be expected on thoſe ſubjects, unleſs our mode of calculus be either greatly improved or totally changed. And as neither of theſe events is likely ſoon to take place, we ought certainly, in the mean time, to apply to the common concerns of life the principles of which we are already in poſſeſſion. But ſince war and merchandiſe ſeem at preſent to be the chief buſineſs of all European nations, and ſince neither the one nor the other can be carried on to any great extent without navigation, nor can any veſſel with ſafety be navigated without a proper degree of ſtability; it is therefore a matter of the greateſt importance to determine with accuracy the ſtability of nautical veſſels of all kinds.

However operoſe and difficult the neceſſary calculations may in ſome caſes become before the degree of this eſſential quality can be obtained, yet they all depend upon the four following ſimple and obvious theorems, accompanied with other well known ſtereometrical and ſtatical principles.

THEOREM I. Every floating body diſplaces a quantity of the fluid in which it floats, equal to its own weight: and conſequently, the ſpecific gravity of the fluid will be to that of the floating body, as the magnitude of the whole is to that of the part immerſed.

THEOREM II. Every floating body is impelled downward by its own eſſential power, acting in the direction of a vertical line paſſing through the centre of gravity of the whole;

whole; and is impelled upward by the re-action of the fluid which supports it, acting in the direction of a vertical line passing through the centre of gravity of the part immersed: therefore, unless these two lines are coincident, the floating body thus impelled must revolve round an axis, either in motion or at rest, until the equilibrium is restored.

THEOREM III. If by any power whatever a vessel be deflected from an upright position, the perpendicular distance between two vertical lines passing through the centres of gravity of the whole, and of the part immersed respectively, will be as the stability of the vessel, and which will be positive, nothing, or negative, according as the metacentre is above, coincident with, or below, the centre of gravity of the vessel.

THEOREM IV. The common centre of gravity of any system of bodies being given in position, if any one of these bodies be moved from one part of the system to another, the corresponding motion of the common centre of gravity, estimated in any given direction, will be to that of the aforesaid body, estimated in the same direction, as the weight of the body moved is to that of the whole system.

From whence it is evident, that in order to ascertain the stability of any vessel, the position of the centres of gravity of the whole, and of the part immersed must be determined; with which, and the dimensions of the vessel, the line of floatation, and angle of deflection, the stability or power either to right itself or overturn may be found.

In ships of war and merchandise, the calculations necessary for this purpose become unavoidably very operose and troublesome; but they may be much facilitated by the experimental method pointed out in the New Transactions of the Swedish Academy of Sciences, first quarter of the year 1787, page 48.

In river and canal boats, the regularity and simplicity of the form of the vessel itself, together with the compact disposition and homogeneal quality of the burden, render that method for them unnecessary, and make the requisite calculations

lations become very eaſy. Veſſels of this kind are generally of the ſame tranſverſe ſection throughout their whole length, except a ſmall part in prow and ſtern, formed by ſegments of circles or other ſimple curves; therefore a length may eaſily be aſſigned ſuch, that any of the tranſverſe ſections being multiplied thereby, the product will be equal to the whole ſolidity of the veſſel. The form of the ſection ABCD is for the moſt part either rectangular as in *fig.* 1. (*Plate XIII.*), trapezoidal as in *fig.* 2. or mixtilineal as in *fig.* 3. in all which MM repreſents the line of floatation when upright, and EF that when inclined at any angle MXE; alſo G repreſents the centre of gravity of the whole veſſel, and R that of the part immerſed.

If the veſſel be loaded quite up to the line AB, and the ſpecific gravity of the boat and burden be the ſame, then the point G is ſimply the centre of gravity of the ſection ABCD; but if not, the centres of gravity of the boat and burden muſt be found ſeparately, and reduced to one by the common method, namely, by dividing the ſum of the momenta by the ſum of weights, or areas, which in this caſe are as the weights. The point R is always the centre of gravity of the ſection MMCD, which, if conſiſting of different figures, muſt alſo be found by dividing the ſum of the momenta by the ſum of the weights as common. Theſe two points being found, the next thing neceſſary is to determine the area of the two equal triangles MXE, MXF, their centres of gravity *o*, *o*, and the perpendicular projected diſtance *n n* of theſe points on the water line EF. This being done, through R and parallel to EF draw RT = a fourth proportional to the whole area MMCD, either triangle MXE or MXF, and the diſtance *n n*; through T, and at right angles to RT or EF, draw TS meeting the vertical axis of the veſſel in S the metacentre; alſo through the points G, B, and parallel to ST, draw NGW and BV; moreover through S, and parallel to EF, draw WSV meeting the two former in V and W; then SW is as the ſtability of the veſſel, which will be poſitive, nothing, or negative, according as the point S is above, coincident with, or below, the point G. If now we ſuppoſe W to repreſent the weight of the whole veſſel and burden (which will be equal to the ſection MMCD multiplied by the length of the veſſel), and P to repreſent the required weight applied at the gunwale B to ſuſtain the veſſel at the given angle of inclination; we ſhall always have this proportion: as VS : SW :: W : P; which proportion is general, whether SW be poſitive or negative; it muſt only in the latter caſe be ſuppoſed to act upward to prevent an overturn.

In the rectangular veſſel, of given weight and dimenſions, the whole proceſs is ſo evident, that any farther explanation would be unneceſſary. In the trapezoidal veſſel, after having found the points G and R, let AD, BC be produced until they meet in K. Then ſince the two ſections MMCD, EFDC are equal, the two triangles MMK, EFK are alſo equal; and therefore the rectangle $EK \times KF = KM \times KM = \overline{KM}^2$; and ſince the angle of inclination is ſuppoſed to be known, the angles at E and F are given. Conſequently, if a mean proportional be found between the ſines of the angles at E and F, we ſhall have the following proportions:

As the mean proportional thus found: ſine ∠E :: KM : KF,
And as the ſaid mean proportional: ſine ∠F :: KM : KE;
therefore ME, MF become known; from whence the area of either triangle MXE or MXF, the diſtance *nn*, and all the other requiſites may be found.

In the mixtilineal ſection, let AB = 9 feet = 108 inches, the whole depth = 6 feet = 72 inches, and the altitude of MM the line of floatation 4 feet or 48 inches; alſo let the two curvilinear parts be circular quadrants of 2 feet, or 24 inches radius each. Then the area of the two quadrants = 904·7808 ſquare inches, and the diſtance of their centres of gravity from the bottom = 13·8177 inches very nearly; alſo the

the area of the included rectangle $abie = 1440$ square inches, and the altitude of its centre of gravity 12 inches; in like manner the area of the rectangle ABcd will be found = 5184 square inches, and the altitude of its centre of gravity 48 inches; therefore we shall have

Momentum of the 2 quadrants	= 904·7808	× 13·8177	=	12501·98966016
Momentum of the rectan. $abie$	= 1440·	× 12	=	17280·
Momentum of the rectan. ABcd	= 5184·	× 48	=	248832·
	7528·7808			278613·98966016

Now the sum of the momenta divided by the sum of the areas will give $\frac{278613 \cdot 98966016}{7528 \cdot 7808} = 37 \cdot 006$ inches, the altitude of G the centre of gravity of the section ABCD above the bottom. In like manner the altitude of R the centre of gravity of the section MMCD will be found to be equal $\frac{123093 \cdot 98966016}{4936 \cdot 7808} = 24 \cdot 934$ inches; and consequently their difference, or the value of GR = 12·072 inches, will be found.

Suppose the vessel to heel 15°, and we shall have the following proportion, namely, As radius : tangent of 15° : : MX = 54 inches : 14·469 inches = ME or MF; and consequently the area of either triangle MXE or MXF = 390·663 square inches. Therefore, by theorem 4th, As 4936·7808 : 390·663 : : 72 = nn = $\frac{2}{3}$AB : 5·6975 inches = RT; and again, As radius : sine of 15° : : 12·072 = GR : 3·1245 inches = RN; consequently RT−RN = 5·6975 − 3·1245 = 2·573 inches = SW the stability required.

Moreover, As the sine of 15° : radius : : 5·6975 = RT : 22·013 = RS, to which if we add 24·934, the altitude of the point R, we shall have 46·947 for the height of the metacentre, which taken from 72, the whole altitude, there remains 25·053; from which and the half width = 54 inches, the distance BS is found = 59·529 inches very

7 nearly,

nearly, and the angle SBV = $80^\circ-06'-42''$; from whence SV = 58·645 inches.

Again: Let us ſuppoſe the mean length of the veſſel to be 40 feet, or 480 inches, and we ſhall have the weight of the whole veſſel equal to the area of the ſection MMCD = 4936·7808 multiplied by 480 = 2369654·784 cubic inches of water, which weighs exactly 85708 pounds avoirdupoiſe, allowing the cubic foot to weigh 62·5 pounds.

And, finally, as SV : SW (*i. e.*) as 58·645 : 2·573 :: 85708 : 3760+, the weight on the gunwale which will ſuſtain the veſſel at the given inclination. Therefore a veſſel of the above dimenſions, and weighing 38 tons, 5 cwts. 28 lbs. will require a weight of 1 ton, 13 cwts. 64 lbs. to make her incline 15°.

In this example the deflecting power has been ſuppoſed to act perpendicularly on the gunwale at B; but if the veſſel is navigated by ſails, the centre velique muſt be found; with which, and the angle of deflection, the projected diſtance thereof on the line SV may be obtained; and then the power, calculated as above, neceſſary to be applied at the projected point, will be that part of the wind's force which cauſes the veſſel to heel. And converſely, if the weight and dimenſions of the veſſel, the area and altitude of the ſails, the direction and velocity of the wind be given, the angle of deflection may be found.

X. *New Method of freeing Molaſſes from their ſharp Taſte, and rendering them fit to be uſed inſtead of Sugar. From* Crell's Chemical Annals, 1798, *Vol. I. Part* 2.

CADET DEVAUX, according to the experiments made by Lowitz, gives the following method: Take twenty-four pounds of molaſſes, twenty-four pounds of water, and ſix pounds of charcoal coarſely pulveriſed; and having mixed them in a kettle, boil the whole over a ſlow wood fire.

 When

When the mixture has boiled half an hour, pour it into a flat veffel, in order that the charcoal may fubfide to the bottom; then pour off the liquid, and place it over the fire once more, that the fuperfluous water may evaporate, and to give to the molaffes their former confiftence. Twenty-four pounds of molaffes will produce twenty-four pounds of fyrup.

This method has been employed on a large fcale with the happieft effects; the molaffes become fenfibly milder, and can be employed in many articles of food; though in difhes where milk is ufed, or for cordials mixed with fpices, fugar is to be preferred.

XI. *Defcription and Ufe of the Dynanometer, or Inftrument for afcertaining the relative Strength of Men and Animals. Invented by Cit.* REGNIER. *From* Journal de l'Ecole Polytechnique, *Vol. II. 6th Year.*

WHEN Sanctorius invented his balance, he taught us what we lofe by infenfible perfpiration; and no one, without this difcovery, would perhaps ever have imagined that the matter thrown out from the body is more than half what we receive as nourifhment. Knowledge no lefs important might be acquired, had we the eafy means of afcertaining, in a comparative manner, our relative ftrengths at the different periods of life, and in different ftates of health. Buffon and Gueneau, who had fome excellent ideas on this fubject, requefted me to endeavour to invent a portable machine, which, by an eafy and fimple mechanifm, might conduct to a folution of this queftion, on which they were then engaged. Thefe philofophers were acquainted with that invented by Graham, and improved by Dr. Defaguliers, at London; but this machine, conftructed of wooden-work, was too bulky and heavy to be portable; and, befides, to make experiments on the different parts of the body, feveral machines

machines were neceſſary, each ſuited to the part required to be tried. They were acquainted alſo with the dynanometer of Cit. Leroy of the Academy of Sciences at Paris. It conſiſted of a metal tube ten or twelve inches in length, placed vertically on a foot like that of a candleſtick, and containing in the inſide a ſpiral ſpring, having above it a graduated ſhank terminating in a globe. This ſhank, together with the ſpring, ſunk into the tube in proportion to the weight acting upon it, and thus pointed out, in degrees, the ſtrength of the perſon who preſſed on the ball with his hand.

This inſtrument, though ingenious, did not appear ſufficient however to Buffon and Gueneau; for they wiſhed not merely to aſcertain the muſcular force of a finger or hand, but to eſtimate that of each limb ſeparately, and of all the parts of the body. I ſhall not here give an account of the attempts I made to fulfil the wiſhes of theſe two philoſophers, but only obſerve, that in the courſe of my experiments I had reaſon to be convinced that the conſtruction of the inſtrument was not ſo eaſy as might have been expected. Beſides the uſe which an enlightened naturaliſt may make of this machine, it may be poſſible to apply it to many other important purpoſes. For example, it may be employed with advantage to determine the ſtrength of draught cattle; and, above all, to try that of horſes, and compare it with the ſtrength of other animals. It may ſerve to make known how far the aſſiſtance of well-conſtructed wheels may favour the movement of a carriage, and what is its *vis inertiæ* in proportion to the load. We might appreciate by it, alſo, what reſiſtance the ſlope of a mountain oppoſes to a carriage, and be able to judge whether a carriage is ſufficiently loaded in proportion to the number of horſes that are to be yoked to it. In the arts, it may be applied to machines of which we wiſh to aſcertain the reſiſtance, and when we are deſirous to calculate the moving force that ought to be adapted to them. It may ſerve, alſo, as a Roman balance to weigh burdens. In ſhort, nothing would be more eaſy than to convert it into an anemometer, to diſcover the abſolute force of the wind, by fitting to it a frame of a determined ſize filled up with wax-cloth; and it would not be impoſſible to aſcertain by this machine the recoil of fire-arms, and conſequently the ſtrength of gunpowder.

This dynanometer, in its form and ſize, has a near reſemblance to a common graphometer. It conſiſts of a ſpring twelve inches in length, bent into the form of an ellipſis; from the middle of which ariſes a ſemicircular piece of braſs, having engraved upon it the different degrees that expreſs the force of the power acting on the ſpring. The whole of this machine, which weighs only two pounds and a half, opposes, however, more reſiſtance than may be neceſſary to determine the action of the ſtrongeſt and moſt robuſt horſe. The ſimplicity of its mechaniſm will be better illuſtrated by the following deſcription:

A, an elliptical ſpring, ſeen in perſpective, covered with leather, that it may not hurt the fingers when ſtrongly preſſed on with the hands, (*ſee Plate XIII.*) This ſpring is compoſed of the beſt ſteel well welded and tempered, and afterwards ſubjected to a ſtronger proof than is indicated by its graduation, in order that it may not loſe any of its elaſticity by uſe.

B, a piece of ſteel ſtrongly faſtened to the ſpring by means of a claw and ſcrews, in order to ſupport a ſemicircular plate of braſs C, mounted on the ſpring, ſeen geometrically. On this plate are engraved two arcs, one divided into myriagrammes, and the other into kylogrammes. Each of theſe arcs is ſtill farther divided by points, which expreſs the weight in pounds *de marc*; and all theſe degrees having been exactly valued by accurate weights, it thence reſults that all dynanometers of this kind may be compared with each other.

D, a ſmall ſteel ſupport, adjuſted like the former to the other branch of the ſpring, and having a cleft towards its upper extremity to receive freely a ſmall copper lever E, which is kept in its place by a ſmall ſteel pin *a*. The whole of this mechaniſm is ſeen of its full ſize at H.

F, a ſteel index, very light and elaſtic, fixed upon its axis by a ſcrew in the centre of the braſs ſemicircle. This index has a ſmall bit of leather or cloth glued upon the ſmall circular part G, in order to render the friction on the plate eaſy, uniform, and almoſt inſenſible. It is to be obſerved, that this index is terminated by a double point, adapted to the diviſions on both the ſemicircular arcs. The firſt, divided into myriogrammes and points, expreſſing ten pounds *de marc*, ſerves for all experiments which oblige the ſpring to be elongated in the direction of its greater axis, as is the caſe in trying the ſtrength of the reins; in a word, for all trials where it is neceſſary to draw the ſpring by the two ends. The ſecond, divided into kylogrammes and points, expreſſing pounds *de marc*, is deſtined for experiments which compreſs the two ſides of the ſpring, as in trying the force of the hands.

J, a ſmall plate of braſs which covers the mechaniſm, to prevent it from being injured. This ſmall plate has on it alſo a divided arc, the degrees of which correſpond with thoſe of the firſt arc of the machine; and by the play of a ſmall index *b*, which is under the plate, the movements of the ſpring may be aſcertained.

K, an aperture in the covering plate, through which may be introduced a ſmall turnſcrew, for the purpoſe of tightening or eaſing the index as may be neceſſary.

L, a pallet of braſs, with a ſcrew, having a cap like that on the needle of the mariner's compaſs, in which the lower pivot of the lever, that puſhes round the index or handle, is made to play. This pallet, acting as a ſpring, yields to any ſudden ſhock, and prevents the derangement of the mechaniſm.

M, a

M, a ſocket riveted on the plate J, in which the upper pivot of the lever turns.

N, N, N, ſmall cylindric pillars that ſupport the covering plate, which is fixed to them by three ſcrews.

O, an iron rack, on the lower part of which the feet muſt be placed when it is intended to try the ſtrength of a perſon's body.

P, a double handle of wood, with an iron hook, to be held at the ſame time in the two hands.

Q, a double hook made of iron, one end of which is to be hooked to the end of the ſpring, and the other to a rope faſtened to a ſtake, as at *c*, when experiments are to be made on the ſtrength of horſes, or others, that require the dynanometer to be ſupported by hooks.

R, the manner of holding the dynanometer to aſcertain the ſtrength of the hands.

S, poſition of a man when trying the ſtrength of his reins.

T, diſpoſition of the dynanometer to try the ſtrength of a horſe or any other draught animal.

The effects of this machine may be thus explained: If a perſon preſſes on the ſpring with the hands, or draws it out lengthwiſe, by pulling the two extremities in a contrary direction, the two ſides of the ſpring approach each other; and in proportion as they are brought nearer, the ſmall lever of the mechaniſm puſhes before it the index, which, by the tightneſs with which it is ſcrewed in its place, will remain at the point to which it has been brought by the pin *d*, in conſequence of the force acting on the ſpring.

The muſcular force of the arms, or rather the ſtrength of the hands, may be tried by laying hold of the two ſides of the ſpring neareſt to the centre, as may be ſeen figure R; ſo that the arms may be a little ſtretched, and inclined downwards, almoſt at an angle of 45 degrees. This poſition, which appears the moſt natural, is alſo the moſt convenient for a man to act with his full force. It is to be recollected, that the lower arc of division, divided into kylogrammes, is that which serves to express the force of hands, and of all the actions which press the two sides of the spring. The strength of the hands may also be tried one after the other; and if an account be kept of the degree of pressure of the right hand, and then of the left, and these two sums be added together, it will be found that the sum-total is, in general, equal to the strength of both the hands when acting together.

To try the strength of the body, or rather the reins, the person must place his feet on the bottom part of the rack O; one of the ends of the spring is then to be placed in one of the hooks of the rack; and the hook P is to be put into the other end. In this position the body is perpendicular; the shoulders only being inclined a little forwards, to be able, in throwing back the body, to pull the spring with all the force which a person is capable of exerting. In this situation, represented by S, a man may raise a great weight without being exposed to those accidents which might be occasioned by an effort made in a more constrained position.

Nothing can be more convenient than this dynanometer to ascertain and compare the strength of horses and that of all draught animals. Figure T shews, in a sufficient manner, the dispositions necessary for experiments of that kind. The trials I made on this subject are not extensive; but as they were conducted with care, they may serve to give a very just idea of the absolute force of horses of middling strength. For this purpose I employed four horses of middle size, in good health and well-conditioned, which were subjected separately and in succession to the same trial. The first drew equivalent to 36 myriagrammes; the second $38\frac{1}{2}$; the third $26\frac{1}{2}$; and the fourth 43. The sum of all these is 144 myriagrammes; and if we take the mean of this sum, we shall have, for the strength of ordinary horses, 36 myriagrammes, or 736 pounds *de marc*.

XII. *Method of filling up Engraving on Silver with a durable Black Enamel, as practised in Persia and India. Communicated in a Letter from Siberia to Professor* PALLAS. *From* Neue Nordische Beytrage, *Vol. V.*

I AM now acquainted with the secret of our silversmiths for filling up the engraving in plate with a black, glassy, durable mass, respecting which we have so often conversed; and it is very singular that the Russians must have derived this process from the Persians and the Indians.

They take half an ounce of silver, $2\frac{1}{2}$ ounces of copper, $3\frac{1}{2}$ ounces of lead, 12 ounces of sulphur, and $2\frac{1}{2}$ ounces of sal ammoniac. The metals are melted together and poured into a crucible, which has been before filled with pulverised sulphur made into a paste by means of water; the crucible is then immediately covered that the sulphur may not take fire, and this regulus is calcined over a smelting fire until the superfluous sulphur be burnt away. This regulus is then coarsely pounded, and, with a solution of sal ammoniac, formed into a paste, which is rubbed into the engraving on silver plate. The silver is then wiped clean, and suffered to become so hot under the muffle, that the substance rubbed into the strokes of the engraving melts and adheres to the metal. The silver is afterwards wetted with the solution of sal ammoniac, and again placed under the muffle till it becomes red hot. The engraved surface may then be smoothed and polished without any danger of the black substance, which is an artificial kind of silver ore (*fahlerz*), either dropping out or decaying. In this manner is all the silver plate brought from Russia ornamented with black engraved figures, &c.

 XIII. *Dif-*

XIII. *Different Methods employed in Encaustic Painting, according to the Principle followed by the ancient Greek and Roman Painters, discovered by the Abbé* REQUENO, *and since practised with much Success at Rome.* Communicated by Mr. CHARLES HEATHCOTE TATHAM, Architect.

THE following receipt for painting in *encausto*, copied from an original paper, was presented to Mr. Tatham, at Caserta near Naples, by Mr. Philip Hackert, painter to his Neapolitan Majesty. It exemplifies the mode supposed to be practised by the ancients in their arabesque. After this manner a large bath was decorated in a casino of the king of Naples at Belvidere near Caserta, the walls and vaulted cieling of which were entirely covered with encausto, under the direction of Mr. Hackert, who was so obliging as to accompany Mr. Tatham to visit the success of it, which he did, much to his satisfaction, when upon his travels in the year 1795.

The first preparation is as follows: Infuse a pound of gum tragacanth * in a proportionate quantity of water, for twenty-four hours, in an earthen vessel. When this solution is pretty thick, add to it mineral colours of any sort, broke into pieces without being pounded, and which must afterwards be prepared in the following manner:

Put an ounce of white wax and an ounce of gum tragacanth into a small earthen vessel well glazed, together with two or three pounds of water, and keep the vessel over a brisk fire, that the ingredients may become liquid, stirring them continually with a small stick. When the whole are well dissolved, take the vessel from the fire, and, after the liquor has cooled, skim off the wax from the surface. The oily parts of this wax are left in the gum water, which must be afterwards strained through a piece of linen cloth. This liquid and the colours prepared

* Commonly called gum dragon.

with

with it may be kept ſeveral months, in bottles cloſely ſtopped, after a little brandy or ſpirit of wine is added to it, and will be good even at the end of ſeveral years.

The colours moiſtened with the ſolution of gum tragacanth muſt, for the greater convenience, be ground with pure water, and afterwards with the above-mentioned preparation, till they become exceedingly fine; and they may then be employed for painting all ſorts of figures or landſcapes in arabeſque, in the manner of diſtemper or *de gauche*. When they are perfectly dry, they are then covered with white liquid wax, warmed by burning coals placed in a chaffing-diſh: when the wax begins to melt, it is ſpread out by means of a badger-hair bruſh, to render it every where equal; and when cool, a poliſh and luſtre are given to it with a proper rubber or piece of ſoft cloth.

The ſecond method of preparation, which was found more convenient, is the following: Having put an equal quantity of white wax grated and of gum arabic in an earthen veſſel, with as much water as may be neceſſary to render it more or leſs thick, according to pleaſure, the ſame proceſs is then to be followed as in the preceding caſe: the colours muſt be finely ground with this mixture, and may then be employed for painting.

Theſe two preparations were employed with great ſucceſs, for three years, to paint various pictures, decorations and ornaments, ordered by the empreſs of Ruſſia; and the tranſparency of the colours produced a moſt brilliant effect. In the beginning of the year 1791 the three ableſt artiſts in *encauſto*, M. dell' Era, in the hiſtorical line; M. Campovecchio for landſcapes; and M. Vincent Angeloni for arabeſque ornaments, uſed them with a very happy effect, and the pieces they produced were not inferior in luſtre and brilliancy to the fineſt paintings in oil mixed with varniſh. Several trials were made in this way on walls, wood, cloth, paper, copper, and marble; and it was found that paintings on the latter ſubſtances could be waſhed by means of a ſponge

 dipped

dipped in water, but that too ſtrong friction penetrated to the colours, and carried off a part of them. Paintings on walls or wooden pannels reſiſted friction much better; but if the hand preſſed too hard, ſome of the colour was deſtroyed, eſpecially in places to which the liquid wax had not ſufficiently penetrated.

To prevent theſe inconveniences, trial was made of other preparations, pointed out before by the Abbé Requeno, agreeably to ſeveral paſſages of Pliny and Vitruvius. Theſe trials were perfectly ſucceſsful, and paintings executed with the preparations, as hereafter mentioned, reſiſted much better friction with a wet ſponge. The mechaniſm even of painting in this manner, with theſe colours, was found more convenient and much eaſier, becauſe the colours did not dry ſo ſpeedily as thoſe prepared in the firſt and ſecond manner.

The preparation of colours agreeably to the laſt method is as follows: Take a vaſe of vitrified earth, and place it over a ſmall fire with an ounce of white wax; and when the wax is melted, add four ounces of olibanum *(incenſo maſchio,)* reduced to powder, which muſt be alſo diſſolved with the wax. This mixture muſt be put into a ſmall veſſel with water, and you will obtain a hard brittle crayon, which muſt be mixed with the colours when ground up.

The ſame proceſs may be followed with maſtic, by taking five ounces of that ſubſtance and two of wax, and this crayon will ſerve for the brighter colours. For darker colours the crayon may be made of four ounces of aſphaltos and two ounces of wax.

Method of making Diſtemper for preparing the Colours.

Infuſe, for twenty-four hours, a pound of the gum of the cherry-tree, and, when it is diſſolved, put it into a ſmall earthen veſſel, and boil it with two ounces of wax and half an ounce of olibanum reduced to a fine powder. When this liquor is cool, take off the wax which floats on the top,

and

and then mix the liquid with the colours, in order to render them more oily and fluid. Care must be taken that this preparation be a little thick.

XIV. *Chemical Observations on the Epidermis. By J. A. Chaptal. From* Annales de Chimie, *Vol. XXVI.*

THE epidermis of the human skin is perhaps the best expanded and the easiest to be detached of any, and for that reason I made it the subject of the following experiments.

The human skin becomes shrivelled in hot water, and divides itself into two distinct parts, the *epidermis* and the *cutis.* The latter resembles then in its consistence a softened cartilage. The continued action of warm water at length dissolves the cutis, but does not sensibly affect the epidermis. Alcohol kept a long time in digestion on the epidermis likewise produces no effect. Caustic alkali dissolves it, and the same effect is produced by lime, though more slowly. There is then an analogy between the external covering of the human body and that which covers silk. From these observations we are authorised to deduce the following consequences, which may be applied, without overstraining the principle, to the operations of tanning. 1. If we plunge into a tanning infusion a piece of skin covered by its epidermis, the tan penetrates only on the flesh-side: the other side is secured from it by the epidermis, which is not susceptible of any combination with the tanning principle.

2. When the epidermis is removed by the operation of liming, the tan then penetrates on both sides of the skin.

3. Lime, which is generally employed for taking off the hair, seems to act only by dissolving the epidermis. Lime-water has more action than undissolved lime; but its effect ceases the moment that the small quantity of lime held in solution is combined with the epidermis: hence the necessity of renewing the lime-water till the whole effect required be produced.

XV. Of

XV. *Of a remarkable Cure effected by the Use of Carbonic Acid Gas, communicated in a Letter to his Excellency Prince Demetrius de Golitzin, Minister of the Imperial Court of Russia at the Hague. By M. D.* Jansens *of Oosterbout. From the* New Transactions of the Imperial Academy of Sciences at Petersburgh, *Vol. I.*

Oosterhout, Nov. 23d, 1778.

IN the conversation I had the honour of having with your Excellency on the medical virtue of carbonic acid gas, or fixed air, I promised to give you an account of the effects it might produce in the putrid fever, by being injected into the rectum; but though in the following case, which is certainly very uncommon, I have not exactly followed the method pointed out by your Excellency, having been obliged to give as much of the cinchona or Peruvian bark as possible, I however believe that it greatly contributed to the cure.

The wife of a bargeman at G. Berg, named N. Swart, aged thirty-two, of a sanguine temperament and a sound constitution from the time of her birth, was attacked, after her third natural delivery, according to every appearance a favourable one, which happened on the 6th of October at two o'clock in the morning, with a fever that began on the 8th. It may be right to premise, that on the 6th she was exceedingly well, and her evacuations were perfectly free.

On the 7th they flowed less, and she began to complain of lassitude, a great heaviness in all her limbs attended with a loss of appetite, and the disappearance of milk from her breasts. At the commencement of the third day the evacuations were stopped, and the fever came on by cold and successive fits of shivering with reaching and pain in the head, which was not acute, but accompanied with a sensation like that of a weight pressing on the cranium, and from which she suffered less when in bed than when sitting up. These symptoms were followed by a great heat, with vomiting of a bilious, greenish, highly corrupted stuff: her tongue

was

was covered with a viscous matter of a yellowish colour the two first days, but it was afterwards brown till the 6th.

Her breathing was short, oppressive, and accompanied with a fetid smell. The pulse, which was weak, beat from 90 to 94 in a minute. The heat was not examined by a thermometer. The urine was red and fetid, without sediment. The patient had a violent thirst, and drank a great deal of whey with lemon juice.

On the second day of the fever she was affected with delirium, coma, restlessness, and a dread of death. On the third all these symptoms increased. On the fourth there was an involuntary discharge of urine, &c. On the fifth there came on a diarrhœa of a bilious and putrid matter; and the delirium being then continual, she suffered every thing to escape her. On the sixth the symptoms were no better. On the seventh the tonsils were white, and this thickened secretion, at length, covered all the parts of the mouth; deglutition became difficult, there was subsultus tendinum, and the patient with her trembling fingers picked the blankets. On the eighth all the symptoms were as before, with vibices half an inch in diameter, which rose in small blisters, and appeared on the breast, the hands, and other parts of the body. On the ninth these blisters discharged blood, for the most part thin and corrupted, the ground of which was in some a brown purple, and in others red. The cheeks were also of a brown purple colour, the eyes hollow, and the pupils much dilated. At last a cold sweat broke out on the face, the hands and feet; the mouth quivered, and the cheeks, lips, and all the members of the body were slightly convulsed.

All these bad symptoms gave reason to be apprehensive for the life of the patient; but the pulse continuing regular gave me some hope. While the patient was in this condition, being called in to consult with the physician who had treated the case according to the rules of the art, I advised the application of carbonic acid gas by the rectum, together

gether with the following decoction: Twenty-five grains of salt of tartar (carbonat of potash) dissolved in five ounces of a strong decoction of bark. I gave five ounces of this decoction, in which I had put as many drops of spirit of vitriol (sulphuric acid), to extricate the fixed air.

This injection was given twice the two first days, and only once daily for the three following.

In regard to medicine, the patient took every hour, in a cup-full of tea, the following decoction: Cinchona or bark in a coarse powder, four ounces, digested in a sufficient quantity of common water for three hours, till reduced to two pounds. I dissolved in a pound of this decoction a grain of salt of tartar, to which I added the other pound, into which I had put as many drops of spirit of vitriol as were necessary to saturate the alkali, and disengage the carbonic acid gas*.

On the tenth day all the symptoms were the same, except that the sweats were less cold. On the eleventh they were still less so; and perspiration proceeding equally from every part of the body, the tonsils began to look better, deglutition was not so difficult, and the delirium was not so continual. From time to time the patient was collected, and called for the urinal.

The twelfth and thirteenth she was still much better; the colour of the cheeks was almost natural, and the vibices became of a brighter red; the convulsions ceased, and all the other symptoms had almost disappeared. On the fourteenth a perfect crisis took place in regard to the urine and perspiration. On the fifteenth the patient felt no more fever, and had no symptom of disease except great debility; so that on the twentieth day she was perfectly re-established.

During the course of the disease her breasts were flaccid and very small, without milk; but having visited her on the

* This does not appear to be the best method that might have been devised for introducing the carbonic acid gas. In fact, the greatest part of that extricated from the carbonat would be thrown off at the moment of joining the ingredients. EDIT.

tenth

tenth of November, I saw milk issue from her breast; and, as she had almost recovered her strength, I advised her to let her infant try to suck, and the milk was restored.

I have been particular in detailing this case, that your Excellency, from the circumstances both of the nature of the disease and of its cause, which was probably a stoppage of the floodings after delivery, might the better be enabled to judge of the medical virtue of carbonic acid gas; and, at the same time, to see the reasons I have had for varying the application. I was afraid of a putrefaction or universal gangrene; against which I prescribed bark; and as the latter could not prevent the extrication of the carbonic acid gas, I added the substances necessary to produce it.

XVI. *Extract of a Memoir on the Fossil Bones of Quadrupeds. By Cit.* CUVIER. *From* Bulletin des Sciences, *No. XVIII.*

THE author's object in this memoir was to collect, as far as possible, every information respecting the various kinds of fossil bones hitherto found, whether seen by himself or described by others; to examine the skeletons, and to compare them with those of animals now existing on the globe, in order to determine how far they are similar or different. The following are the kinds which he examined:

1. The bones and tusks called by the Russians the bones and horns of the mammoth. Such fossil remains are found in various parts of Europe. This animal is a kind of elephant nearly resembling that of Asia, but differs from it in the alveoli of its tusks being longer; that the angle formed by its lower jaw is more obtuse, and that the laminæ of which its grinders are composed are thinner. A living animal really analogous to it is not known, though it has hitherto been considered as a common elephant.

2. The

2. The remains of an animal which have been found on the banks of the Ohio in North America, and which the Americans and the English consider as those of the mammoth also, though this animal is very different from the preceding. Remains of it are found also in Europe and Asia. It must be almost of the same height as the elephant, but more bulky. Its tusks are smaller; its grinders are armed with large cutting points, the section of which presents, when they are worn down, double transversal lozenges. There are three grinders on each side; one of which has four points, the second six, and the other eight.

3. The animal, the teeth of which tinged by copper furnish the turquois. Of these fossils there was a mine at Sinore in Languedoc. Remains of the same kind are found in the department of Ain, in Peru, and other places. This animal must have resembled the preceding; but the points of its grinders are of a conical form, and, when worn down, their section presents, first a circle, then a semi-oval, and then the figure of a trefoil; which has made them be confounded with the teeth of the hippopotamus. Some of these teeth have twelve points, others six, and others four.

4. The hippopotamus. There are found in France, and other countries, teeth and the fragments of jaw bones, in which the author has never yet been able to discover any thing different from those of the common hippopotami. As he never saw, however, a whole bone, he cannot affirm the identity.

5. That species of rhinoceros with an elongated cranium, the bones of which are found in Siberia, Germany, and other countries. The author has seen teeth and portions of the jaws found in France, which appeared to him to belong to this animal. The principal characterising mark of this species consists in the osseous partition of the nose. A living animal analogous to it is unknown.

6. A

6. A grinder with two transversal eminences, in the possession of Cit. Gillet, and of which a germ is preserved in the National Museum. It has no resemblance to the teeth, nor to the germs of the teeth, of any animal, whether living or in a fossil state, hitherto known. The only teeth to which it bears a resemblance is the last lower grinder of the rhinoceros. This tooth indicates, then, the existence of a sixth fossil species analogous to no living animal known.

7. The animal, twelve feet in length and six in height, the skeleton of which was found below the earth in Paraguay, and is now preserved in the Cabinet of Natural History belonging to the king of Spain at Madrid. By a minute comparison of the bones of this skeleton with those of all the known quadrupeds, the author proves that it is a peculiar and distinct species, which approaches nearer to the sloth than to any other kind, and that it might be named the giant-sloth. Cit. Cuvier here mentions, occasionally, an interesting discovery he has made, that the aï, or three-toed sloth (*bradypus tridactylus*, Lin.) has naturally and invariably nine cervical vertebræ. This is the first known exception to the rule established by C. Daubenton, that all the viviparous quadrupeds have neither more nor less than seven cervical vertebræ.

8. The animal, remains of which are found in the caverns near Gaylenreuth and Muggendorf, in the margraviate of Bayreuth in Franconia. Several have considered this animal as a sea-bear; but it differs from it, as well as from all the bears known, in the form of its head, characterised above all by the projection of the forehead; the want of the small tooth, which the bears hitherto known have behind each canine tooth; by the osseous canal of the humerus, through which the tracheal artery passes; and by several other circumstances in the figure and proportion of the bones. It is however to the bear that this animal has the greatest affinity.

9. The carnivorous animal, bones of which are found in

the plaster ſtone of Montmartre. The form of its jaw-bones, the number of its grinders, the points with which they are armed, indicate that this ſpecies muſt belong to the genus of the canis. It however does not exactly reſemble any known ſpecies of that genus. The moſt ſtriking diſtinctive mark is, that the ſeventh lower grinder is the greateſt in the animal of Montmartre; whereas it is the fifth in the dog, wolf, fox, &c.

10. The animal, a lower jaw of which, found near Verona, has been conſidered by Joſeph Monti as a portion of the cranium of the ſea-cow; an opinion adopted by all geologiſts, though contrary to the ſimpleſt principles of comparative anatomy. This jaw, according to Cit. Cuvier, has belonged to an animal approaching near to the mammoth, the animal of the Ohio, and that of Sinore, though ſpecifically different. Its moſt particular characteriſing mark conſiſts in the beak formed by its ſymphyſis.

11. The animal of the ſtag kind, bones and horns of which are found in Ireland, England, at Maeſtricht, &c. It is evidently diſtinct from all the ſtags known, and even from the elk, to which it has been referred, on account of the enormous ſize of its horns, the flatneſs of the upper part of them, and the branches that ariſe from the root. Several figures of them may be ſeen in the Philoſophical Tranſactions.

12. The genus of the ox alone furniſhes ſeveral ſpecies of foſſils. The ſkulls of two which have been deſcribed by Pallas, were found in Siberia. One of theſe he referred to the common buffalo; but he afterwards referred it to a particular ſpecies named arni, originating from Thibet. Cit. Cuvier proves, by oſteological compariſon, that this ſkull does not belong to the buffalo. The other kind appeared to Pallas to belong to the buffalo of the Cape, or the muſk-ox of Canada. Cit. Cuvier ſhews that they could not have belonged to the former; but, not having the cranium of the arni nor the muſk-ox, he does not ſpeak with certainty of their identity or non-identity with theſe foſſil crania.

The

The author describes, also, two sorts of crania found in the mosses in the department of La Somme, and which have a great resemblance to those of the urus, which are nearly one fourth larger.

Cit. Cuvier concludes his researches as follows: 1. It is not agreeable to truth to assert that the animals of the south have formerly existed in the north, their species not being perfectly identic. 2. That there have existed in all countries animals which do not exist at present, and that are no where to be found in any known part of the globe. He therefore leaves it to geologists to make such changes or additions, in regard to their systems, as they may think necessary to explain the facts which he has thus established.

XVII. *Observations on the Constituent Parts of Atmospheric Air. By Count de* MOROZZO. *With the Remarks of* F. VAN HUMBOLT. *From the* Journal de Physique, *Fructidor, 6th Year.*

IN the memoir which I published in 1784, on animal respiration in dephlogisticated or oxygen gas, I offered some reflections respecting the constituent parts of atmospheric air, founded on experiments I had made. Lavoisier, in his Elementary Treatise of Chemistry, does not agree with my experiments. That author says, that the component parts of atmospheric air are 73 parts of mephitic or azotic gas, and 27 of oxygen gas, eminently respirable. It will then be seen, adds he, that when animal substances are dissolved in the nitric acid, there is disengaged a great quantity of gas, which extinguishes a lighted candle, injures animals, and which has a perfect resemblance to that part of atmospheric air which is unfit for respiration. If to 73 parts of this fluid we add 27 of oxygen gas, obtained from mercury reduced to the state of an oxyde by calcination, there is formed a

fluid

fluid perfectly similar to that of the atmosphere, and which has all its properties.

The following, on the other hand, are the corollaries which I have deduced from a great number of experiments made to ascertain the duration of animal life in noxious aeriform fluids, mixed in different proportions with oxygen gas, tending to illustrate the real composition of atmospheric air.

1. The examination by means of burning tapers is not accurate for ascertaining the salubrity of the air. I shall quote only two examples. A fifth part of oxygen gas mixed with air contaminated by the vapour of sulphur, suffered a candle to burn, while an animal shut up in it died in a few seconds. A seventh part of the same gas mixed with air vitiated by the vapour of charcoal, supported flame, while an animal died in it almost instantaneously.

2. That pure and salutary part said to be contained in atmospheric air, which forms a third of it according to Scheele, and a fourth according to Lavoisier, is not a real dephlogisticated oxygen gas; since this gas united with mephitic airs, in a much less proportion than a third or fourth, supports the flame of a candle after an animal dies in it, which is not the case with atmospheric air.

3. The real component parts of atmospheric air are still unknown; since, with a mixture of different gases, nothing has been obtained but compound gases, which have indeed some properties of air, but never those of atmospheric air.

The author, to illustrate the question, relates eight characterising marks of atmospheric air, acknowledged by philosophers; and adds, that though he tried, by a multitude of experiments, to compose atmospheric air, by mixing dephlogisticated gas with different mephitic gases, the gases so obtained always contained something not to be found in atmospheric air.

He

He repeated the experiments of Lavoisier, by mixing 73 parts of fixed air (carbonic acid gas), obtained from lime, with 27 of gas obtained from the red precipitate. This mixture, indeed, exhibited to him all the characters and properties of atmospheric air, but it differed considerably from it in its essential property.

A candle is suddenly extinguished in atmospheric air in which an animal has died; another animal could not live in it an instant. On the other hand, in this artificial mixture, a flame burnt with vivacity; and a second animal, a sparrow, lived 25 minutes, a third 14 or 15: a light, introduced after the death of the third sparrow, burnt still with a bright flame. "*This mixture then does not form an elastic fluid perfectly similar to that of atmospheric air, and having all its properties.*" He tried to add to this mixture phlogisticated gas, inflammable air, and that in which an animal had died. A second and third animal lived in them some time, and a candle was not extinguished.

Remarks on the above Observations, by F. Von Humbolt.

The memoir of Count Morozzo treats of a very important subject, with which I have been engaged for some months. The Italian philosopher has observed the difference between natural atmospheric air and an artificial compound of azot and oxigen; but, in my opinion, he goes too far, in asserting that atmospheric oxygen is not vital gas; though I agree with him that we are not able to form an aeriform fluid, such as the illustrious Lavoisier announces in his Elements of Chemistry, perfectly similar to that of the atmosphere. I however find that this difficulty consists neither in our ignorance of the *quantity*, nor of the *quality* of the two gaseous bases. The difference found between the effect of natural and artificial atmospheric air, is to be ascribed to the *state of the combination* in which the oxygen is joined to the azot. The atmosphere is not a *mixture:* its constituent parts ought to be considered as in a state of *chemical combination.*

nation. It is for this reason that the two bases of a specific gravity so different, that of azot and that of oxygen, do not entirely separate from each other, though the high regions are most charged with azot. Hence azot retains so strongly the last portion of the oxygen, which phosphorus, the sulphure of potash, and other acidifiable bases ought to take from it; and I have for this reason seen that the nitrous gas acts in proportions very different in decomposing the natural atmospheric air, or a compound of 27 of oxygen and 73 of azot. But how could Morozzo think to imitate the atmosphere by mixing the carbonic acid and oxygen? He has confounded azot with the carbonic acid gas. But he assures us that his atmospheric air with a carbonic acid base, gave the same specific weight as atmospheric air. Here is a very striking experiment: one cubic inch of azot weighing 0,46624 grains, while the same cubic inch of carbonic acid weighed 0,67500 grains! Morozzo tells us that a candle burnt in his artificial mixture with a very brilliant flame (*con fiamma lucidissima*). By combining 0,25 of the carbonic acid with 0,75 of oxygen, I have seen a wax taper extinguished. The same thing took place when in company with Tasseart in Vauquelin's laboratory, I mixed two parts of the carbonic acid gas with ten parts of atmospheric air. There is then formed a new chemical combination: the carbonic acid lays hold so strongly of the oxygen of the atmosphere, that the affinity presented by the lighted wax taper is not powerful enough to take it away. In my work on the analysis of the mephitic vapour of mines, which is about to be translated into French, it will be seen that there exists airs not unfit for respiration, which are composed of 0,27 of oxygen, 0,70 of azot, and 0,03 of carbonic acid gas. It is the state of the combination, and not always the quantity of oxygen, which renders air more or less capable to destroy animal life, or to extinguish flame.

XVIII. *Cur-*

XVIII. *Curſory View of ſome of the late Diſcoveries in Science.*

[Continued from the laſt Number, page 309.]

LUMINOUS FLUID.

THERE are two principal opinions entertained by philoſophers reſpecting the nature of the luminous fluid. Some, with the ſchool of Epicurus, think that this fluid is a continual emanation of the luminous body which throws to a diſtance a portion of its ſubſtance. This is what is called the emiſſion of light, and was the opinion adopted by Newton.

Others, among whom is Euler, think that the luminous fluid is diffuſed throughout infinite ſpace, and that it is acted upon by the luminous bodies as the air is by ſonorous bodies. This opinion appears to Cit. de la Metherie much more probable than the former.

One of the ſtrongeſt objections made to this opinion is, that light is never propagated but in a ſtraight line. Objects cannot be ſeen, except when no opake body is interpoſed between them and the eye, whereas ſounds are heard in every kind of direction. Euler replied to this, by ſaying, that bodies are permeable to ſounds. Beſides there are circumſtances where ſounds alſo cannot be propagated but in a right line; for example, in echoes which are heard only in a very ſmall ſpace.

Chemiſts likewiſe are divided in their opinions reſpecting the luminous fluid. Some believe it to be an elementary ſubſtance, and others have confounded it with fire. Richter believes that it is compoſed of the inflammable principle and caloric.

Benedict Prevoſt has endeavoured to eſtimate the gravity of the luminous fluid. He made to float on water very thin round plates of tin, and theſe bodies were repelled when a cylinder of red hot iron was preſented to them obliquely at ſome diſtance, or when the rays of the ſun collected into a focus by a lens were made to fall upon them. Prevoſt is of opinion that the rays of the ſun penetrating the tin-plate are thus combined with a matter more denſe, and form therein a very expanſible fluid; but being leſs ſubtle, it becomes ſuſceptible of acting by impulſion on very large maſſes, and iſſuing with impetuoſity from the plate, but more rapidly from the focus, puſhes it backwards, and purſues its way through the water, which acts as a conductor to this fluid.

The author conjectures, from theſe experiments, that it is poſſible to deterrmine the gravity of light. It is well known that it takes about eight ſeconds to come from the ſun to the earth, that is to ſay, to traverſe a ſpace of about thirty-three millions of leagues. According to ſome ſuppoſitions, he finds that the light which in a ſecond of time falls upon the ſurface of a ſquare league, containing 2,283 toiſes on each ſide, would weigh about a dram (*gros*) and a quarter. It may be readily perceived that all theſe calculations are very hypothetical; and we may add, that from ſome experiments made by Profeſſor Wilſon of Glaſgow*, with a view to a different object, there is reaſon for calling in queſtion the effect produced upon the thin plates, or tin foil, as being at all produced by the impulſe of light. Heat only ſeems to be here concerned. The water at firſt being of an uniform temperature, has all its parts in a ſtate of equilibrium and reſt. When the tin foil is heated, it is evident that a very active cauſe is introduced tending to deſtroy that equilibrium. Heat being communicated by the tin to the water in contact with it, that portion of the water endeavouring by its expanſion to move from under the tin, muſt tend to move the tin from its place.

[To be continued.]

* See the Profeſſor's experiments on ſmall lighted wicks floating on oil, inſerted in the Edinburgh Tranſactions, Vol. IV. See alſo Count Rumford's Experiments on Heat.

XIX. *Com-*

XIX. *Communication from Dr. THORNTON, Lecturer on Medical Botany at Guy's Hoſpital, reſpecting a ſuppoſed Luſus Naturæ now exhibiting in London.*

IN the firſt volume of the Philoſophical Tranſactions, No. XXIX. publiſhed November 1667, you have the following communication, entitled,

"Some Hortulan Experiments about the engrafting of Oranges and Lemons or Citrons, whereby is produced an individual Fruit, half Orange and half Lemon, growing together as one Body upon the ſame Tree."

We have here orange trees (ſaith the intelligence from Florence), that bear a fruit which is citron on one ſide and orange on the other. They have been brought hither out of other countries, and they are now *much propagated* by *engrafting*. This was confirmed to us (ſays the Editor of the Tranſactions of the Royal Society), by a very ingenious Engliſh gentleman, who aſſerted, that himſelf not only had ſeen, but bought of them, anno 1660, in Paris, whither they had been ſent by Genoa merchants; and that on ſome trees he had found an orange on one branch, and a lemon on another branch, (which is not ſo remarkable as what follows;) as alſo, one of the ſame fruit, half orange and half lemon; and ſometimes three quarters of one, and a quarter of the other.

In the third part of the Reports of the Board of Agriculture, among the foreign communications, we ſee, with equal pleaſure and aſtoniſhment, an account of the American apple, which, by a peculiar mode of budding *, is half ſweet and half ſour, half white and half red, without the leaſt confuſion of the reſpective halves.

At Mr. Maſon's, floriſt, Fleet-ſtreet, oppoſite the Bolt and Tun, there is a production now to be ſeen half peach and half nectarine. It has all the ſoftneſs and yellow down of

* The manner in which the extraordinary nectarine-peach firſt produced in this country was effected, was by inſerting the bud of one fruit upon the ſtock bearing a different ſort.

the peach, and the sleek red smoothness of the nectarine; supposed to be a lusus naturæ, but probably is rather the sportings of art, than of nature, and which perhaps will be the cause why we shall in future see many other such vegetable wonders, which, as I have shewn, were known to our ancestors.

Respecting my promised communication concerning the silk-worm, I must beg leave to delay it, until I have ascertained for certain the difference of the Chinese, from the mulberry trees, cultivated here; the former being, I have reason to believe, only a shrub, with a very broad leaf, and dying down to the ground every year, springing up the next.

INTELLIGENCE.

LEARNED SOCIETY.

THE directors of the Imperial Academy of the Searchers into Nature, have proposed the following questions as subjects for prizes.

I. In which of the known parts of vegetable productions, the bark (*cortex*), inner bark (*liber*), wood (*alburnum et lignum*), pith (*medulla*), does the sap ascend? Does a reflux of the sap towards the root, proportioned to the ascent, take place in the bark or the pith, or in both? And, if this be the case, by what way is it conveyed from the interior parts to the bark? What course does it, in particular, take to pass through the leaves to the bark?

The Academy wishes, in particular, that the motion of the sap in the bark upwards may be proved or refuted; both by a careful repetition, varying the circumstances, of the experiments which have already been adduced as a proof of it, and by a sufficient number of well chosen and appropriate new experiments. The best founded experiments, which prove the ascent of sap in plants, have been enumerated by Duhamel, in *Physique des Arbres*, b. v. chap. 2, art. 7—11,

 and

and the moſt important of them are as follows: 1. If a plant is ſuffered to imbibe a coloured fluid, it aſcends in the veſſels between the pith and the bark, penetrates to the leaves, and then proceeds through the bark a certain ſpace downwards. 2. When a plant or a twig is compreſſed at the bottom by a ligature, a ſwelling takes place upwards towards the ligature. 3. When the bark of a tree is taken off, without injuring the interior part, the upper edge of the wound produces a greater quantity of moiſture than the under. 4. Under theſe circumſtances an excreſcence is formed on the upper part of the bark, and not on the under; and the renovation of the inner bark, which has been loſt, takes place from the top downwards.

II. What beneficial uſe may practical medicine derive from Humboldt's well known experiments on Galvaniſm and metallic irritation?

The Academy expects that the diſeaſes and caſes, in which Galvaniſm may be uſeful, will be accurately determined by proper experiments; and that the experiments will be clearly and fully deſcribed. Experiments, however, on perſons apparently dead, are to be omitted.

The Academy requeſts all anſwers to theſe queſtions, if founded on experiments actually made by the authors, to be legibly written in Latin; to be inſcribed with any motto according to pleaſure; and to be accompanied with a ſealed note, having on it the ſame motto, and containing in the inſide, the name, title and place of reſidence of the author; and to be tranſmitted, before the firſt of October 1799, to the preſident of the Academy, G. H. R. von Schreber at Erlangen.

The prize, for each queſtion, is a gold medal of twenty ducats value, bearing the uſual impreſſion, and will be adjudged to the author of the beſt papers, by the commiſſioners of the Academy, on the 5th of January 1800.

MAGNETISM.

MAGNETISM.

Wenzel has proved that cobalt is ſuſceptible of magnetic attraction, and has magnetic poles. Klaproth has proved that the pureſt nickel, that even of the Chriſopraſus, is alſo ſuſceptible of the ſame attraction, and has magnetic poles. The ſerpentine of Humboldt has magnetic poles, but does not attract iron. The caſe is the ſame with ſeveral ſorts of lava. Here then are bodies which have polarity, without attracting iron. Are there bodies which act upon iron without having polarity? Tralles, a geometrician of Berne, has taken very ſmall fragments of Humboldt's ſerpentine, which had very perceptible poles, and having placed them cloſe to very ſtrong magnets, the poles of which were oppoſite to thoſe of the ſerpentine, the poles of the ſerpentine became inverted.

MINERALOGY.

Several mineralogiſts think that the metallic veins in mines diminiſh always in thickneſs the deeper they proceed; ſo that theſe veins reſemble a kind of wedge, the baſe of which is directed towards the ſurface of the earth, and the point towards the centre. But this is not preciſely the caſe. Several veins appear indeed to be of that form; but there are many others, the form of which is quite the reverſe. Humboldt ſays that the vein of Kuhchacht at Freyberg, which contains argentiferous galena, grows broader, inſtead of becoming narrower, the deeper it goes; and yet it is one of the deepeſt worked, as it proceeds to the depth of ſeveral hundreds of fathoms. Thoſe of Golderonach in Franconia, which contain arſenical and auriferous pyrites, are much broader at a certain depth than at the ſurface.

COLD PRODUCED BY COMPRESSED AIR.

Thoſe machines employed for ſtrongly compreſſing atmoſpheric air are well known. Profeſſor Pictet of Geneva ſays,

ſays, he has ſeen this air, thus compreſſed, produce a very great degree of cold when the cocks were opened to ſuffer it to eſcape. To demonſtrate this in an eaſy manner, let a ſmall quantity of water be put into a compreſſing machine. When the air eſcapes, it iſſues with a hiſſing noiſe, and carries with it a part of the water; and at the end of the operation, the water adhering to the cock, will be found converted into ice. To explain this phenomenon, we may ſuppoſe that a portion of the water, which is carried off by the air, is reduced to an aeriform ſtate, or that of vapour. But this could not be the caſe, unleſs a pretty conſiderable quantity of caloric were combined with the vapour. The remaining drops of water are therefore ſufficiently deprived of it to be congealed. It is in the ſame manner that the rapid evaporation of ether, applied to the ball of a thermometer, makes the liquor ſpeedily deſcend ſeveral degrees.

PHYSIOLOGY.

Dr. Sœmmering has proved, by a great number of obſervations, that the degree of intelligence of different animals is always in proportion to the bulk of the brain, compared with that of the nerves. Man has the moſt voluminous brain, and his nerves are very ſmall: it is this which gives him his high degree of intelligence. The aſs has very large nerves, and a very ſmall brain. Dr. Ebel has publiſhed on this ſubject a very intereſting diſſertation, which we hope ſoon to be able to lay before our readers.

GRAVITY OF WATER.

Bodies are dilated by warmth, and conſequently become ſpecifically lighter the hotter they are. On the contrary, they are contracted by cold, and become ſo much denſer the colder they are. But this law of condenſation is ſubject to ſome exceptions: melted metal, for example, dilates to a certain degree as it becomes ſolid; water experiences the

ſame

ſame dilatation in congealing. To find then the greateſt ſpecific gravity of water, we ought not to take ice, for we know that it ſwims on water. We muſt make choice of a certain degree of heat between that of congelation and that of expanſion. Experience has determined this point to be about 41° of Fahrenheit. Conſequently, to find the greateſt quantity of water which can be contained in a veſſel of a given capacity, we muſt take water at that temperature.

This circumſtance ſhould be attended to in determining meaſures of capacity. Some people are ſo well aware of it that they buy liquids in cold, and endeavour to ſell them in hot weather.

METEOROLOGY.

On the 10th inſt. about twelve o'clock at night, a remarkable meteor was obſerved by one of the maſters of the Free-ſchool at Alnwick, and another perſon; it appeared in the ſouth-weſt, at a conſiderable altitude. At firſt it was no bigger but far brighter than a common ſtar, but preſently expanded into the form and ſize of an apothecary's peſtle. It was then obſcured by a cloud, which was ſtill illuminated behind; when the cloud was diſpelled, it re-appeared with a direction ſouth and north, with a ſmall long ſtreamer, cutting the peſtle a little below the centre, and iſſuing away to the eaſtward. It was again obſcured, and on its re-appearance, the ſtreamer and peſtle had formed the figure of a hammer, or a croſs; preſently after the ſtreamer, which made the ſhaft to the hammer, or ſtalk to the croſs, aſſumed two horns, at the extreme point towards the eaſt, reſembling a fork. It was then obſcured a third time, but when the cloud paſſed over, it was changed into the ſhape of two half-moons, back to back, having a ſhort thick luminous ſtream between the two backs; it then vaniſhed totally from their ſight. It is obſervable, that every new appearance became brighter and brighter, till it became an exceedingly brilliant object, all the other ſtars in compariſon appearing to

be

be only dim ſpecks. The time of obſervation was above five minutes.

The *Decade Philoſophique* contains an account of a ſingular phenomenon which was obſerved on the 19th of Auguſt laſt, at Caumont, principal town of the diſtrict, at the extremity of the department of Calvados.—"The weather was fine; a few light clouds ſcattered here and there in the ſky. The atmoſphere was loaded with vapours, the wind North Weſt, the barometer at 28 and a fraction, and Reaumur's thermometer at between 18 and 19 degrees, about 72° of Fahr. A circle of white clouds was formed about the altitude of the ſun, paſſed through its centre, ſtretching uniformly to the ſame height in a horizontal plane. This circle, or belt, in its greateſt breadth, was nearly the ſize of the ſun's ſemi-diameter. On this circle were projected two parhelia or diſks nearly of the ſame ſize as that of the ſun, from which they were at equal diſtances; the one at the right, the other at the left, at the diſtance of about 45 degrees each from the ſun. In each of theſe diſks, the part oppoſite to the ſun was very luminous, to the extent of nearly three parts of their diameter, and preſented priſmatic colours. The reſt was nebulous (that part next the ſun). At about 110 degrees from the ſun on each ſide, appeared two other diſks traced upon the ſame circle at equal diſtances. But they were perfectly of the ſame whiteneſs with the circle, and were not quite round. A ſemicircle roſe above the ſun, and formed an arch, the cord or baſe of which was a ſection of the great white circle, the centre of which was the ſun. The radius of this ſemicircle was about 22 degrees, and terminated on each ſide of the ſun nearly at half the diſtance of the ſun from each of the luminous diſks. This ſemicircle uniformly contained a vapour of a clear brown, the extremities of which, without any ſhade, ran into the ſurrounding atmoſphere. This phenomenon continued for nearly an hour. The circle began to fade on the North ſide, where

where it never had been so clearly marked out. The luminous disk disappeared last.

"These observations were made by a great number of people, as it was market day in the place. As prejudices are still very strong in most parts of the country, every one reasoned according to his religious or political prejudices—Some said that it was a sign of the anger of God against the changes which had taken place: others, of an opposite opinion, said that God had crowned the republic: others again thought that the great circle which seemed to embrace all this hemisphere, announced a general peace." The writer of the account concludes, "I had no great difficulty in persuading the majority that these signs were the effect of the vapours and exhalations occasioned by the heat. Ten years ago I should not have been so successful."

DYEING.

Cit. Chaptal, having been lately engaged in examining the causes of the fixity of certain yellow colours, has observed, that the yellow colour extracted from vegetables is in general in the inverse ratio of its splendour. He has endeavoured to ascertain the cause which renders the pale yellow more durable, and has discovered it in the existence of the tanning principle, which is found united with the yellow principle in most vegetables. By analysing fustic (*morus tinctoria*) he obtained, 1st, a principle partaking of the nature of resins or gums, and which can communicate a beautiful yellow colour; 2d, an extractive principle, which is also yellow, and furnishes a beautiful colour; 3d, a tanning principle, of a pale yellow colour, which grows black in the air and by ebullition—it tarnishes the colour of the other two principles. As it was necessary to separate the tanning principle, in order to leave to the rest the full vivacity of their colour, Chaptal found means to accomplish that object by a simple and cheap process. He boiled, with the wood, some animal substance

ſubſtance containing gelatinous matter, ſuch as bits of ſkin, ſtrong glue, &c. The tanning principle precipitated itſelf with the gelatinous matter, and the bath held in ſolution only the principles which produce a lively and ſtrong yellow. By the help of this proceſs, colours as bright as thoſe communicated by yellow weed (*reſeda luteola*) and quercitron bark, may be procured from ſeveral vegetables.

NEW COINAGE.

We have already mentioned (p. 220.) that it was propoſed to improve our coin, and that the ſubject was referred to the Royal Academy. The following circular notice has been ſince iſſued to the academicians.

"Royal Academy, Auguſt 20th, 1798.

"SIR,

"The Lords of the Committee of Council having expreſſed a deſire that the gold and ſilver coins of this kingdom ſhould have every improvement which the preſent ſtate of the arts can afford, and the Royal Academy having agreed to take the ſame into their conſideration, the preſident has accordingly ordered a general meeting of the academicians on the 20th of September next, at ſeven o'clock in the evening, to receive the deſigns or models of ſuch of the members of the academy as will then offer; which deſigns or models are intended by the lords of the committee to be preſented for his majeſty's inſpection, previous to their being carried into effect.

"The coins intended are as follow—

Gold—A two guinea piece, a guinea, and a half guinea.

Silver—Five ſhilling piece, half crown ditto, one ſhilling, and ſix-pence.

The head of his preſent majeſty, the arms of the realm, the lion, the crown, and Britannia.

"In forming the deſigns or models, it is deſired that attention be paid to the roundneſs and ſimplicity of the coin; to to the whole or part of the inſcription on the ſame, and to guard againſt the wearing or filing.

"JOHN RICHARDS, R. A. Secretary."

In conſequence of the above notice, a meeting took place at the time appointed, when ſeveral drawings and models were produced, which were afterwards forwarded to the Lords of the Committee of Council, for his majeſty's inſpection.

Much ought to be done. If hiſtorical facts are not to be recorded on our coins, the whole intellect and abilities of the artiſts of Great Britain ought to be concentrated as it were in one focus to produce the *acmé* of excellence.

SURGERY.

We have to announce that a conſiderable improvement has lately been made on the German key for extracting teeth. Mr. Charles Brown, ſurgeon, having for ſome time paſt turned his attention to the ſtructure and mechanical powers of thoſe inſtruments uſed in the leſſer operations of ſurgery, it appeared to him, that the German-key moſt commonly in uſe, notwithſtanding the various improvements it has undergone, partly by profeſſional men, and partly by inſtrument-makers, was not well calculated to extract teeth with ſafety and eaſe. Having had great experience in this particular branch of ſurgery, he endeavoured, and with ſucceſs, to remedy the defects that were ſtill obvious in the inſtrument. As the one produced by Mr. Brown poſſeſſes in an eminent degree many advantages over all others, we ſhall, in a future number, preſent our readers with a deſcription of it, which the ingenious inventor has promiſed to furniſh us with, illuſtrated with an engraving. In the mean time, ſuch of our readers as wiſh for a more early knowledge of its ſtructure, may ſee one of them at Mr. Whitford's, ſurgeon's inſtrument-maker, in the Cloiſters, St. Bartholomew the Leſs, Smithfield.

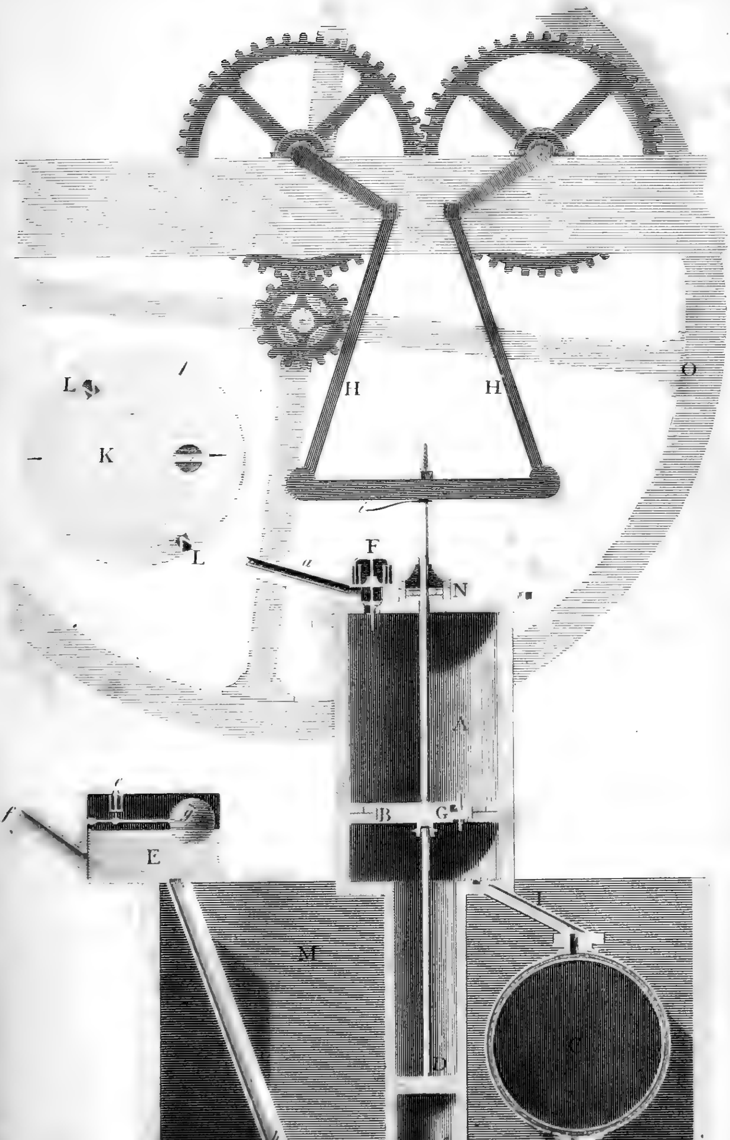

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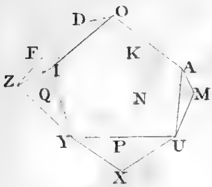
Fig. 3.



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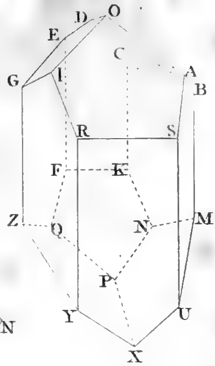
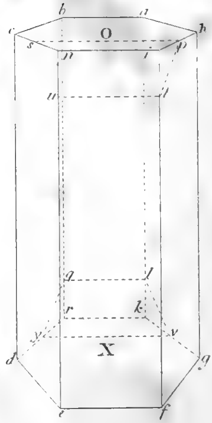


Fig. 1.



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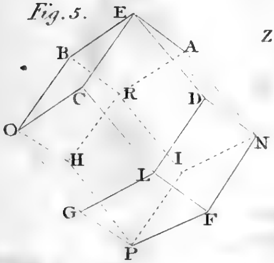

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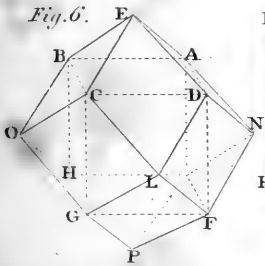

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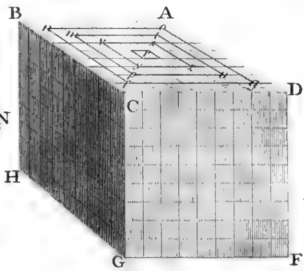

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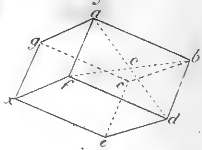

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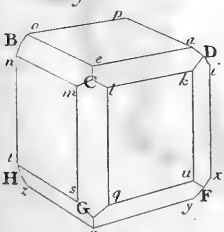

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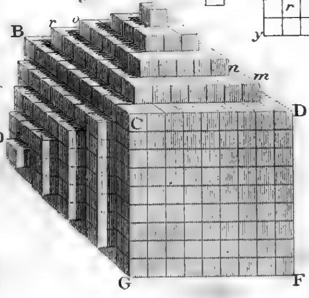
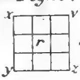


Fig. 11.

Fig. 10.



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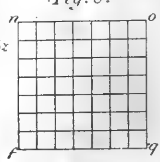

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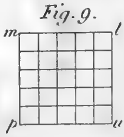

W. Lowry sculp.

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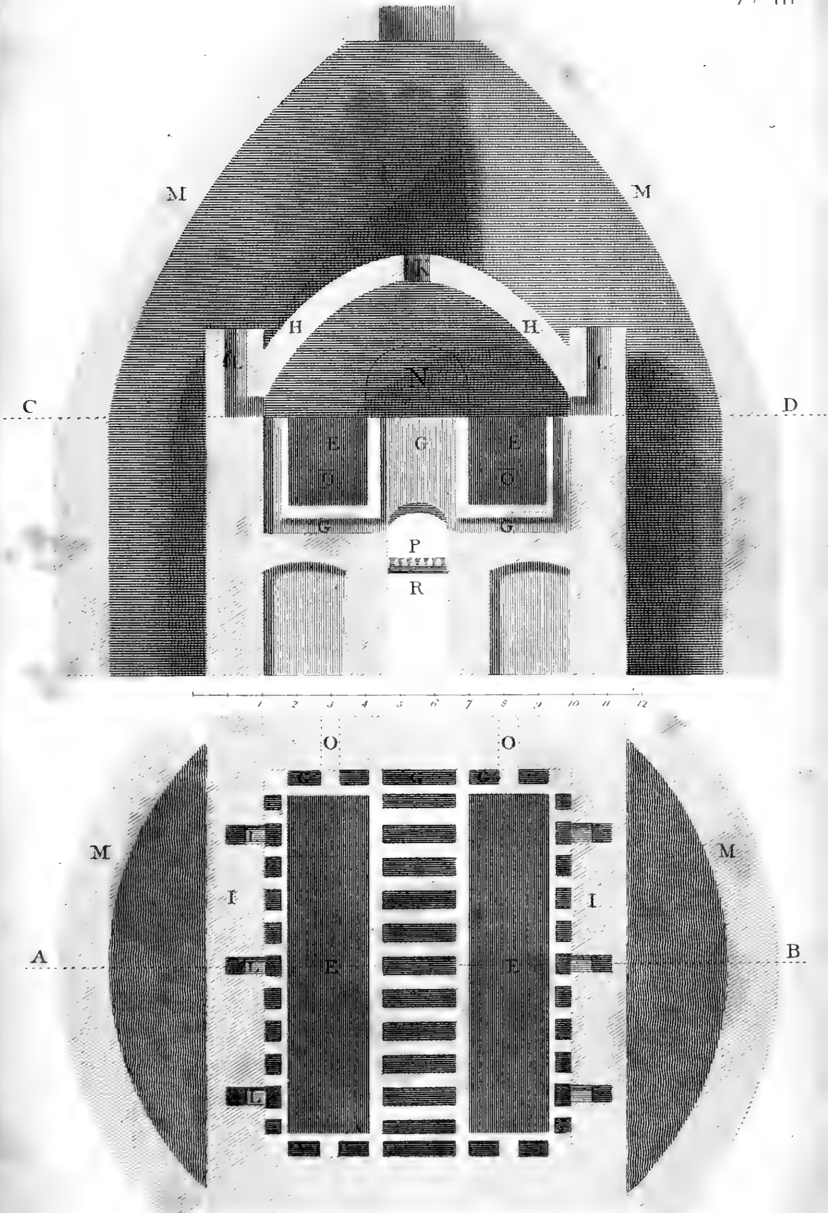

Engraved by W. Lowry

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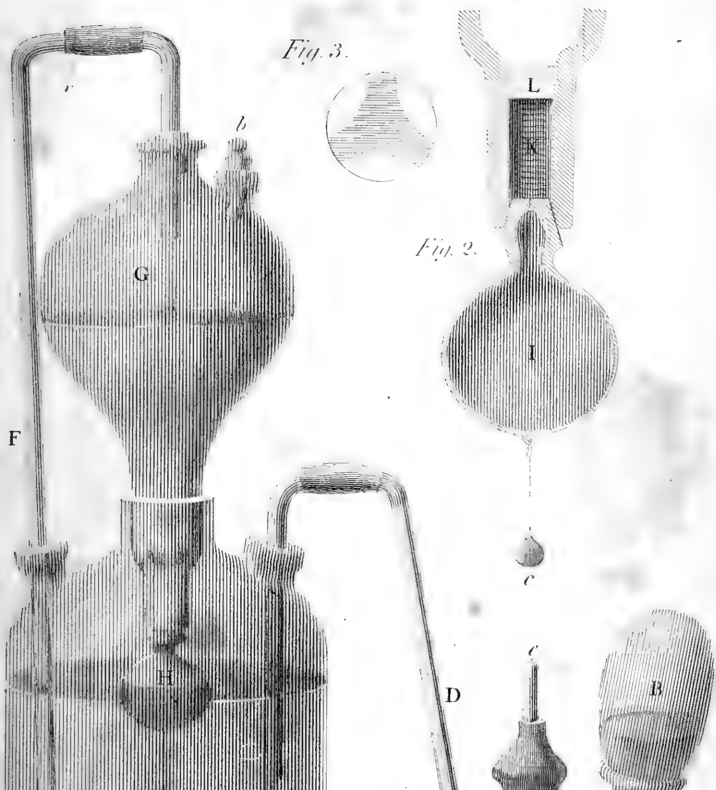

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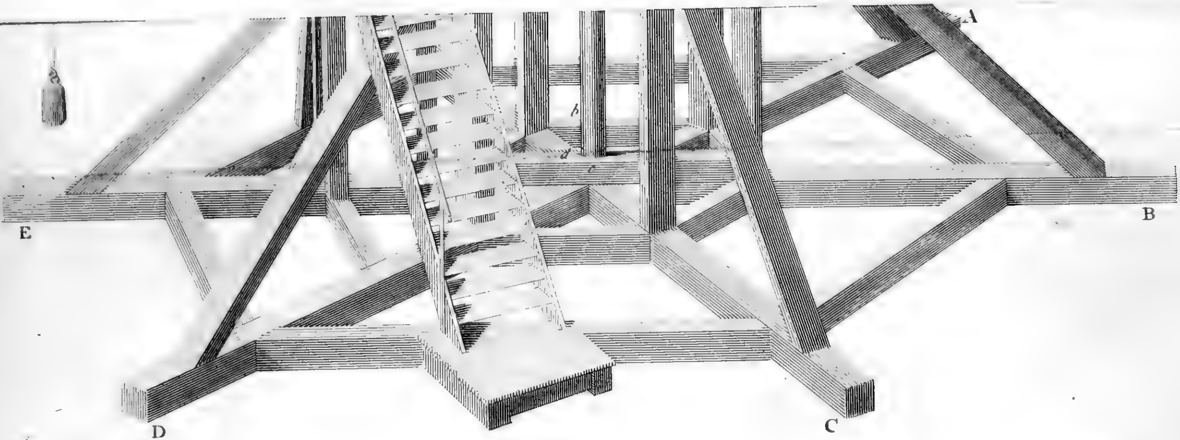
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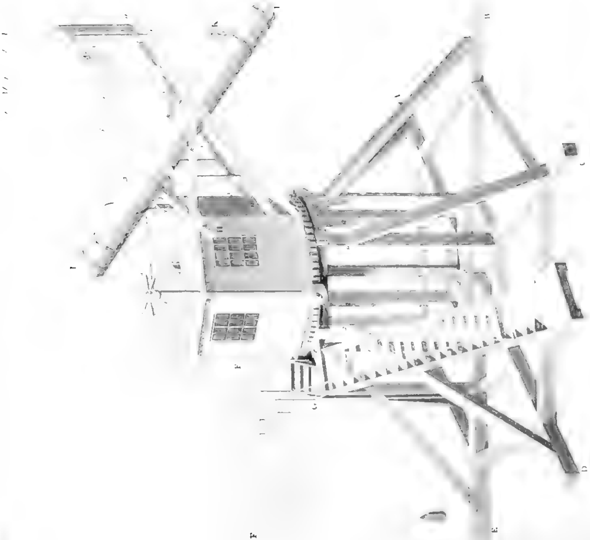
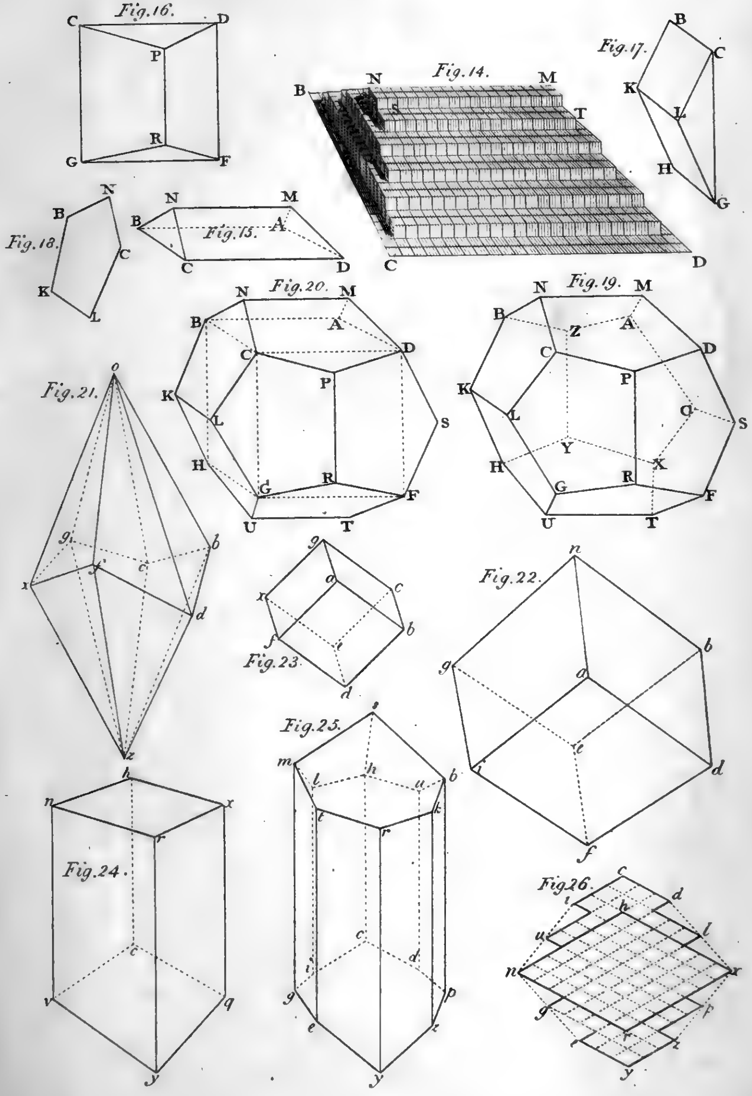


Pl. IV.

PHILOSOPHICAL MAGAZINE.



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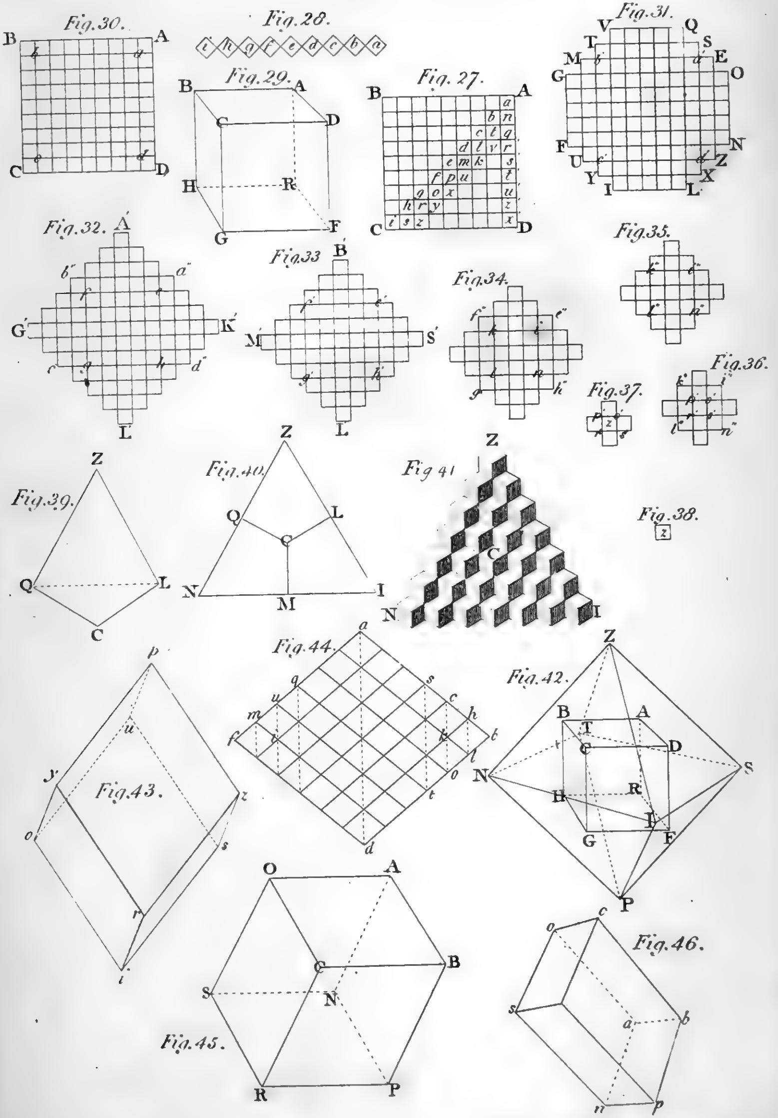
Fig. 30.
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Fig. 28.
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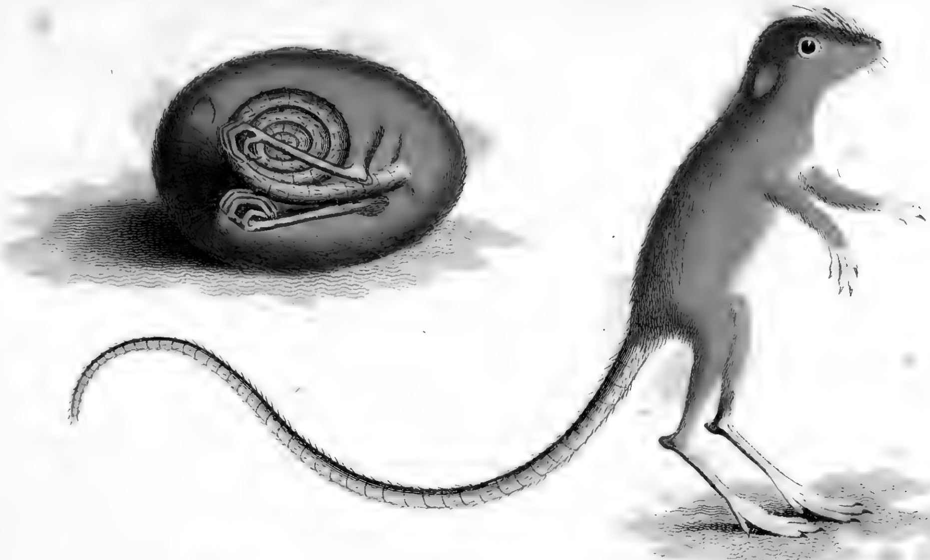
Fig. 29.
B A C D H R G F
Fig. 27.
B A C D
Fig. 31.
V Q T S M E G O F N U Z Y X I L
Fig. 32.
A' G' K' L
Fig. 33
B' M' S' L
Fig. 34.
Fig. 35.
Fig. 36.
Fig. 37.
Fig. 38.
Fig. 39.
Z Q L C
Fig. 40.
Z Q L C N M I
Fig 41
Z C N I
Fig. 44.
Fig. 42.
Z B A T C D N S H R I G F P
Fig. 43.
Fig. 45.
O A C B S N R P
Fig. 46.

Lowry sculp.

Jumping Mouse of Canada.



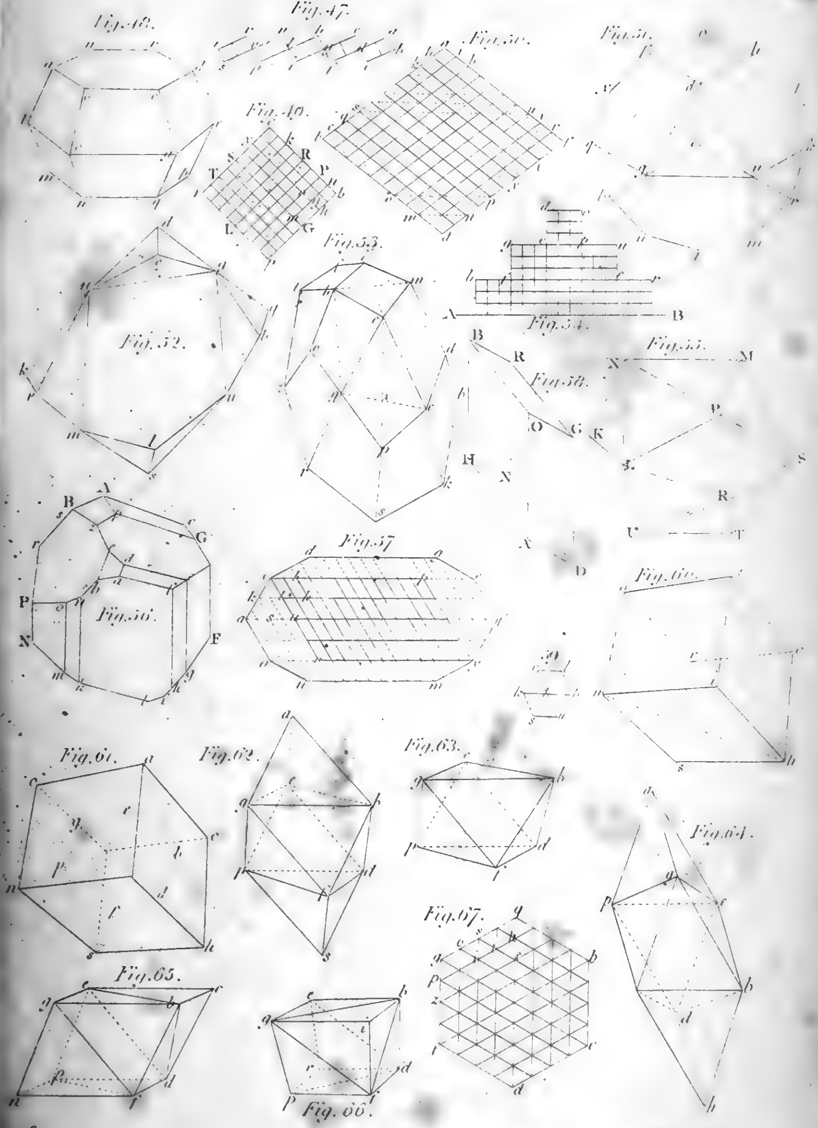


Fig. 47.
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Fig. 67.

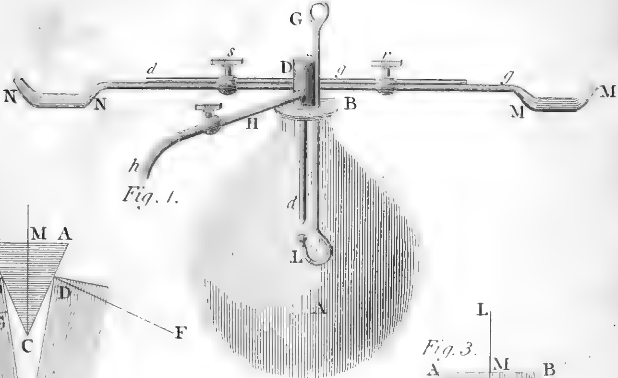


Fig. 1.

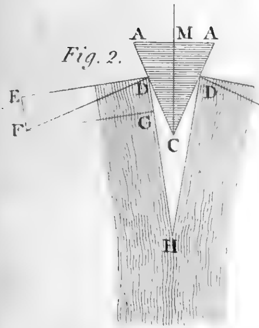


Fig. 2.

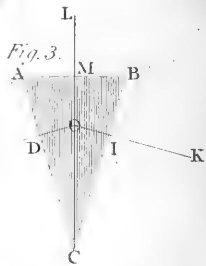
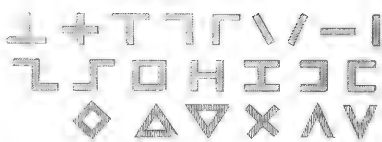


Fig. 3.

E



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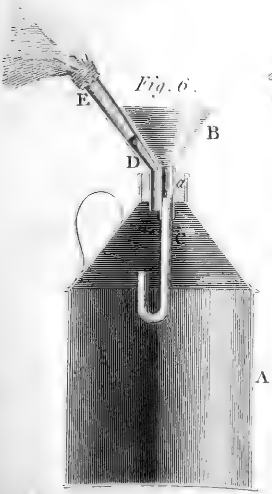

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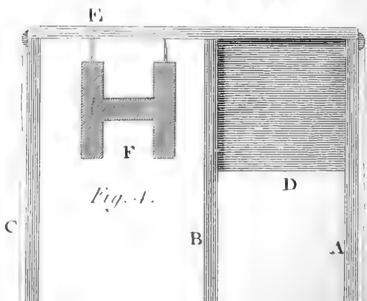

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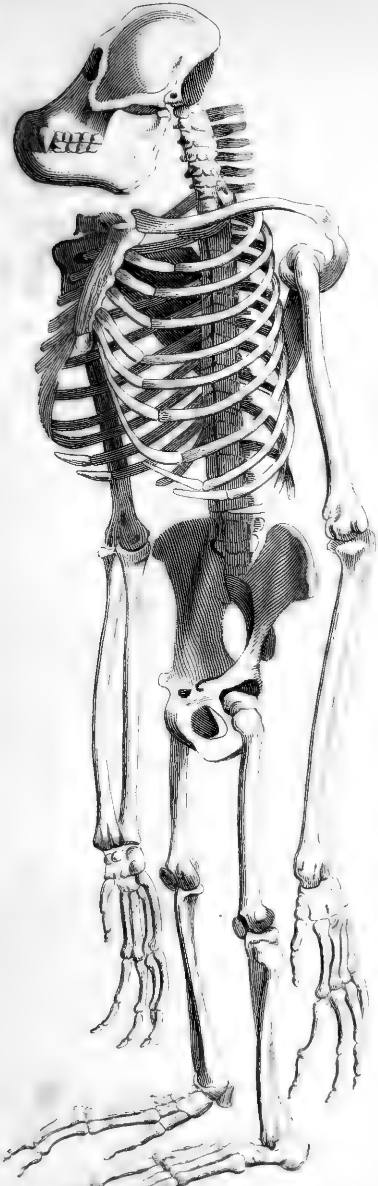


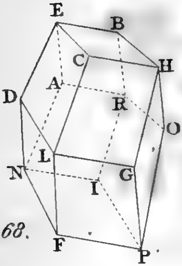
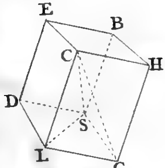


Fig. 68.



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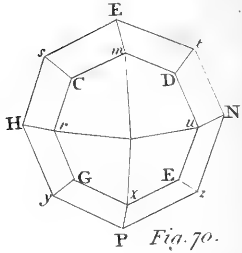
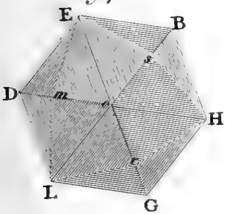


Fig. 70.

Fig. 71.



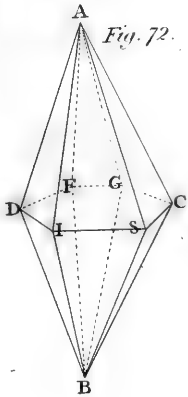
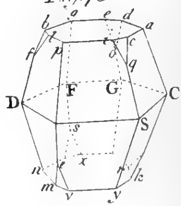


Fig. 72.

Fig. 73.



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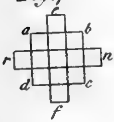

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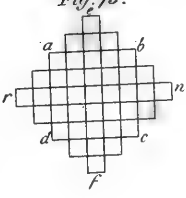

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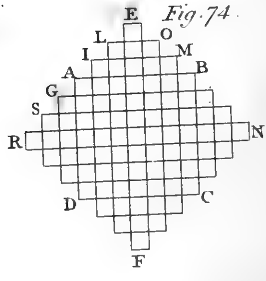


Lowry sculp.

Fig. 3.

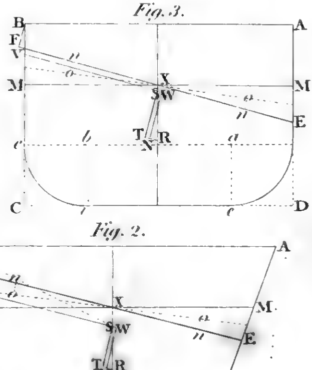


Fig. 1.

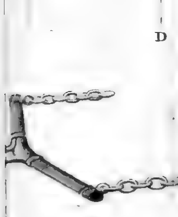
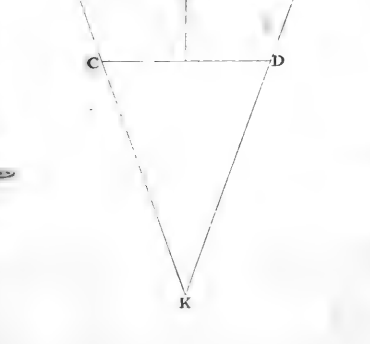
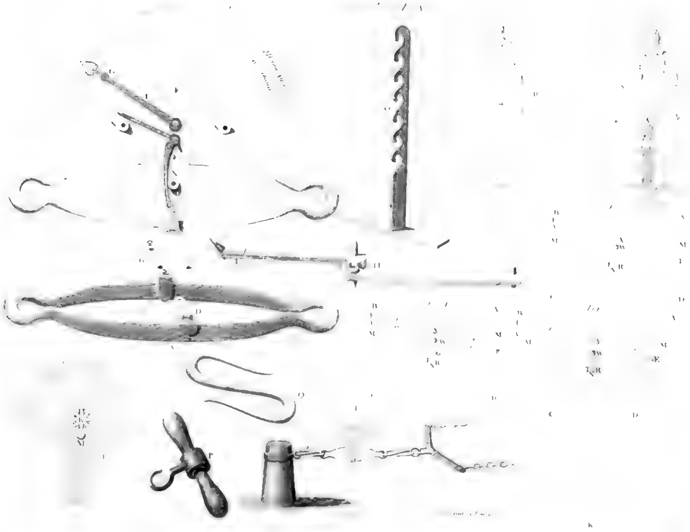


Fig. 2.



Engraved by Lowry.



INDEX TO VOL. I.

National

END OF THE FIRST VOLUME.

ERRATA.

Page 3, l. 34, for *axles* read *axes*.——P. 13 last line, for *potashes and wine stone*, read *potash and crude tartar*.——P. 60, l. 22, for 12 *hours*, read 10 *hours*.——P. 82, l. 18, for *mine*, read *ore*.——P. 101, l. 8 and l. 12, for *strontiat*, read *strontian*.—— P. 145, l. 22, for *ether of vitriol*, read *sulphuric ether*.——P. 311, l. 29, for *oxydated*, read *oxygenated*.——P. 332, line 5, after *muriat of*, insert *mercury or*.——P. 376, l. 17, dele *the*.——P. 373 in the note, for *lex*, read *lilex*.

The Binder is desired to place the Plates, in their order, before the Index, at the end of the Volume.