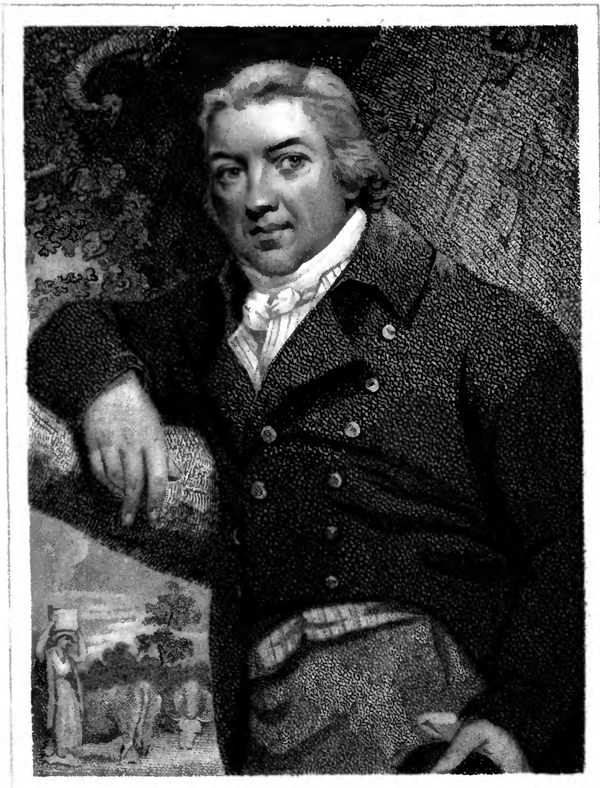

Mackenzie sc

Edward Jenner. M.D. F.R.S.

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THE

PHILOSOPHICAL MAGAZINE:

COMPREHENDING

THE VARIOUS BRANCHES OF SCIENCE,

THE LIBERAL AND FINE ARTS,

AGRICULTURE, MANUFACTURES,

AND

COMMERCE.

BY ALEXANDER TILLOCH,

MEMBER OF THE LONDON PHILOSOPHICAL SOCIETY, ETC. ETC.

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

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OF THE

THIRTEENTH VOLUME.

XXXVII. *Me-*

CONTENTS.

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THE

THE

PHILOSOPHICAL MAGAZINE.

I. *On the different Proportions of Carbon which conſtitute the various Qualities of Crude Iron and Steel; being a Continuation of the Experiments on the ſame Subject detailed in our laſt Number. By* DAVID MUSHET, *Eſq. of the Calder Iron Works* *.

HAVING ſelected a parcel of well-prepared Stourbridge clay crucibles, with covers exactly fitting, I proceeded to make the following experiments upon the quantity of charcoal which forms crude iron and ſteel; firſt premiſing that both crucible and cover were brought to a bright red heat before the ſubſtances acted upon were introduced. This was done with the greateſt poſſible caution, to avoid volatilizing any part of the charcoal, and rendering the reſult inaccurate. From the approximation of theſe reſults in repeating moſt of theſe experiments, I found that no material difference had occurred.

		Grains.
Exp. I. Swediſh bar iron - -		885
Charcoal $\frac{1}{2}$, or - -	grs. 442	
This mixture was expoſed for half an hour, and a perfect button of ſupercarbonated crude iron was obtained. Along with the metal was found of intenſely black charcoal not taken up -	290	
Charcoal diſappeared, equal to 34·4 per cent.	152	
The metallic button now obtained was found to weigh		928
Gained in weight by the combination, equal to $\frac{1}{20\frac{1}{2}}$ part of the original weight of the iron - -		43
Charcoal diſappeared - -		152
Total loſs in charcoal		109

* Communicated by the Author.

Collective

Grains.

Collective weight of the iron and charcoal originally introduced - - - grs. 1327

Iron obtained in the fusion - grs. 928

Charcoal not taken up - 290

1218

Total loss in this experiment 109

Exp. II. Swedish bar iron - - - 925

Charcoal $\frac{1}{4}$th part, or - grs. $231\frac{1}{4}$

This mixture, after a similar exposure, was completely fused. When cold, the crucible was found to contain of very fine charcoal - $125\frac{1}{4}$

Charcoal disappeared in the fusion, equal to 45 per cent. - - - 106

The metallic button was richly carbonated, and weighed 972

Gained in weight by the union of charcoal, equal to $\frac{1}{19\frac{9}{10}}$th part of the original weight of the iron, - 47

Charcoal disappeared - - - 106

Lost in fusion 59

Collective weight of iron and charcoal originally introduced - - - grs. $1156\frac{1}{4}$

Iron obtained in the fusion grs. 972

Charcoal not taken up - $125\frac{1}{4}$

1097

Total loss in this experiment 59

Exp. III. Swedish bar iron - - 915

Charcoal $\frac{1}{7}$th, or - grs. 152

This mixture was subjected to a similar heat, and a perfect fusion effected. There was found of charcoal not taken up - - 65

Charcoal disappeared, equal to 57 per cent. 87

The metallic button resembled the produce of No. I. and II., and weighed - - - 960

Gained by the fusion, equal to $\frac{1}{20\frac{3}{10}}$th part the first weight of the iron - - - 45

Charcoal disappeared - - 87

Lost in the fusion 42

Collective

	Grs.	Grs.
Collective weight of the iron and charcoal used	1067	
Iron obtained - - grs. 960		
Charcoal remaining - - 65		
	1025	
Total loss in this experiment		42

Exp. IV. Swedish bar iron - - 977
Charcoal $\frac{1}{8}$th, or - grs. 122
This mixture entered into fusion in nearly the same time as the former. There was found on the surface of the metal a portion of very beautiful carbon, which weighed - - 40

Lost of charcoal in fusion, equal to $67\frac{2}{10}$ths per cent. - - - 82
The metallic button obtained in this experiment was superbly carbonated, and apparently formed an entire mass of carburet. It weighed - - 1020

Gained in weight by the union of carbon, equal to $22\frac{4}{10}$th part the first weight of the iron - - 43
Charcoal disappeared - - 82

Lost in the fusion 39

Original weight of the mixture - grs.	1099	
Iron obtained - grs. 1020		
Charcoal remaining - 40		
	1060	
Total loss in this experiment		39

Exp. V. Swedish bar iron - - 1125
Charcoal $\frac{1}{9}$th, or - grs. 122
From this fusion was obtained a supercarbonated button of crude iron, upon the surface of which was found of fine charcoal - - 25

Lost of charcoal, equal to 80 per cent. 97
Compared with the former results, the metal now obtained was inferior in point of carbonation. Its surface was smooth, and of a dull lead colour; entirely free from the usual shining specks of carburet which very rich crude iron contains upon its surface. It weighed - - - - 1168

			Grains.
Gained in fusion, equal to $\frac{1}{26}$th part the weight of iron employed	- - -		43
Charcoal disappeared	- -		97
	Loss in the fusion		54
Collective weight of the mixture	-	grs. 1247	
Weight of metallic button	- grs. 1168		
Charcoal not taken up	- - 25		
		1193	
	Total loss in this experiment		54

Exp. VI. Swedish iron	- - -		880
Charcoal $\frac{1}{12}$th, or	-	grs. 73	
This was sufficiently heated to produce fusion. When cold, there was found upon the surface of the metal a portion of very black charcoal weighing	- - -	12	
Lost in the fusion, equal to $83\frac{1}{2}$ per cent.		61	
The metallic button possessed a uniformly smooth surface, partially covered with carburet, and weighed			920
Gained by the combination of charcoal, equal to $\frac{1}{22}$d part	- - - -		40
Collective weight of the mixture originally introduced	- - -	grs. 953	
Charcoal not taken up	- grs. 12		
Iron obtained	- - 920		
		932	
	Loft in the fusion		21
Charcoal disappeared	-	grs. 61	
Iron gained in weight	- -	40	
	Total loss in this experiment		21

From the results of these experiments it becomes obvious that bar iron may be converted into the finest qualities of crude iron by the addition of any portion of charcoal from $\frac{1}{2}$ to $\frac{1}{12}$th part its weight: that in passing from the malleable to the carbonated crude state, it uniformly gains in weight by a combination of carbonaceous matter equal to $\frac{1}{20\frac{1}{2}}$, $\frac{1}{19\frac{9}{10}}$th, $\frac{1}{20\frac{3}{10}}$th, $\frac{1}{22\frac{4}{10}}$th, $\frac{1}{26}$th, $\frac{1}{22}$d: average $\frac{1}{21\frac{8}{10}}$th part its own weight.

It is here again worthy of remark, that in all these experiments

riments with open vessels, a portion of charcoal disappeared always in proportion to the quantity introduced, and not analogous to the quantity of iron.

Disappeared of Charcoal.		Iron gained.
When $\frac{1}{2}$ was used, 34·4 per cent.	-	$\frac{1}{20\frac{1}{2}}$th part.
When $\frac{1}{4}$th was used, 45 per cent.	-	$\frac{1}{19\frac{5}{10}}$th part.
When $\frac{1}{6}$th was used, 57 per cent.	-	$\frac{1}{20\frac{3}{10}}$th part.
When $\frac{1}{8}$th was used, 67·2 per cent.	-	$\frac{1}{22\frac{4}{10}}$th part.
When $\frac{1}{9}$th was used, 80 per cent.	-	$\frac{1}{26}$th part.
When $\frac{1}{12}$th was used, 83·5 per cent.	-	$\frac{1}{22}$d part.

Upon the whole, if the results of these six experiments, performed in open vessels, are compared with the three first detailed in last communication, where a similar quality of crude iron was obtained in vessels perfectly close, no material difference will be found. They mutually support each other, as to the quantity of carbon necessary to form crude iron, while they still leave in doubt the cause of the disappearance of the charcoal in close vessels. In the case of open vessels, it is highly probable that a considerable portion of the charcoal is destroyed before the heat of the furnace is sufficiently strong to lute the cover of the crucible.

This still, however, leaves unexplained, why, in experiment I. a loss of 152 grains of charcoal is sustained; while in No. VI. the original quantity introduced did not amount to half that quantity, yet 12 grains of the latter was found entire resting upon the surface of the reduced metal. The thickness and capacity of the crucible in both cases, and, indeed, all these experiments, were nearly alike.

The fact of malleable iron being convertible into the most carbonated state of crude iron, either in close or open vessels, where a portion of the carbonaceous matter was found reposing upon the surface of the newly-changed metal, creates some doubts as to the existence of oxygen in crude iron. If it is admitted that bar iron is destitute of oxygen, which it is highly probable is the case; if a portion of this iron is introduced and fused along with a portion of carbonaceous matter in a vessel impervious to air, which vessel is found, when cold, to be more than half filled with charcoal, protecting a metallic button of crude iron below; it is with the greateſt difficulty we can admit of the preſence of oxygen in the metallic maſs. It may be urged, that charcoal, conſidered as an oxide of carbon, might impart a portion of oxygen to the metal. This muſt ſuppoſe, however, a continual action and reaction of affinity, wherein it is preſumable the carbon would finally prevail, and carry off the oxygen. I conceive it more juſt to ſuppoſe, that what quantity of oxygen was contained in the charcoal, would be diſcharged by the latter deoxydating itſelf analogous to its ſuperior affinity, rather than combining with the iron.

It is a fact well known amongſt manufacturers, that caſt iron of a ſilvery white fracture may be ſaturated to exceſs with carbonaceous matter ſimply by cementing it in contact with charcoal. In this proceſs it acquires a ſoft gray fracture, eaſily reducible by the file. If this caſt iron originally contained oxygen, a long cementation in contact with charcoal, moſt likely, would deprive it of this; yet we find it ſtill poſſeſſed of all the properties of caſt iron. From this we ſhould be apt to conclude that oxygen at leaſt is not neceſſary to the production of crude iron.

Again, in the proceſs of cementation bar iron is firſt changed, by a comparatively ſmall doſe of carbon, into ſteel. If this ſteel, by accident or intention, be continued ſomewhat longer in the furnace under an increaſed temperature, an exceſs of affinity is eſtabliſhed betwixt the metal and the charcoal without the preſence of a third principle: the ſteel becomes gradually more and more carbonated: it changes its fracture of granulation, if I may be allowed the term, from that peculiar to bliſtered ſteel, through all thoſe breaks peculiar to the reſpective qualities of crude iron; and may at laſt paſs into the ſtate of a carburet of iron totally different in its properties and appearance from either ſteel or crude iron. This proceſs may be carried on to the utter excluſion of atmoſpheric air; and here, if the proceſs is ſtopped in its proper ſtages, will be found all the various qualities of crude iron formed without perfect fuſion, where we cannot conceive oxygen to have exiſted.

I am aware of adducing circumſtances from theſe experiments, at variance with the preſent received opinions upon the conſtituent parts of caſt iron, and alſo in oppoſition to principles which I have formerly laid down. I wiſh not the preſent hints to be conſidered as aſſertions. As irreconcileable in ſome degree with former opinions, I wiſh they may lead to an ample inveſtigation of the ſubject. The diſtinction hitherto made betwixt crude iron and ſteel, particularly by by the French chemists, has been, that crude iron was the metal imperfectly reduced, but that the latter was iron perfectly reduced, combined with a small portion of carbon. The fact, however, of malleable iron passing into the state of fine crude iron without the contact of an oxygenous body, puts it upon a similar footing with steel, only altered by a greater comparative quantity of carbon. This reduces us to the necessity of drawing one of the two following conclusions: that steel is, equally as crude iron, a combination of iron, carbon, and oxygen; or, that crude iron differs from steel only in the proportion of the carbon with which it is saturated.—The communication which shall be forwarded for the next number of the Magazine, will, I hope, leave little doubt upon this head.

II. *Memoir on Gluten.* *By* CHARLES LOUIS CADET, *of the College of Pharmacy, Paris* *.

THE chemists who have made researches in regard to the glutinous principle of vegetables, and particularly that of wheat, have found no solvents of that matter but weak acids and caustic alkalies. When the gluten indeed is fresh, these two kinds of re-agents only have the power of dissolving it; but, however, by altering it, that is to say, by taking from it the agglutinative property. These solutions have not yet afforded any application useful to the arts; and gluten itself, in its natural state, has been employed only to cement broken china; but, when gluten has experienced a commencement of fermentation in damp air, its solubility is increased, as I proved by the following experiments:

I put into an earthen vessel about three hectogrammes of gluten extracted from wheat in the usual manner. This vessel was placed in a damp hot-bed: at the end of seven or eight days the surface of the gluten became brown, and covered with white *byssus* similar to that which vegetates on ripening fruit. I removed this byssus, and continued to observe the alteration of the gluten: on the fifteenth day the mass appeared to increase in volume; some gaseous bubbles raised up the surface, and an acetous odour manifested itself: on pressing the gluten a little, there issued from it a milky acid liquor. On the twenty-fifth day the odour was stronger, but always acescent; and, on removing the sort of skin which was formed on the paste, the softened gluten had become

* From the *Annales de Chimie*, No. 123.

viscid,

viſcid, and had a great reſemblance to grayiſh white glue. In this ſtate I employed it for making the following trials:

I triturated four grammes of this glue in a glaſs mortar, after having poured over it ſome drops of alcohol. The gluten appeared to me to diſſolve. I gradually added alcohol, and thus brought the gluten to the liquid conſiſtence of thick ſyrup. I increaſed the quantity of alcohol, hoping to obtain a complete ſolution; but when the quantity of alcohol was nearly double that of the gluten, the latter ſuddenly ſeparated, reappeared under its firſt form, and it was impoſſible for me to charge the ſolution more. I filtered the alcohol, which paſſed with a ſlight amber colour.

To aſcertain whether this ſolution contained much gluten, I poured over it an equal volume of diſtilled water: the mixture immediately became white like an emulſion, and ſuffered to be ſlowly depoſited an abundant precipitate, which had the appearance of a fecula, but which, when more cloſely examined, appeared to be gluten very much divided. The alcoholic ſolution of gluten, when left for fifteen months in a flaſk ſtopped with cork, depoſited a part of the gluten in the form of a white, thick, elaſtic membrane, which ſhrinked when expoſed to heat, burned in the manner of animal matters, and had a great reſemblance to white caout-chouc formed from the juice of the heræa.

I evaporated, at a gentle heat, the remainder of the ſolution, and obtained dry gluten, brittle, yellowiſh at the ſurface, and ſhining like beautiful varniſh.

It reſults from theſe experiments, that the gluten which has experienced acid fermentation is in a great part ſoluble in alcohol. This effect is owing, no doubt, to the acetous acid which is formed by the fermentation, and which breaks the force of the aggregation of the gluten; for I kneaded the freſh gluten a long time in alcohol without being able to diſſolve a ſenſible quantity. This chemical fact is of very little importance in itſelf, but it ſuggeſts ſome uſeful applications.

Having brought the fermented gluten to the conſiſtence of ſyrup by means of alcohol, I ſpread this thick ſolution with a bruſh over different bodies, ſuch as wood, glaſs, and paper. It dried ſpeedily, and formed a tranſparent varniſh, which adhered ſtrongly and did not become ſcaly. Paper varniſhed in this manner might be ſubſtituted for that brought from England under the name of *papier à cautere* *.

The fermented gluten, diluted in acetous acid, furniſhed a

* We imagine the author means that kind of brown paper in which ironmongery goods are uſually lapped up.—Edit.

varniſh

varniſh nearly ſimilar; but that obtained by an alcoholic ſolution of gluten evaporated to the conſiſtence of ſyrup is preferable.

I employed this varniſh to preſerve ſeveral objects of natural hiſtory from the influence of damp air. As it poſſeſſes a certain degree of elaſticity, I conſider it to be equally proper for varniſhing anatomical preparations. It is more convenient than freſh glue for cementing broken porcelain.

This firſt trial neceſſarily conducted to the idea of employing the ſolution of gluten as an excipient of different colouring matters. I mixed then a certain quantity of glutinous varniſh with white oxide of lead, minium, indigo, and carmine, and obtained colours more or leſs bound, but which were all eaſily extended with the pencil, which adhered ſtrongly even to glaſs, dried ſpeedily, and had no diſagreeable odour. I remarked that the vegetable colours mixed with greater facility than the oxides.

As I formed theſe mixtures in mortars of glaſs or agate, I did not obtain colours ſo homogeneous as if I had ground them on porphyry. When theſe colours are well prepared, that is to ſay, when the proportion of the colouring matter does not exceed that of the gluten, the painting may be waſhed without any fear of altering it, unleſs rude friction be employed.

This gluten preſents then to artiſts a new kind of painting, leſs ſolid, perhaps, than oil painting, which experience will determine, but perhaps leſs ſuſceptible of changing by the action of air and light. It would be attended with two great advantages in printing figures or paintings—that of ſpeedily drying, and of not expoſing the perſons who inhabit apartments newly painted to any of thoſe accidents frequently occaſioned by oil painting.

As the price of alcohol might render this painting dear, I tried to prepare colours with glutinous varniſh made by means of acetous acid; but I was never able to mix it with any oxide: the gluten immediately ſeparated itſelf, and was precipitated in a more ſolid form than it had before its ſolution: it is therefore neceſſary to employ alcohol; but the common alcoholic products, ſold commonly in the ſhops under the name of *varniſhers' ſpirit of wine*, may be employed.

If this painting were adopted, it would be neceſſary that the gluten ſhould be found in ſufficient quantity and at a low price. It might be furniſhed by the ſtarch-makers, if they ſubſtituted for their method of operation a proceſs analogous to that employed in the laboratories for ſeparating the ſtarch from gluten. It would be eaſy to conſtruct a machine to triturate the paſte under a ſtream of water, and to prepare a gluten entirely freed from any amylaceous principle. But before this object can be carried into execution, it will be neceſſary that various trials ſhould be made by artiſts to aſcertain whether the glutinous ſolution has the properties requiſite for painting, or at leaſt for varniſhing.

Chemiſts may, however, employ it in the mean time as luting. I mixed with fermented gluten diluted in alcohol a certain quantity of quicklime: ammonia and caloric were diſengaged, and the mixture aſſumed a ſoft conſiſtence. With this paſte I luted ſeveral veſſels, placed over them bands of linen dipped in the ſolution of gluten, and beſprinkled them with quicklime: they ſoon adhered with ſuch force that I think this luting preferable to that prepared with the whites of eggs.

It appears to me to reſult from theſe exeperiments:

1ſt, That freſh gluten is inſoluble in alcohol.

2d, That it becomes ſoluble when it has undergone acid fermentation.

3d, That the alcoholic ſolution of gluten is precipitated by water.

4th, That this ſolution, evaporated to the conſiſtence of ſyrup, furniſhes a varniſh which may be employed in the arts.

5th, That fermented gluten diluted in alcohol becomes an excipient of colouring matters, and makes them adhere to the ſmootheſt bodies.

6th, That vegetable colouring ſubſtances combine with gluten better than others.

7th, That painting where gluten has been uſed dries very ſoon, has no noxious odour, and may be waſhed.

8th, That a very ſtrong and tenacious luting may be made with gluten and lime.

III. *Obſervations on the Acetic and Acetous Acids.* By C. Darracq*.

THE numerous opinions of chemiſts on the difference between the acetic and acetous acids have induced me to make a few reſearches on the ſubject. But before I give an account of my experiments I ſhall mention a few of thoſe of the modern chemiſts, and alſo the concluſions which they have drawn from them.

C. Adet read a memoir in the Inſtitute, on the 11th Thermidor,

* From the *Annales de Chimie*, No. 122.

midor, year 6, on the acetic acid, publiſhed in the *Annales de Chimie* of the ſame year. By very intereſting and well-performed experiments C. Adet endeavoured to prove that there did not exiſt two acids of vinegar, and he concluded from them, that the acetous acid is conſtantly at the higheſt degree of oxygenation; that it is conſequently in the ſtate of acetic acid; and, in the laſt place, that the difference which exiſts between the acetous and acetic acid ſeems to depend on the leſs quantity of water contained in the latter, and not on a greater proportion of oxygen, as before believed. I ſhall not deſcribe his experiments, as they are too numerous; I ſhall only obſerve that they are very exact.

In the month of Brumaire, year 7, C. Chaptal publiſhed his obſervations on the ſame ſubject *. By new experiments he combats not thoſe of C. Adet, but the conſequences he has deduced from them. He however does not conſider the acetic acid as more oxygenated than the acetous acid, but only as containing leſs carbon; he mentions ſeveral experiments which ſeem to ſupport his theory, and particularly the diſtillation of acetite of copper. This celebrated chemiſt ſays, that when this ſalt is diſtilled the acetous acid is decarbonized; a part of this carbon combines itſelf with the oxygen of the oxide of the copper, and eſcapes in carbonic acid; while the other remains in its natural ſtate in the retort with the metallic oxide, and while the acetous acid, thus deprived of a portion of its carbon, paſſes into the receiver in the ſtate of acetic acid. A number of other experiments are quoted in ſupport of this reaſoning; but I ſhall not deſcribe them as they are printed, I ſhall only deſcribe thoſe made by myſelf.

To aſcertain whether the acetic acid was more oxygenated than the acetous acid, I repeated ſome of C. Adet's experiments, which I found to be perfectly correct; but it would be uſeleſs to deſcribe them, ſince all thoſe chemiſts acquainted with them are agreed in regard to the oxygenation of the acetic and acetous acids; but it will not be improper, perhaps, to mention ſome new ones which ſeem to ſupport this theory.

As the two acids in queſtion differ a great deal by their concentration, I brought them before I employed them to the ſame degree; and for this purpoſe employed the ſpecific gravity of pure acetous acid, which was 1·007: on the other hand, I mixed with the acetic acid a ſufficient quantity of diſtilled water until its denſity was equal to that of 1·007, or of acetous acid. In this ſtate there is very little difference

* *Annales de Chimie*, vol. xxviii. p. 113.

between

between theſe two acids, only that the acetic acid emits a very ſlight empyreumatic odour.

I took 2000 parts of acetous acid, which I put into a retort with 500 parts of nitric acid. The apparatus being properly diſpoſed for collecting the liquid and gaſeous products, the mixture was carried to the ſtate of ebullition, and continued till the 2000 parts nearly of the acetous acid employed were diſtilled. No gas paſſed during the operation, and the product, when examined, ſhowed no mark of alteration, its ſpecific gravity being equal to that of the acid employed, that is to ſay, 1·007. When combined with oxide of lead, I obtained, by proper evaporation, a cryſtallized ſalt, which was found to be common acetite of lead: it appears to be nearly certain that the acetous acid experienced no change during this operation; its odour was neither ſtronger nor more penetrating than that of the acetous acid employed, and its ſavour was neither ſtronger nor more pungent.

By a ſecond experiment I again endeavoured to oxygenate, if poſſible, the acetous acid. For this purpoſe I prepared what was neceſſary to obtain oxygenated muriatic acid gas, and the apparatus being arranged the gas was received in a flaſk containing acetous acid: after more than a ſufficient quantity had paſſed over, the apparatus was unluted, and the acid collected was carefully examined.

As the odour of the oxygenated muriatic acid conceals that of the acetous acid, the product was placed in a capſule, and expoſed to a gentle heat. When the greater part of the oxygenated muriatic acid had been deſtroyed, the acetous acid exhibited no ſenſible change; its ſavour only appeared to be ſtronger; on account, no doubt, of the muriatic acid which it contained. When combined, like that of the firſt experiment, with oxide of lead, I obtained a needle-formed cryſtallization of muriate of lead; and then a ſecond ſalt, perfectly ſimilar to common acetite of lead, and to that of the firſt experiment. I am therefore of opinion, eſpecially when I call to mind the numerous experiments of C. Adet, that we may aſſert that there do not exiſt two degrees of oxygenation in vinegar. Other experiments would be ſuperfluous, ſince, as I have already ſaid, chemiſts are agreed on this point; but that on which opinions differ, is in regard to the different proportions of the carbon: the experiments I made on this ſubject I ſhall here deſcribe.

Exp. I. After having brought the acetic and acetous acids, as in the former caſe, to the ſame degree of ſpecific gravity, I ſaturated a given quantity of pure and cryſtallized carbonate

of

of potash with the two acids. As it is very difficult to ascertain with certainty the true point of saturation, I shall not speak of the respective quantities employed; they appeared to me to be nearly equal. When I had evaporated these two salts to dryness, they both presented themselves under the form of laminæ, of a savour equally pungent and hot, and, at last, urinous and alkaline; in a word, no difference could be observed between them.

For the present, I shall call the one *acetite of potash*, and that made with acetic acid *acetate*. I took 576 parts of each of these salts, which had been evaporated and brought as far as possible to the same degree of desiccation, and put them into two glass retorts. They were exposed in a furnace to an equal heat, and during the distillation the same phænomena were observed. Some drops of a liquor slightly coloured, and of an acrid savour, passed over into the two receivers. This liquor increased in a sensible manner till the end of the distillation; and after exposure to a strong heat there remained in the two retorts a carbonaceous matter, which was treated with boiling water in order to remove by washing all the alkaline part mixed with the carbon. Being separately filtered, there remained in the filters two light residuums known to be charcoal. The two filters which contained them were placed in a stove for 24 hours, and consequently were dried nearly in an equal degree. In this state the two portions of charcoal being weighed, that of the acetite weighed $22\frac{1}{2}$ parts, while that of the acetate weighed only 22. It is seen by this result that the difference is exceedingly small, and that there is reason to believe that the degree of the desiccation of the residuums, or of the salts employed, may be the cause of the small quantity of charcoal which the acetite furnished more than the acetate.

Exp. II. I saturated crystallized carbonate of soda with equal quantities of the acetous and acetic acid, and, by repeated evaporations, I obtained the two salts crystallized in the same manner: they exhibited striated prisms, among which I remarked some hexaedral; their savour was equally pungent and bitter, and their colour white and brilliant.

These two salts, well crystallized, were dried in an equal degree between filtering paper in a place slightly heated, where they were left till the paper was no longer moistened. I then took, as in the former experiment, 576 parts of acetite and acetate of soda, and put them into two retorts: these two salts, exposed to a graduated heat, first became liquid: in proportion as I augmented the heat they became black, and there passed over into the two receivers liquors slightly co-

loured,

loured, in which floated a kind of oil, the quantities of which were apparently equal. After ſtrongly urging the fire, there remained in the two retorts black reſiduums, which I treated with boiling water as in the firſt experiment. The charcoals remaining in the filters were dried in a ſtove, and then weighed: that produced by the acetate of ſoda weighed eight parts, and that produced by the acetite eight parts and a half. Theſe two reſiduums when examined were found to be charcoal, ſimilar to that obtained by the acetite and acetate of potaſh. This experiment, which on account of the cryſtallization of the ſalts ought to be conſidered as correct, ſince the proportions of the conſtituent parts of the ſalts were found to be the ſame, explains what we have already announced, why the acetite of potaſh gave a little more charcoal than the acetate. There is reaſon, no doubt, to believe that it aroſe from the greater or leſs deſiccation of the ſalts, and the manner in which they were burnt, ſince in the ſecond experiment I found not only the ſame quantity of charcoal in the reſiduum of the acetate of ſoda, but even a ſmall quantity more than in the acetite.

Exp. III. Being perſuaded, by the reſults of theſe two experiments, that the acetous was not more carbonized than the acetic acid, I made as a new proof the following experiment: I put equal parts of ſulphate of copper and acetite of lead, both cryſtallized, pulverized, and mixed, into a retort, which was placed in a furnace over an open fire, joined to the retort an adapter and a receiver, and to the latter a bent tube to collect the elaſtic fluids. At a very gentle heat there paſſed over a white liquid, which increaſed without changing its colour: the fire being continued a conſiderable time that I might obtain all the acetic acid, no other gas paſſed over but a part of the air of the veſſels; the heat was continued till the glaſs retort began to enter into fuſion, upon which it was taken from the fire. There remained a reſiduum of a reddiſh yellow colour, the weight of which was equal to two-thirds that of the mixture employed: the liquid obtained had a perfect reſemblance to pure acetic acid, its weight was equal to a third of the quantities employed. A ſimilar experiment is deſcribed in the *Annales de Chimie* by C. Badolier; but its object, indeed, was different from that of the preſent one, it was publiſhed merely for the purpoſe of giving a ſimple and economical proceſs for obtaining radical vinegar. The author, however, obſerves very juſtly that no carbonic acid was diſengaged, as was the caſe in my operation; nor did I obtain a ſingle atom of acid gas. I endeavoured alſo to diſcover whether any carbon remained in the reſiduum; a rigorous

examination

examination showed that none existed. This experiment with that above described seems evidently to prove that acetous acid is not more carbonized than acetic acid; for it is certain that, if it contained more, the excess above that necessary to constitute the acetic acid produced would have remained in the residuum.

However conclusive my experiments might be in my own opinion, I ought not to lose sight of that of Chaptal, since it is described in the observations I have quoted. Having distilled then, with a proper apparatus, 576 parts crystallized acetite of copper, there passed over into the receiver a white liquor, which was coloured by the progress of the distillation, and which became green by the copper: this liquid was acetic acid. Before the distillation there were disengaged 65 inches of a gaseous fluid, which, when examined, was found to be a mixture of carbonic acid gas and hydrogen gas: the residuum, of a blackish brown colour, being treated with muriatic acid, the latter dissolved the oxide of copper, and left a powder slightly black, which was collected on a filter: this black matter, when edulcorated, dried, and then subjected to chemical examination, was found to be charcoal, the weight of which was 22 parts. As this result was perfectly similar to that described by the chemists, it was necessary to examine whether the consequences they deduced from it were very exact; for it may be asked, why the acetous acid was decarbonized under these circumstances alone, and not in that of which I here give an account. Presuming that I should find a solution of this question by means of comparative experiments, I made the following:

I prepared acetate of copper by dissolving oxide of copper in acetic acid diluted with water, and by proper evaporation I obtained a salt crystallized in octaedra. Of this salt, when dried to the same degree as the acetite of copper, I introduced 576 parts in a retort, and exposed it to heat: it exhibited exactly the same phænomena as the acetite. I obtained nearly equal quantities of hydrogen gas and carbonic acid. The liquid, when collected in the receiver, had the same colour; when examined comparatively with that produced by the acetite, it was impossible to find any difference between them. The residuum, of a blackish brown colour, was treated with muriatic acid, which dissolved the oxide of copper, and left a black matter, which floated on the liquid. This matter, separated by means of the filter, and dried on a stove, being subjected to analysis, was found to be charcoal perfectly similar to that of the preceding experiment: it had absolutely the same weight as that produced by the distillation of the acetite of copper; that is to say, it weighed 22 parts.

From this result it is evident that the charcoal obtained by distilling acetite of copper does not arise from the acetous acid containing more than the acetic acid, since the latter, when subjected to the same operation, gives an equal quantity. In my opinion, that produced in these operations does not arise from a portion of the acid decomposed, the quantities of which ought to vary according to the progress of the decomposition. Experience authorizes me to believe that the difference which may exist between the two acids in question does not depend either on the proportions of the oxygen or of the charcoal. I superintended some trials, not on the constituent principles of vinegar, but on vinegar itself, and the kind of mucilage with which it is accompanied. Before I describe this labour I must not forget to observe that C. Chaptal furnished me with the idea by his observations on the acetic and acetous acids. He says on this subject, that the acid of vinegar may be considered as existing primitively in a state almost saponaceous; which diminishes its action, and weakens its properties.

After having ascertained, by some experiments, the existence of this extractive or mucilaginous principle, I endeavoured to separate it. Distillation as well as filtration were found to be imperfect means: my vinegar always contained mucilage: it remained nearly the same. However, by combining it, after distillation, with alkaline bases, it deposited very little of that flaky matter called *extractive matter*. Having not forgot, during these researches, the opinion of C. Adet, who says that the quantity of water might occasion the difference between the acetous and acetic acids, comparing the observations of these two chemists, I made some experiments, which appear to me to be interesting; but I shall describe that only which appeared to me to be most conclusive.

Entertaining the idea that there was no difference between the acetous acid and the acetic, but a larger quantity of water, and an extractive or mucilaginous matter, I endeavoured to find the proper means of separating the former from it, and bringing it to the state of acetic acid. For this purpose, I prepared muriate of lime, which I strongly calcined. After reducing it to powder, I put it into a tubulated retort, and poured over it common acetous acid with an apparatus proper for receiving the products. The retort, which was on a sand-bath, being exposed to a gentle heat, the matter immediately

entered

entered into ebullition, on account of the heat produced by the calcareous ſalt in ſolidifying the major part of the water contained in the vinegar. During this diſtillation there paſſed over a clear liquor, which fell in ſtriæ on the ſides of the adaptor, and which was collected in a receiver. This liquor totally changed in appearance; had a ſtronger and more pungent ſavour than the acetous acid employed, and its odour was ſharper and more penetrating: one might have taken it for diluted radical vinegar. This product, when ſubjected to a ſecond diſtillation with dried muriate of lime, acquired a little more ſtrength: after a third and a fourth rectification, a tranſparent liquor was obtained, of an odour and ſavour very ſimilar to that of common acetic acid. During theſe rectifications, not an atom of charcoal was depoſited. To aſcertain whether the acid obtained, in loſing a great quantity of its water, had loſt alſo the mucilaginous matter which accompanied it, I ſaturated a portion with cryſtallized carbonate of potaſh: in vain did I add an exceſs of this ſalt, for nothing was precipitated; whereas common acetous acid, by a ſimilar ſaturation, precipitates a flaky matter, which is collected in the bottom of the veſſel employed.

Though the ſtrong and penetrating odour of the acetic acid obtained by the ſimple means above deſcribed was ſufficient to induce me to conclude that it was really ſimilar to that obtained from metallic acetites, I endeavoured to aſcertain this fact by a new experiment. For that purpoſe I took equal parts of this radical vinegar and of alcohol to try to make acetic ether: the attempt was not unſucceſsful; and, by Pelletier's proceſs, I obtained an ether perfectly agreeable, and having an exact reſemblance to the acetic ether found in laboratories. I muſt here obſerve, in ſpeaking of the acetic acid obtained by rectification alone with muriate of lime, that it is far more agreeable than the acetic acid produced, for example, by the diſtillation of metallic acetites; and eſpecially when they are diluted with water. The latter then aſſumes a diſagreeable empyreumatic odour, and an oily ſavour, ariſing from a portion of acetic acid which has been decompoſed by the heat, and which has given birth to a kind of oil which the acid retains in combination. The other, on the contrary, paſſes only to the ſtate of common acid of vinegar by preſerving an agreeable pungency. Before any concluſion can be drawn from the preceding reſults, I muſt not forget to mention an intereſting fact remarked by C. Pontier. This able chemiſt and mineralogiſt, who diſcovered the chromate of iron in France, ſent, about eight

 months

months ago, to C. Vauquelin a flask containing a liquor obtained by the distillation of vinegar on a large scale. As C. Pontier was not ignorant that the first product of the distillation of the acetous acid is aqueous, he separated it from that which followed. After uniting several phlegms of the same kind, he was much astonished to find that these phlegms had a very agreeable aromatic odour: having discovered, by preliminary trials, the properties which gave this product a similarity to ethereal liquors, he rectified all the supposed phlegms, and by these means obtained a peculiar ether, which Vauquelin found to be acetic ether completely rectified.

From an identity so striking in the experiments above described, it is evident that there exists no difference between the constituent parts of the acetic and acetous acids; that the water, and mucilaginous or extractive matter, are the only two apparent differences observed in these two acids; and, consequently, that there exists only one acid of vinegar, which being at its maximum of oxygenation, ought, according to the chemical nomenclature, to be distinguished by the name of *acetic acid*. In future, therefore, there will not exist two different kinds of salts, either by the combination of distilled vinegar or of radical vinegar; they will hereafter be so many products, the names of which must be the same; and hence *acetates* will exist, and not *acetites*.

IV. *Description of a new Implement called a Cultivator. By Mr.* William Lester, *of Northampton**.

SIR,

As the health and luxuriance of corn depend, in a great measure, on the pulverization of the soil previous to the seed being sown, the Society of Arts will, I am persuaded, give every encouragement in their power to the introduction of any implement that promises an abridgement of labour; and as all tenacious soils are pulverized in the best manner in dry weather, when their particles are the most disjointed, and their contact broken, the propriety of taking the advantage of working them in that state will be obvious: and at the same time it follows, that an improved implement for the abridgement of labour would be a desirable thing in a climate like England, where the seasons are so uncertain.

* From the *Transactions of the Society for the Encouragement of Arts, &c.* vol. xix.—The Society's silver medal was awarded to Mr. Lester for this invention.

 In

In working on a rough fallow, my cultivator ſhould be ſet at its greateſt expanſion, and contracted in proportion as the clods are reduced. I am confident that one man, a boy, and ſix horſes, will move as much land in a day, and as effectually, as ſix ploughs; I mean land in a fallow ſtate, that has been previouſly ploughed.

It will be requiſite in ſome ſtates of the ſoil to alter the breadth of the ſhares; but of this, I preſume, the farmer will always be a proper judge. By the expanſion and contraction of the cultivator, the points of the ſhares are, in a ſmall degree, moved out of the direct line; but this is ſo trifling, that it is no impediment to its working. I am, Sir,

Your moſt obedient ſervant,

Northampton, Feb. 10, 1801. WILLIAM LESTER.

Mr. C. Taylor.

A certificate from Mr. William Shaw, of Cotton End, near Northampton, accompanied this letter; in which he ſtates, that he had uſed Mr. Leſter's cultivator upon a turnip fallow laſt ſummer, and that he believes it to be a very uſeful implement for cultivating the land in a fallow ſtate, by its working or ſcuffling off ſeven acres per day, with ſix horſes. He adds, that, from its property of contracting and expanding, it is calculated to work the ſame land in a rough or fine ſtate, by which mean it unites the principles of two implements in one; and, by the index on the axis, it may be worked at any given depth required.

Deſcription of Mr. Leſter's Cultivator. (Plate I. fig. 1.)

A, the beam.

B B, the handles.

C C, a croſs bar of a ſemicircular form, containing a number of holes, which allow the two bars D D, to be placed nearer or further from each other.

D D, are two ſtrong bars, moveable at one end upon a pivot E, and extending from thence, in a triangular form, to the croſs bar C. In theſe bars are ſquare holes, which allow the ſhares F, placed therein, to be fixed to any height required.

The ſeven ſhares marked F, are ſhaped at their lower extremities like ſmall trowels: the upper parts of them are ſquare iron bars.

G G } are three iron wheels, on which the machine is
G, } moved; they may be raiſed or lowered at pleaſure.

H, the iron hook to which the ſwingle-tree and horſes are to be fixed.

When the machine is firſt employed on the land, the bars DD are expanded as much as poſſible. As the ſoil is more looſened, they are brought nearer to the centre: the ſhares then occupy a leſs ſpace, and the ſoil will conſequently be better pulverized.

V. *Deſcription of a newly invented Underſhot Water-wheel. By Mr.* J. Besant, *of Brompton**.

SIR,

I BEG leave to lay before the Society ſome obſervations reſpecting the common underſhot water-wheel, and to point out the ſuperiority of that of my invention.

1ſt, In common water-wheels more than half the water paſſes from the gate through the wheel, without giving it any aſſiſtance.

2dly, The floats coming out of the tail-water are reſiſted with almoſt the whole weight of the atmoſphere at the inſtant they leave the ſurface of the water.

3dly, The ſame quantity of water which paſſed between the floats at the head, muſt of courſe paſs between them at the tail, and conſequently impede the motion of the wheel.

In the water-wheel of my invention,

1ſt, No water can paſs but what acts, with all its force, on the extremity of the wheel.

2dly, The floats coming out of the water in an oblique direction, prevent the weight of the atmoſphere from taking any effect.

3dly, Although the new water-wheel is heavier than that on the old conſtruction, yet it runs lighter on its axis, the water having a tendency to float it.

4thly, By experiments made with the models, proofs have been ſhown that the new wheel has many advantages over the common wheel; and that, when it works in deep tail-water, it will carry weights in proportion of three to one, ſo that it will be particularly ſerviceable for tide-mills.

I hope on trial, before the Society, my invention will prove ſucceſsful; and am, Sir,

Your obedient ſervant,

No. 26, Brompton J. Besant.

To the Secretary of the Society of Arts, &c.

* From the *Tranſactions of the Society for the Encouragement of Arts, &c.* vol. xix.—Ten guineas were voted to Mr. Beſant's widow for this invention.

Repeated

Fig. 1.

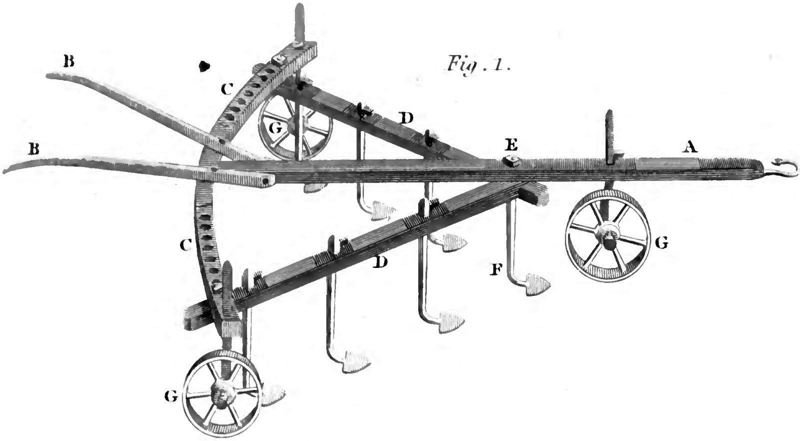


Fig. 2.

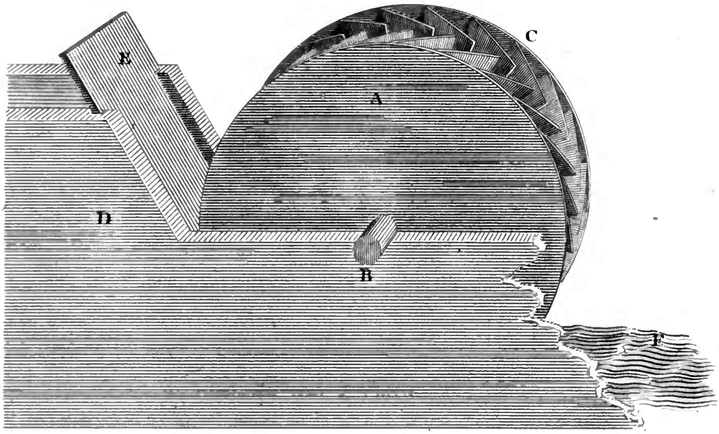
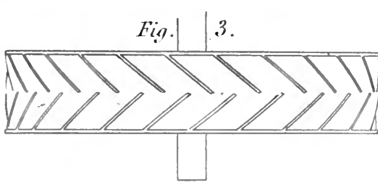


Fig. 3.



Lowry, sculp.

*** Repeated experiments of the above invention were made by the committee; from the result of which it appeared to possess some advantages over the common wheel, and to have a greater power of action.

Description of the late Mr. Besant's Water-wheel. (Plate I. fig. 2 and 3.)

A, (fig. 2.) the body of the water-wheel, which is hollow in the form of a drum, and is so constructed as to be proof against the admission of water within it.

B, the axis on which it turns.

C, the float boards, placed on the periphery of the wheel. Each board is obliquely fixed firm to the rim of it, and to the body of the drum.

D, the reservoir, containing the water.

E, the penstock, which regulates the quantity of water running to the wheel.

F, the current of water which has passed the wheel.

Fig. 3 is a front view of the water-wheel, showing the oblique direction in which the float-boards, C, are placed on the face of the wheel.

VI. *Experiments and Observations on certain Stony and Metalline Substances which at different Times are said to have fallen on the Earth; also on various Kinds of Native Iron.* By EDWARD HOWARD, *Esq. F. R. S.**

THE concordance of a variety of facts seems to render it most indisputable, that certain stony and metalline substances have, at different periods, fallen on the earth. Whence their origin, or whence they came, is yet, in my judgment, involved in complete obscurity.

The accounts of these peculiar substances, in the early annals, even of the Royal Society, have unfortunately been blended with relations which we now consider as fabulous; and the more antient histories of stones fallen from heaven, from Jupiter, or from the clouds, have evidently confounded such substances with what have been termed *ceraunia, bætilia, ombria, brontia*, &c. names altogether unappropriate to substances fallen on our globe. Indeed some mislead, and others are inexpressive.

The term *ceraunia*, by a misnomer, deduced from its supposed origin, seems, as well as *bætilia* †, to have been an-

* From the *Transactions of the Royal Society of London for* 1802.

† Mercati, Metallotheca Vaticana, p. 241.

tiently uſed to denote many ſpecies of ſtones, which were poliſhed and ſhaped into various forms, though moſtly wedge-like or triangular, ſometimes as inſtruments, ſometimes as oracles, and ſometimes as deities. The import of the names *ombria*, *brontia*, &c. ſeems ſubject to the ſame uncertainty.

In very early ages it was believed that ſtones did in reality fall, as it was ſaid, from heaven, or from the gods; theſe, either from ignorance, or perhaps from ſuperſtitious views, were confounded with other ſtones, which, by their compact aggregation, were better calculated to be ſhaped into different inſtruments, and to which it was convenient to attach a ſpecies of myſterious veneration. In modern days, becauſe explosion and report have generally accompanied the deſcent of ſuch ſubſtances, the name of thunderbolt, or thunderſtone, has ignorantly attached itſelf to them; and becauſe a variety of ſubſtances accidentally preſent near buildings and trees ſtruck with lightning have, with the ſame ignorance, been collected as thunderbolts, the thunderbolt and the fallen metalline ſubſtance have been ranked in the ſame claſs of abſurdity. Certainly, ſince the phænomena of lightning and electricity have been ſo well identified, the idea of a thunderbolt is ridiculous. But the exiſtence of peculiar ſubſtances fallen on the earth, I cannot heſitate to aſſert; and on the concordance of remote and authenticated facts I ſhall reſt the aſſertion.

Mr. King, the learned author of "Remarks concerning Stones ſaid to have fallen from the Clouds, in theſe Days, and in antient Times," has adduced quotations of the greateſt antiquity, deſcriptive of the deſcent of fallen ſtones; and, could it be thought neceſſary to add antique teſtimonies to thoſe inſtanced by ſo profound an antiquarian, the quotations of Monſ. Falconet, in his papers upon bœtilia, inſerted in the *Hiſtoire des Inſcriptions et Belles-Lettres* *; the quotations in Zahn's *Specula Phyſico-mathematica Hiſtoriana* †; the *Fiſica Sotterranea* of Giacinto Gemma; the works of Pliny, and others, might be referred to.

Dr. Chladni, in his "Obſervations on the Maſs of Iron found in Siberia, and on other Maſſes of the like Kind," as well as in his "Obſervations on Fire-balls and hard Bodies fallen from the Atmoſphere," has collected almoſt every modern inſtance of phænomena of this nature.

Mr. Southey relates an account, juridically authenticated, of a ſtone weighing ten pounds which was heard to fall in

* Tom. vi. p. 519, et tom. xxiii. p. 228.

† Fol. 1696, vol. i. p. 385, where a long enumeration of ſtones fallen from the ſky is given.

Portugal

Portugal Feb. 19, 1796, and was taken, ſtill warm, from the ground *.

The firſt of theſe peculiar ſubſtances with which chemiſtry has interfered, was the ſtone preſented by the abbé Bachelay to the Royal French Academy. It was found on the 13th of Sept. 1768, yet hot, by perſons who ſaw it fall. It is deſcribed as follows †:

" The ſubſtance of this ſtone is of a pale aſh-gray colour; when examined with a magnifying glaſs, it is found to be interſperſed with a multitude of ſmall brilliant metallic points of a pale yellow colour; its exterior ſurface, that which, according to the abbé Bachelay, was not engaged in the earth, was covered with a ſmall and very thin ſtratum of a blackiſh matter, puffed up in ſome places, and which appeared to have been fuſed. This ſtone, when the interior of it was ſtruck with ſteel, produced no ſparks: on the other hand, when ſtruck on the thin external ſtratum, which appeared to have been attacked by fire, ſome few ſparks were elicited."

The ſpecific gravity of this ſtone was as 3535 to 1000.

The academicians analyſed the ſtone, and found it to contain

Sulphur - -	$8\frac{1}{2}$
Iron - - -	36
Vitrifiable earth -	$55\frac{1}{2}$
	100

Of their mode of analyſis, I ſhall have occaſion to ſpeak hereafter. They were induced to conclude, that the ſtone, preſented to the academy by the abbé Bachelay, did not owe its origin to thunder; that it did not fall from heaven; that it was not formed by mineral ſubſtances, fuſed by lightning; and that it was nothing but a ſpecies of pyrites, without peculiarity, except as to the hepatic ſmell diſengaged from it by marine acid. " That this ſtone, which was, perhaps, covered by a ſmall ſtratum of earth or turf, may have been ſtruck with lightning, and thus uncovered: the heat may have been ſufficiently great to fuſe the ſurface of the part ſtruck, but it may not have been long enough continued to be able to penetrate to the inſide: on this account, the ſtone has not been decompoſed. The quantity of metallic matters it contains, oppoſing leſs reſiſtance than another body to the current of the electric matter, may perhaps have contributed to determine the direction of the lightning."

The memoir is however concluded, by obſerving it to be

* Letters written during a ſhort Reſidence in Spain and Portugal, page 239.

† Here, and in the two following quotations, Mr. Howard gives the original words of the author: we have ſubſtituted faithful tranſlations.—Edit.

ſufficiently

ſufficiently ſingular, that M. Morand le fils had preſented a fragment of a ſtone, from the environs of Coutances, alſo ſaid to have fallen from heaven, which only differed from that of the abbé Bachelay becauſe it did not exhale the hepatic ſmell with ſpirit of ſalt. Yet the academicians did not think any concluſion could be drawn from this reſemblance, unleſs that the lightning had fallen by preference on pyritical matter *.

Monſ. Barthold, profeſſeur à l'école centrale du Haut-Rhin, gave, I believe, the next, and laſt †, analytical account of what he alſo denominates *pierre de tonnerre*. He deſcribes it thus:—"The maſs of ſtone known under the name of *pierre de tonnerre d'Enſiſheim*, weighing about two quintals, has its exterior form rounded, almoſt oval, is rugged, and of a dull earthy appearance.

"The ground of the ſtone is of a blueiſh gray colour interſperſed with inſulated cryſtals of pyrites, the cryſtallization of which is confuſed, in ſome places ſcaly, accumulated, forming nodes and ſmall veins, which traverſe it in every direction: the pyrites is of a golden colour: poliſhing gives it the ſplendour of ſteel, and, when expoſed to the atmoſphere, it becomes tarniſhed and brown. One may diſtinguiſh alſo with the naked eye gray ſcaly iron ore, not ſulphureous, ſuſceptible of being attracted by the magnet, little oxidated, or approaching much to the metallic ſtate.

"The fracture is irregular, granulated, of a grain ſomewhat compact: in the inſide very ſmall fiſſures are ſeen. It does not ſtrike fire with ſteel; its texture is ſo ſoft, that it readily ſuffers itſelf to be attacked by a knife. By pounding, it is eaſily reduced to a blueiſh gray powder of an earthy odour. Sometimes there are found ſmall cryſtals of iron ore, which preſent a greater reſiſtance to the blows of the ſtamper."

The ſpecific gravity of the piece in profeſſor Barthold's poſſeſſion was 3233, diſtilled water being taken at 1000.

The analyſis of M. Barthold, of which I ſhall alſo have occaſion to ſpeak hereafter, gave in the 100,

Sulphur - -	2
Iron - -	20
Magneſia - -	14
Alumina - -	17
Lime - -	2
Silica - -	42
	97.

* See *Journal de Phyſique*, tom. ii, p. 251.

† A very intereſting detail of a meteor, and of ſtones fallen in July 1790, was given by profeſſeur Baudin in the *Magazin für das Neueſte aus der Phyſik*, by profeſſor Voigt.

From

From the external characters, and from his analysis, the professor considers the stone of Ensisheim to be argillo-ferruginous; and is of opinion, that ignorance and superstition have attributed to it a miraculous existence, at variance with the first notions of natural philosophy *.

The account next in succession is already printed in the Transactions of the Royal Society; but cannot be omitted, as it immediately relates to one of the substances I have examined. I allude to the letter received by Sir William Hamilton from the earl of Bristol, dated from Sienna, July 12, 1794:—"In the midst of a most violent thunder-storm, about a dozen stones, of various weights and dimensions, fell at the feet of different persons, men, women, and children. The stones are of a quality not found in any part of the Siennese territory: they fell about eighteen hours after the enormous eruption of mount Vesuvius; which circumstance leaves a choice of difficulties in the solution of this extraordinary phænomenon. Either these stones have been generated in this igneous mass of clouds, which produced such unusual thunder; or, which is equally incredible, they were thrown from Vesuvius, at a distance of at least 250 miles; judge then of its parabola. The philosophers here incline to the first solution. I wish much, Sir, to know your sentiments. My first objection was to the fact itself; but of this there are so many eye witnesses, it seems impossible to withstand their evidence." (Phil. Trans. for 1795, p. 103.) Sir William Hamilton, it seems, also received a piece of one of the largest stones, which weighed upwards of five pounds; and had seen another which weighed about one. He likewise observed, that the outside of every stone which had been found, and had been ascertained to have fallen from the clouds near Sienna, was evidently freshly vitrified, and was black, having every sign of having passed through an extreme heat; the inside was of a light gray colour, mixed with black spots and some shining particles, which the learned there had decided to be pyrites.

In 1796 a stone weighing 56 pounds was exhibited in London, with several attestations of persons who, on the 13th of December 1795, saw it fall, near Wold Cottage, in Yorkshire, at about three o'clock in the afternoon. It had penetrated through twelve inches of soil and six inches of solid chalk rock; and, in burying itself, had thrown up an immense quantity of earth to a great distance: as it fell, a number of explosions were heard, about as loud as pistols.

* See *Journal de Physique*, Ventose, an. 8, p. 169.

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In the adjacent villages, the ſounds heard were taken for guns at ſea; but, at two adjoining villages, were ſo diſtinct of ſomething ſingular paſſing through the air, towards the habitation of Mr. Topham, that five or ſix people came up to ſee if any thing extraordinary had happened to his houſe or grounds. When the ſtone was extracted, it was warm, ſmoked, and ſmelt very ſtrong of ſulphur. Its courſe, as far as could be collected from different accounts, was from the ſouth-weſt. The day was mild and hazy, a ſort of weather very frequent in the Wold hills, when there are no winds or ſtorms; but there was not any thunder or lightning the whole day. No ſuch ſtone is known in the country. There was no eruption in the earth; and, from its form, it could not come from any building; and, as the day was not tempeſtuous, it did not ſeem probable that it could have been forced from any rocks, the neareſt of which are thoſe of Flamborough Head, at a diſtance of twelve miles*. The neareſt volcano I believe to be Hecla in Iceland.

The exhibition of this ſtone as a ſort of ſhow, did not tend to accredit the account of its deſcent, delivered in a hand-bill at the place of exhibition; much leſs could it contribute to remove the objections made to the fall of the ſtones preſented to the Royal French Academy. But the right hon. Preſident of the Royal Society, ever alive to the intereſt and promotion of ſcience, obſerving the ſtone ſo exhibited to reſemble a ſtone ſent to him as one of thoſe fallen at Sienna, could not be miſled by prejudice: he obtained a piece of this extraordinary maſs, and collected many references to deſcriptions of ſimilar phænomena. At length, in 1799, an account of ſtones fallen in the Eaſt Indies was ſent to the preſident by John Lloyd Williams, eſq. which, by its unqueſtionable authenticity, and by the ſtriking reſemblance it bears to other accounts of fallen ſtones, muſt remove all prejudice. Mr. Williams has ſince drawn up the following more detailed narrative of facts.

Account of the Exploſion of a Meteor near Benares, in the Eaſt Indies; and of the Falling of ſome Stones at the ſame Time, about 14 *Miles from that City. By* John Lloyd Williams, *Eſq. F.R.S.*

A circumſtance of ſo extraordinary a nature as the fall of ſtones from the heavens could not fail to excite the wonder and attract the attention of every inquiſitive mind.

Among a ſuperſtitious people, any preternatural appearance is viewed with ſilent awe and reverence: attributing the

* Extracted from the printed paper delivered at the place of exhibition.

cauſes

causes to the will of the Supreme Being, they do not presume to judge the means by which they were produced, nor the purposes for which they were ordered; and we are naturally led to suspect the influence of prejudice and superstition in their descriptions of such phænomena: my inquiries were therefore chiefly directed to the Europeans, who were but thinly dispersed about that part of the country.

The information I obtained was, that on the 19th of December 1798, about eight o'clock in the evening, a very luminous meteor was observed in the heavens, by the inhabitants of Benares and the parts adjacent, in the form of a large ball of fire; that it was accompanied by a loud noise resembling thunder; and that a number of stones were said to have fallen from it near Krakhut, a village on the north side of the river Goomty, about 14 miles from the city of Benares.

The meteor appeared in the western part of the hemisphere, and was but a short time visible: it was observed by several Europeans, as well as natives, in different parts of the country.

In the neighbourhood of Juanpoor, about twelve miles from the spot where the stones are said to have fallen, it was very distinctly observed by several European gentlemen and ladies; who described it as a large ball of fire, accompanied with a loud rumbling noise, not unlike an ill-discharged platoon of musketry. It was also seen, and the noise heard, by various persons at Benares. Mr. Davis observed the light come into the room where he was, through a glass window, so strongly as to project shadows from the bars between the panes, on a dark coloured carpet, very distinctly; and it appeared to him as luminous as the brightest moonlight.

When an account of the fall of the stones reached Benares, Mr. Davis, the judge and magistrate of the district, sent an intelligent person to make inquiry on the spot. When the person arrived at the village near which the stones were said to have fallen, the natives, in answer to his inquiries, told him, that they had either broken to pieces, or given away to the *tesseldar* (native collector) and others, all that they had picked up; but that he might easily find some in the adjacent fields, where they would be readily discovered (the crops being then not above two or three inches above the ground) by observing where the earth appeared recently turned up. Following these directions, he found four, which he brought to Mr. Davis: most of these the force of the fall had buried, according to a measure he produced, about six inches deep, in fields which seemed to have been recently watered; and it appeared, from the man's deſcription, that they muſt have lain at the diſtance of about a hundred yards from each other.

What he further learnt from the inhabitants of the village concerning the phænomenon was, that about eight o'clock in the evening, when retired to their habitations, they obſerved a very bright light, proceeding as from the ſky, accompanied with a loud clap of thunder, which was immediately followed by the noiſe of heavy bodies falling in the vicinity. Uncertain whether ſome of their deities might not have been concerned in this occurrence, they did not venture out to inquire into it until the next morning; when the firſt circumſtance which attracted their attention was the appearance of the earth being turned up in different parts of their fields as before mentioned, where, on examining, they found the ſtones.

The aſſiſtant to the collector of the diſtrict, Mr. Erſkine, a very intelligent young gentleman, on ſeeing one of the ſtones, brought to him by the native ſuperintendant of the collections, was alſo induced to ſend a perſon to that part of the country to make inquiry; who returned with ſeveral of the ſtones, and brought an account ſimilar to that given by the perſon ſent by Mr. Davis, together with a confirmation of it from the cauzy, (who had been directed to make the inquiry,) under his hand and ſeal.

Mr. Maclane, a gentleman who reſided very near the village of Krakhut, gave me part of a ſtone that had been brought to him the morning after the appearance of the phænomenon, by the watchman who was on duty at his houſe; this, he ſaid, had fallen through the top of his hut, which was cloſe by, and buried itſelf ſeveral inches in the floor, which was of conſolidated earth. The ſtone muſt, by his account, previous to its having been broken, have weighed upwards of two pounds.

At the time the meteor appeared, the ſky was perfectly ſerene; not the ſmalleſt veſtige of a cloud had been ſeen ſince the 11th of the month, nor were any obſerved for many days after.

Of theſe ſtones, I have ſeen eight, nearly perfect, beſides parts of ſeveral others, which had been broken by the poſſeſſors to diſtribute among their friends. The form of the more perfect ones appeared to be that of an irregular cube, rounded off at the edges; but the angles were to be obſerved on moſt of them. They were of various ſizes, from about three to upwards of four inches in their largeſt diameter; one of them, meaſuring four inches and a quarter, weighed two pounds twelve ounces. In appearance, they were exactly

actly ſimilar: externally they were covered with a hard black coat or incruſtation, which in ſome parts had the appearance of varniſh, or bitumen; and on moſt of them were fractures, which, from their being covered with a matter ſimilar to that of the coat, ſeemed to have been made in the fall, by the ſtones ſtriking againſt each other, and to have paſſed through ſome medium, probably an intenſe heat, previous to their reaching the earth. Internally, they conſiſted of a number of ſmall ſpherical bodies, of a ſlate colour, embedded in a whitiſh gritty ſubſtance, interſperſed with bright ſhining ſpiculæ, of a metallic or pyritical nature. The ſpherical bodies were much harder than the reſt of the ſtone: the white gritty part readily crumbled, on being rubbed with a hard body; and, on being broken, a quantity of it attached itſelf to the magnet, but more particularly the outſide coat or cruſt, which appeared almoſt wholly attractable by it.

As two of the more perfect ſtones which I had obtained, as well as parts of ſome others, have been examined by ſeveral gentlemen well verſed in mineralogy and chemiſtry, I ſhall not attempt any further deſcription of their conſtituent parts; nor ſhall I offer any conjecture reſpecting the formation of ſuch ſingular productions, or even record thoſe which I have heard of others, but leave the world to draw their own inferences from the facts above related. I ſhall only obſerve, that it is well known there are no volcanos on the continent of India; and, as far as I can learn, no ſtones have been met with in the earth, in that part of the world, which bear the ſmalleſt reſemblance to thoſe above deſcribed.

[To be continued.]

VII. *Mineralogical Notice reſpecting two great Peculiarities lately found in Iron-ſtone from Hachenburg and Iſchenburg. By Mr.* CRAMER, *Counſellor of Mines at Altenkirchen**.

THE firſt mineral I ſhall here mention is native iron. It is well known that a diſpute has long exiſted among mineralogiſts reſpecting the actual exiſtence of this ſubſtance; that by ſome it has always been doubted; and that, beſides the monſtrous maſs of which profeſſor Pallas has given a circumſtantial deſcription, few ſpecimens have ever been produced to give ſupport to the aſſertion, that this mineral is found in a natural ſtate. The certainty of its exiſtence has

* From *Der Geſellſchaft Naturforſchender Freunde zu Berlin Neue Schriften*, vol. ii.

reſted hitherto on very ſlight foundations; and, as moſt of our mineralogiſts have always ſpoken merely of probability, they have ſuffered the doubt to remain, whether the maſſes of iron which have been found were not artificial productions, or the effect of ſubterranean fire, &c. I muſt confeſs that I have myſelf doubted, on good grounds, of the reality of thoſe ſpecimens of ſuppoſed native iron which I have ſeen in different collections of Germany.

If ſuch difficulty of belief is excuſable in a ſcience where every thing ought to be determined by obſervation and experience; a mineralogiſt, however, ought not to perſiſt in a previouſly adopted opinion, when he has been convinced of the contrary by his own eyes. A conviction of this kind occurred to myſelf the preſent year, and by a ſingular accident. A company, who are proprietors of two iron-works in this county, being in want of good iron-ſtone, and on that account prevented from manufacturing the iron of the beſt quality, received a letter from the neighbouring county of Hachenburg containing an offer of a thouſand waggon loads of iron-ſtone for five years, from a quarry of iron-ſtone which had been lately diſcovered at a ſmall diſtance from the borders of this county. The offer was accepted, and the iron-ſtone was delivered at the two works in pretty large maſſes, which were afterwards broken, according to the cuſtom uſual in this part of the country, with ſmall hammers. After its arrival, one of the workmen put a piece under the hammer; but, as it reſiſted every effort made to break it, he was naturally induced to examine it more narrowly. He immediately carried it to a forge in the neighbourhood; and the ſmith, having put it into the fire, forged from it, in a few minutes, ſome excellent horſe-ſhoe nails. It is, however, much to be regretted, that, through the ignorance and careleſſneſs of the workman, this remarkable production of nature was, in a great meaſure, deſtroyed. It weighed altogether four pounds; and only a few fragments, which had almoſt all been in the fire, and which exhibit on the one ſide the native iron, and on the other the forged nails, were ſaved: but theſe fragments are preſerved by the poſſeſſors with as much care as if they were ſacred relics. One piece, which came into my poſſeſſion, ſeems to have been very little in the fire: it weighs nearly half a pound, has a ſhining fracture of a ſteel gray colour, is of a browniſh colour on the outſide running into black, and perfectly malleable.

Being induced by this ſingular phænomenon to make ſome reſearches in the place where it occurred, I repaired thither,

thither, and found a pit newly opened which had a greater reſemblance to a quarry than an iron-mine. Some old pits, of no great extent, one of which forms at preſent a ſmall bog, ſeemed to indicate that a mine had been here worked formerly; but never to any great extent, becauſe the ſtrata of iron-ſtone, very compact, half a fathom in thickneſs, were found at the depth of only half a fathom below the ſurface of the earth.

The whole ſurface of the ſurrounding diſtrict is covered with huge irregular maſſes of baſaltes, a prodigious quantity of which forms in the neighbouring foreſt a group of rocks known under the name of *Wolfſtein*, where large pieces of baſaltes are heaped upon each other, as if by art, to the height of nearly ten fathoms; and, as this accumulation occupies a circumference of ſome hundred fathoms, this maſs, in conſequence of its gravity, and the preſſure thence ariſing, may have deviated from its perpendicular direction, and produced thoſe numerous apertures and fiſſures in the neighbourhood. It forms a very awful appearance in the dark foreſt; which, however, is pretty much on a level, and excites a well-grounded fear, that, in the courſe of time, conſiderable fragments of it may tumble down and cruſh ſome of the inhabitants who ſtray about in the neighbourhood, and who often viſit this Wolfſtein, which they conſider as the ruins of an antient caſtle.

About 200 fathoms to the eaſt of the above iron-ſtone quarry lie the boundaries of the territory of Orange-Naſſau; where the mountains evidently conſiſt of ſtrata, and where bituminous wood may be found almoſt every where at a certain depth. I ſhall abſtain from all further deſcription, as a full account of this diſtrict may be ſeen in a ſmall work on this ſubject, written a few years ago by Mr. Becher, counſellor of mines at Dillenburg, and alſo in the third part of the Mineralogical Deſcription of the Country of Naſſau-Orange. I muſt however obſerve, that near the boundaries of Naſſau and Hachenburg the mountain changes, and the argillaceous ſlate-mountains begin. The diſtrict around the iron-ſtone pits of Hachenburg conſiſts of argillaceous ſlate. The ſtratum itſelf is compoſed chiefly of brown hematite almoſt without variation, in which particles of red iron ochre, lithomarga, and argil, occur. The hematite is pretty fuſible, and abundant in metal, and produces good malleable iron. According to the account of the director of the works, who was examined on the ſubject, the above piece of native iron was imbedded in a round cruſt of ſuch hematite: it was ſomewhat grown on the one ſide, and the iron-ſtone on it was

 very

very hard and compact. He thinks he knows the place where it was broken off, and that more of the ſame kind will hereafter be found: but this, notwithſtanding the ſtricteſt ſearch, has not yet been the caſe.

I am happy therefore that I have been able to give this occaſional notice of a phænomenon ſo remarkable in the mineral kingdom: if I receive any further information on the ſubject, I ſhall not fail to communicate it.

The ſecond remarkable phænomenon in the mineral kingdom occurred to me in the county of Wachterſbach, on the river Kinzig, not far from the town of Gelnhauſen, where I reſided ſome time laſt ſummer, for the benefit of my health, with the reigning count. An iron-work, ſituated at the diſtance of two miles from the count's palace, belongs to Mr. von Lilienſtern, of Franckfort, and is one of the completeſt and moſt beautiful I have ſeen. It conſiſts of an elegant manſion and tavern, a large edifice for the ſubalterns, a caſting-houſe, a forge, and various large and ſmall hammers, which are ſituated ſo advantageouſly under each other that they can all be driven together by the ſame water. The whole forms a ſmall colony, and exhibits to the amateurs of ſuch eſtabliſhments a moſt agreeable proſpect, eſpecially as it is variegated by romantic walks, and agreeable fruit- and kitchen-gardens. The ſmelting of the iron-ſtone is performed in a common high furnace. The product, according to the account of the founder, may be about 24,000 pounds per week, which amounts to nearly 3500 pounds in 24 hours. The iron obtained, as far as I can judge, is malleable, and of a good quality; but, in particular, very proper for caſt work, on which alone the workmen were employed during two viſits which I paid to the eſtabliſhment. They have a very able director, and caſt not only the moſt beautiful round fire-ſtoves, according to the antique mode, with many appropriate ornaments, but alſo pots and other veſſels, according to the demand and other circumſtances. They are employed in making ſuch articles, and caſting the raw iron into the uſual priſmatic pigs, which is afterwards ſubjected to the operation of the different hammers.

Notwithſtanding the great extent of the Budinger foreſt, and the private woods belonging to the count in the neighbourhood, the proprietors of this iron-work have been obliged to purchaſe the neceſſary charcoal at a very dear rate, and to bring ſome of it from a great diſtance, becauſe the numerous ſalt-works, glaſs-houſes, and other ſmaller manufactories in the neighbourhood, naturally increaſe the conſumption; and the many rights of commonage in the Budinger foreſt belonging

to

to the adjacent country, and the neighbouring towns and villages, who employ their privileges to the fulleſt extent, are a great impediment to the cultivation of timber.

The iron-ſtone for this work is procured chiefly from the neighbouring principality of Iſenberg-Birſtein, and in particular from the diſtrict of Wenings, near which there have long been a great many large iron-ſtone works. In all theſe the iron-ſtone is found in ſtrata; and the ſtrata in general are only from four or five inches to one foot in breadth; but in the above-mentioned principal work they are ſometimes from one to two fathoms in breadth, but at preſent they have decreaſed to two or three feet. The iron-ſtone dug up from the different pits, and employed at the Lilienſtern work, is in part compact brown iron-ſtone, and partly brown hematite, which is found for the moſt part in pretty round hard pieces without much variation. It is exceedingly argillaceous, and ſo difficult to be fuſed, that it requires a conſiderable addition of calcareous ſtone, a large quantity of which is found in the county of Wachterſbach. In this diſtrict, at preſent, the work has only a few iron-ſtone pits, none of which are of much importance: one of them, however, on account of the ſingular metallurgic property of the iron-ſtone it produces, deſerves the attention of mineralogiſts.

Under the exterior cruſt there firſt occurs a ſtrong ſtratum of white and red ſandſtone in alternate order, which extends to the diſtance of ſeveral miles in the neighbourhood. Under this lies a gray argillaceous ſtone, which feels ſomewhat greaſy, ſoft, and friable, and is ſcarcely three inches in thickneſs: below this there is a ſtratum of excellent iron-ſtone of equal thickneſs, the bottom of which conſiſts of ſolid ſandſtone, of a kind of millſtone which frequently occurs in theſe diſtricts. This iron-ſtone is different from every other kind in the neighbourhood: it is a compact argillaceous iron-ſtone of a reddiſh brown colour and of a rough fracture, ſometimes mixed with ſhells, among which there is found, though very ſeldom, a variety which has a fibrous fracture, with an almoſt metallic ſplendour, and ſeems worthy of further examination.

When I viſited this work, ſome maſſes of this compact iron-ſtone were dug up which contained charcoal. This charcoal was found looſe in the iron-ſtone, and partly grown into its ſubſtance and adhering to it. By what natural or artificial fire this charcoal was burnt, and by what ſingular revolution it was carried to the depth of from three to four fathoms, and there ſo intimately combined with the iron-ſtone that it ſeems to form one body with it, no mineralogiſt can with certainty explain.

The hypotheſis which I have ventured to form of this ſingular and certainly uncommon ſubterranean mixture is, that the charcoal was burnt in the neighbourhood either in the uſual manner or by natural fire, and that ſome fragments of it, by ſome convulſion of nature, were thrown to the above depth, where they united with the ferruginous matter, and by theſe means produced the above remarkable phænomenon. On many fragments one can obſerve the tranſition of the not completely burnt wood into iron-ſtone; even the bark of the wood, actually converted into iron-ſtone, may be clearly diſtinguiſhed; and the perfectly black natural or artificial charcoal, poſſeſſing all the properties of the charcoal of burnt wood, lies undecompoſed in it: but it would be worth while to ſubject it to a more accurate chemical reſearch, in order to examine its component parts. I hope to obtain, by one of my friends, a more detailed account of this ſubterranean phænomenon; and therefore I ſhall only add at preſent, that this iron-ſtone is exceedingly eaſy of fuſion, and ſo much ſo, that it is uſed as a flux for other kinds, and, in ſome meaſure, indiſpenſably neceſſary at the forges, eſpecially when caſt articles are to be manufactured with advantage.

VIII. *Memoir on the Anatomy of Vegetables. Read before the Phyſical Claſs of the Inſtitute by* C. MIRBEL *.

Of the Elementary Organs.

AFTER ſtudying the works of Duhamel, Senebier, De Sauſſure, and ſeveral other philoſophers, without being able to form any fixed opinion of the internal anatomy of vegetables, it appeared to me that it would be more advantageous to ſtudy nature in her own works. I endeavoured to baniſh from my mind every thing ſyſtematic, in order that my obſervations might be free from every kind of bias. All vegetables have too much relation in the mode of the development of their organization not to exhibit great ſimilitude. This reflection, which naturally preſents itſelf to the mind, induced me to direct my firſt obſervations to one ſpecies. I made choice of the elder, as having a looſer texture, and eaſier to be obſerved, than that of many other vegetables. During ſix months, I employed all the known proceſſes for

* From the *Journal de Phyſique*, Germinal, an. 10.

acquiring

acquiring a knowledge of the organs of that plant. I uſed comparatively four or five different microſcopes; and, when I ſuppoſed that I had got the whole ſeries of facts, I tried the ſame obſervations on a great number of other vegetables. The compariſons I then made greatly contributed to give me information reſpecting the nature and form of the organs; and to obviate, by every mean poſſible, the illuſions which might lead me into a falſe path, I begged C. Maſſey, my friend and fellow-labourer, to reviſe my obſervations, and to examine them with the ſevereſt criticiſm. His obſervations compared with mine have either confirmed or rectified them.

I ſhall now give a deſcription of the parts which I call elementary organs, becauſe all the other organs are compoſed of them.

Chap. I.

Of thoſe Parts which are diſtinguiſhed by the naked Eye.

Vegetables in general are compoſed, as every body may have obſerved, of ſoft and hard parts. Some, indeed, ſuch as muſhrooms and fuci, ſeem to be formed entirely of a homogeneous ſubſtance, pretty ſoft; but this claſs is not very numerous.

The ſtem of the moſt perfect plants preſents at its ſurface a coloured ſubſtance of greater or leſs thickneſs, which is the bark. It adheres ſtrongly to the interior parts in a great many of the monocotyledons, and ſometimes even is confounded and connected with them in ſuch a manner that it is impoſſible to diſtinguiſh them. It may in this caſe be ſaid that no bark exiſts. This phænomenon is obſerved in the palms, gramineous plants, &c. But in the dicotyledons and ſome monocotyledons the bark, very diſtinct from the reſt of the tiſſue, forms an exterior ſtratum, which may be eaſily detached.

Below the bark is found the wood more compact, harder, and more connected in all its parts, and which ſeems to be formed of longitudinal fibres ſtrongly cemented to each other. In the monocotyledons without bark there is found, immediately below the epidermis, a fine tranſparent membrane, which is the exterior part of the vegetable.

The wood, as the learned Desfontaines has ſaid in his excellent memoir on the Comparative Anatomy of Vegetables, is diſtributed lengthwiſe in the ſtem and branches of the monocotyledons in delicate threads: theſe threads are often parallel, and ſometimes convergent one towards the other; they unite one and one, two and two, or divide themſelves, and become ramified in threads of ſtill greater fineneſs. All theſe threads are ſurrounded with a ſoft, elaſtic, ſpongy ſubſtance, eaſily torn, and generally whitiſh, which is called the pith, and to which I ſhall give the name of *parenchyme*, that it may not be confounded with the pith of the dicotyledon plants. The wood of the latter, lying always under the bark, is not divided into diſtinct threads; it generally forms a cylinder, in the centre of which is placed the pith, as in a caſe. Some plants, however, evidently furniſhed with two cotyledons, exhibit ligneous filaments ſimilar to thoſe of the monocotyledons, running along the whole length of the medullary canal: but theſe are exceptions which do not deſtroy the general rule.

In trees or ſhrubs with two cotyledons there are almoſt always obſerved diſtinct lines of the wood, which proceed from the pith, traverſe the ligneous cylinder, and end at the bark. They appear on the tranſverſal ſection of the trunk, ſtem, branches, and twigs, like the hour-lines of a dial. They are called the medullary radii. They ſeldom ſhow themſelves in the ſtems of the dicotyledon herbs, and do not exiſt in the monocotyledons either herbaceous or ligneous.

In the leaves, flowers, pericarpia, &c. there are found alſo parts of greater or leſs ſoftneſs, and greater or leſs hardneſs, the ſubſtance of which appears to be ſimilar to the bark, pith, or wood.

Such are the different parts which vegetables exhibit to the naked eye. We muſt now examine the elementary organs which enter into their compoſition.

Chap. II.

Of the Membranous Tiſſue.

Vegetables are compoſed of a membranous tiſſue, which varies in its form and conſiſtence, not only in the different ſpecies, but even in the ſame individual. I ſhall not here examine whether the membranes are compoſed of organic fibres, ranged cloſe to each other and united by a gluten, as ſome authors aſſert. This ſuppoſition is ſuſceptible neither of ſtrict demonſtration, nor a formal refutation; it is one of thoſe ſyſtems which amuſe the mind when reſearch becomes fruitleſs. I ſhall content myſelf with ſtating, that, whatever may have been the perſeverance of my obſervations, I never obſerved real fibres in vegetables; the filaments to which that name has been given are only membranes, which tear into longitudinal ſtripes: ſuch were the delicate filaments which Duhamel ſeparated from a bit of wood which he obſerved through the microſcope.

The membranous tiſſue, though continued in all its parts, forms two kinds of different organs; the cellular tiſſue, and the tubular tiſſue.

Chap. III.

Of the Cellular Tiſſue.

This tiſſue preſents to the obſerver a ſeries of membranous bags, which on the firſt view ſeem to have no communication with each other. They are not ſmall bladders or utriculi, as moſt authors aſſert; they are a membrane, which bends itſelf, in ſome meaſure, to form vacuities contiguous to each other. In the parts where theſe cells experience no foreign preſſure, they are all equally dilated, their tranſverſal and vertical ſections preſent hexagons ſimilar to the alveolæ of bee-hives; each ſide of theſe geometrical figures is common to two cells, and the whole tiſſue is wonderfully regular: but, when the tiſſue is compreſſed, the hexagons loſe their ſhape, and are converted ſometimes into parallelograms more or leſs elongated. The membranous ſides of the cells are exceedingly thin and colourleſs: they are tranſparent like glaſs, and their organization is ſo delicate, that it cannot be perceived even with the help of the moſt powerful microſcopes. They are generally filled with pores, the apertures of which do not certainly exceed the 300th part of a line; theſe pores are bordered with ſmall unequal and glandulous rolls, which intercept the light, and refract it with force when they receive its rays. The cellular tiſſue is ſpongy, elaſtic, and without conſiſtence; when immerſed in water it becomes altered, and, in a little time, is even deſtroyed: it is then reduced to a kind of mucilage. Theſe pores eſtabliſh a communication between one cell and another, and ſerve for the transfuſion of the juices in that tiſſue, which is exceedingly ſlow. I muſt alſo obſerve, that it is not a *conductor* of the fluids diffuſed throughout the vegetable, and that it produces nothing of itſelf.

I have ſaid that the membranes are tranſparent and colourleſs: when the tiſſue is diſengaged from every foreign body, this is true; but it is often marked by colouring ſubſtances, which tarniſh its tranſparency. This tiſſue exiſts in all vegetables, but not in the ſame proportion. Muſhrooms and fuci appeared to me to be compoſed only of cellular tiſſue. The bark of monocotyledons and dicotyledons is almoſt entirely formed of it: in theſe, it is generally ſomewhat compreſſed between the epidermis and the wood; it is filled with reſinous juices, commonly coloured green, but ſometimes red or yellow, according to the nature of the vegetable. This gives different tints to the epidermis, which is nothing elſe than the exterior ſide of the firſt row of cells, as the illuſtrious Malphigi ſuppoſed. The pith in all plants is compoſed of hexagonal cells. In herbaceous plants, and particularly thoſe which are highly ſucculent, theſe cells are often filled with juices more or leſs thick or coloured. In ligneous plants, naturally drier, they are, on the other hand, almoſt entirely empty, and tranſparent. The cellular tiſſue in bulbous roots is pulpy and ſucculent; in the cotyledons it is hard and brittle; and in the albumen and ſeeds it is dry and arid. The parenchyme of the leaves, of the bracteæ, ſtipulæ, and calyces, is formed by cells filled with a juice almoſt always coloured, and green. The rich corollæ, which diſplay to the light the elegance of their forms and the ſplendour of their colours, but of which the beauty and freſhneſs vaniſh in a moment, are not ſo thin as the delicate membranes of the cellular tiſſue: the juices which ſwell the tranſparent utriculi of which they are formed give them theſe colours; the one ſometimes diffuſed into the other by imperceptible tints, ſometimes abruptly oppoſed, and heightening their ſplendour by the contraſt. Here the cellular tiſſue is ſo delicate, that the ſlighteſt touch is ſufficient to alter and tarniſh it: the leaſt preſſure reduces it to mucilage, and it appears to be the momentaneous product of the air and water. This tiſſue is obſerved alſo in the ſtamina and the piſtils. The pollen, that fine duſt which contains the ſubtile fluid neceſſary for fecundation, appears to be only an accumulation of ſmall bags formed of the cellular tiſſue: in a word, it is this tiſſue which, by dilating itſelf, produces ſucculent fruits.

The cells are proportionally more abundant in herbs than in trees, and in young ſhoots than in old timber. The embryo is compoſed almoſt entirely of cellular tiſſue. The medullary radii, which extend from the centre to the circumference in the trunks and branches of trees with two cotyledons, are ſometimes alſo nothing but a thin membrane of cells.

[To be continued.]

IX. *Method of whitening the Gray Marine Salt to fit it for domeſtic Purpoſes inſtantaneouſly, and without the Aid of Heat.* By PAJOT DESCHARMES*.

GRAY or unrefined marine ſalt, as every body knows, is covered with a thin earthy cruſt which alters more or leſs its whiteneſs; and it is a matter of ſome conſequence, both in

* From the ſame.

regard

regard to cleanlinefs and health, to purify it from this heterogeneous fubftance which covers all the faces of its cryftals.

Hitherto this falt has been purified or refined only by folution, filtration, or precipitation, according as the operation is performed on a large or a fmall fcale, and then by evaporation. This method requires time, wood or charcoal, and proper veffels. Many perfons, however, are unacquainted with this procefs; fometimes they have not leifure to employ it; and fometimes they have neither the neceffary veffels nor fuel.

I have thought, therefore, that a procefs which requires neither fire nor particular veffels, is attended with no expenfe, may be practifed at all times, and is within the reach of every one, might be of general utility. This method is as follows:

Take four ounces of gray falt, and, if dry, befprinkle it gently with water till it be only what is called moift; but it will be very feldom neceffary to have recourfe to this operation. Put the falt into the corner of a table napkin or piece of linen cloth, and form the cloth into a kind of knot or bag, which you muft hold in one hand, while with the other you rub and fhake the falt againft the infide of the cloth for the fpace of half an hour. Then fhift the falt to another place of the cloth, fucceffively repeating the fame manœuvre fix, feven, or eight times, according as the falt is more or lefs gray. After the falt has been rolled for the firft time, the cloth begins to exhibit fpots occafioned by the earth which the falt depofits, and of which the intenfity fenfibly decreafes at each change of place till they entirely difappear. In general, the falt muft be befprinkled every two or three times that its place is changed. The bleaching will be accelerated by pounding the falt flightly before it is befprinkled.

After two or three afperfions and rubbings, the falt is, in general, as pure and white as that refined, according to the ufual method, by folution and evaporation. The lofs in both cafes is nearly the fame; that is to fay, about an eighth, when the falt is dry, and when care has been taken at each change of place to fhake off the grains which adhere to the cloth. It is, for the moft part, the whiteft falt that adheres in this manner; and it may be fhaken off without fear, as the earth depofited on the cloth cannot detach itfelf till the cloth is dry. The gray falt of commerce contains in general $12\frac{1}{2}$ per cent. of foreign matters, nearly one-half of which is water, and about as much earth.

This procefs, which on account of its fimplicity I confider as likely to become ufeful for domeftic purpofes, might perhaps be applicable to falt manufactories and falt refineries.

X. *On*

X. *On the Alteration which Light produces on Red ſulphurated Arſenic, known under the Name of Realgar. Read in the French Inſtitute by* B. G. SAGE, *Director of the Firſt School of Mines* *.

LIGHT alters the red colours of oxides or metallic calces. Minium as well as red oxide of mercury, when expoſed to the light, becomes black, though in cloſe glaſs jars.

One of the moſt celebrated chemiſts, Scheele, made known that muriate of ſilver loſt its white colour by light even when under water. The ſame philoſopher, having decompoſed the light by means of a priſm, found that muriate of ſilver, heretofore known under the name of *luna cornea*, was coloured

In 4 ſeconds, by	-	the violet ray;
In 25 ſeconds, by	-	the purple ray;
In 29 ſeconds, by	-	the blue ray;
In 37 ſeconds, by	-	the green ray;
In 5 minutes, by	-	the yellow ray;
In 12 minutes, by	-	the orange ray;
In 20 minutes, by	-	the red ray.

Native realgar, which is found in conſiderable maſſes among the volcanic productions of Japan, is of a brilliant purple red when it has been poliſhed. Large maſſes of it are found alſo in the tin mines in the province of Kianfu, five days journey from Nankin. Le Camus had a piece of it which weighed twenty-eight pounds. The ſame naturaliſt has ſome worked realgar, in the centre of which there is a vein of calcareous ſpar. The Chineſe and Indians employ it for making pagodas and vaſes. Having put one of theſe pagodas into a glaſs caſe, to which neither the ſun nor external air had any acceſs, I found, ſome months after, that the pagoda had loſt its brilliancy and its red colour, and was covered with an efflorеſcence of an orange-yellow colour, which readily detached itſelf and fell on the ſtand: having collected this efflorеſcence, and fuſed it in a crucible, it preſented realgar.

I have made known that orpiment, or yellow ore of arſenic, the flakes of which are of a brilliant golden-yellow colour, and ſemi-tranſparent, paſſes to the ſtate of realgar, or ſulphurated red ore of arſenic, when fuſed or ſublimated. I have preſented to the Inſtitute a piece of orpiment, a part of which I have made to paſs to the ſtate of realgar by applying beneath it the flame of a taper by means of a blowpipe: for this purpoſe, the flame muſt not be too ſtrong.

* From the ſame.

Pott

Pott has made known that orpiment contains only a tenth of ſulphur. As this ſubſtance paſſes to the ſtate of realgar merely by the action of heat, and afterwards repaſſes to the ſtate of orpiment by the contact of light, it is evident that theſe two ſubſtances, ſo different in colour, are compoſed of the ſame elements. Having taken the realgar pagoda from the glaſs caſe, I ſaw that a part of it, which had not been expoſed to the immediate contact of the light, had retained its colour and brilliancy.

The realgar which is ſublimated at the Solfaterra under the form of octaedral cryſtals, known under the name of *ruby of arſenic*, effloreſces alſo by the light.

XI. *The Marquis of Worceſter's Scantlings of Inventions.*

[This little tract, firſt publiſhed in 1655, being not eaſy to be met with, we inſert a copy of it at the requeſt of a number of our readers, and we flatter ourſelves it will be acceptable to all of them.]

A Century of the Names and Scantlings of Inventions by me already practiſed.

I. *Seals abundantly ſignificant.*

SEVERAL ſorts of ſeals, ſome ſhowing by ſcrews, others by gages faſtening or unfaſtening all the marks at once; others by additional points and imaginary places, proportionable to ordinary eſcocheons and ſeals at arms, each way palpably and punctually ſetting down (yet private from all others but the owner, and by his aſſent) the day of the month, the day of the week, the month of the year, the year of our Lord, the names of the witneſſes, and the individual place where any thing was ſealed, though in ten thouſand ſeveral places, together with the very number of lines contained in a contract, whereby falſification may be diſcovered, and manifeſtly proved, being upon good grounds ſuſpected.

Upon any of theſe ſeals a man may keep accounts of receipts and diſburſements from one farthing to an hundred millions, punctually ſhowing each pound, ſhilling, penny, or farthing.

By theſe ſeals likewiſe any letter, through written but in Engliſh, may be read and underſtood in eight ſeveral languages, and in Engliſh itſelf to clean contrary and different ſenſe, unknown to any but the correſpondent, and not to be read or underſtood by him neither, if opened before it arrive unto him; ſo that neither threats, nor hopes of reward, can make

make him reveal the secret, the letter having been intercepted, and first opened by the enemy.

II. *Seals private and particular to each Owner.*

How ten thousand persons may use these seals to all and every of the purposes aforesaid, and yet keep their secrets from any but whom they please.

III. *A One-line Cypher.*

A cypher and character so contrived, that one line, without returns and circumflexes, stands for each and every of the twenty-four letters; and as ready to be made for the one letter as the other.

IV. *Reduced to a Point.*

This invention, refined and so abbreviated, that a point only showeth distinctly and significantly any of the twenty-four letters; and these very points to be made with two pens, so that no time will be lost, but as one finger riseth the other may make the following letter, never clogging the memory with several figures for words and combination of letters; which with ease, and void of confusion, are thus speedily and punctually, letter for letter, set down by naked and not multiplied points. And nothing can be less than a point, the mathematical definition of being *cujus pars nulla.* And of a motion no swifter imaginable than semiquavers or releshes, yet applicable to this manner of writing.

V. *Varied significantly to all the Twenty-four Letters.*

A way by circular motion, either along a rule or ringwise, to vary any alphabet, even this of points, so that the self-same point individually placed, without the least additional mark or variation of place, shall stand for all the twenty-four letters, and not for the same letter twice in ten sheets writing; yet as easily and certainly read and known, as if it stood but for one and the self-same letter constantly signified.

VI. *A mute and perfect Discourse by Colours.*

How at a window, as far as eye can discover black from white, a man may hold discourse with his correspondent, without noise made or notice taken; being, according to occasion given and means afforded, *ex re natâ*, and no need of provision beforehand; though much better if foreseen, and means prepared for it, and a premeditated course taken by mutual consent of parties.

VII. *To hold the same by Night.*

A way to do it by night as well as by day, though as dark as pitch is black.

VIII. *To*

VIII. *To level Cannons by Night.*

A way how to level and ſhoot cannon by night as well as by day, and as directly; without a platform or meaſures taken by day, yet by a plain and infallible rule.

IX. *A Ship-deſtroying Engine.*

An engine, portable in one's pocket, which may be carried and faſtened on the inſide of the greateſt ſhip, *tanquam aliud agens*, and at any appointed minute, though a week after, either of day or night, it ſhall irrecoverably ſink that ſhip.

X. *How to be faſtened from aloof and under Water.*

A way from a mile off to dive and faſten a like engine to any ſhip, ſo as it may punctually work the ſame effect either for time or execution.

XI. *How to prevent both.*

How to prevent and ſafeguard any ſhip from ſuch an attempt by day or night.

XII. *An unſinkable Ship.*

A way to make a ſhip not poſſible to be ſunk though ſhot an hundred times betwixt wind and water by cannon, and ſhould loſe a whole plank, yet in half an hour's time ſhould be made as fit to ſail as before.

XIII. *Falſe deſtroying Decks.*

How to make ſuch falſe decks as in a moment ſhould kill and take priſoners as many as ſhould board the ſhip, without blowing the decks up, or deſtroying them from being reducible, and in a quarter of an hour's time ſhould recover their former ſhape, and to be made fit for any employment without diſcovering the ſecret.

XIV. *Multiplied Strength in little Room.*

How to bring a force to weigh up an anchor, or to do any forcible exploit in the narroweſt or loweſt room in any ſhip, where few hands ſhall do the work of many; and many hands applicable to the ſame force, ſome ſtanding, others ſitting, and by virtue of their ſeveral helps a great force augmented in little room, as effectual as if there were ſufficient ſpace to go about with an axle-tree, and work far from the centre.

XV. *A Boat driving againſt Wind and Tide.*

A way how to make a boat work itſelf againſt wind and tide, yea both without the help of man or beaſt; yet ſo that the

the wind or tide, though directly oppofite, fhall force the fhip or boat againft itfelf and in no point of the compafs, but it fhall be as effectual as if the wind were in the pupp, or the ftream actually with the courfe it is to fteer, according to which the oars fhall row, and neceffary motions work and move towards the defired port or point of the compafs.

XVI. *A Sea-failing Fort.*

How to make a fea-caftle or fortification cannon proof, and capable of a thoufand men, yet failable at pleafure to defend a paffage, or in an hour's time to divide itfelf into three fhips as fit and trimmed to fail as before; and even whilft it is a fort or caftle they fhall be unanimoufly fteered, and effectually be driven by an indifferent ftrong wind.

XVII. *A pleafant floating Garden.*

How to make upon the Thames a floating garden of pleafure, with trees, flowers, banqueting-houfes, and fountains, ftews for all kind of fifhes, a referve for fnow to keep wine in, delicate bathing-places, and the like; with mufic made with mills: and all in the midft of the ftream, where it is moft rapid.

XVIII. *An Hour-glafs Fountain.*

An artificial fountain to be turned like an hour-glafs, by a child, in the twinkling of an eye, it holding great quantity of water, and of force fufficient to make fnow, ice, and thunder, with a chirping and finging of birds, and fhowing of feveral fhapes and effects ufual to fountains of pleafure.

XIX. *A Coach-faving Engine.*

A little engine within a coach, whereby a child may ftop it, and fecure all perfons within it, and the coachman himfelf, though the horfes be never fo unruly in a full career; a child being fufficiently capable to loofen them in what pofture foever they fhould have put themfelves, turning never fo fhort; for a child can do it in the twinkling of an eye.

XX. *A Balance Water-work.*

How to bring up water balance-wife, fo that as little weight or force as will turn a balance will be only needful, more than the weight of the water within the buckets, which, counterpoifed, empty themfelves one into the other, the uppermoft yielding its water (how great a quantity foever it holds) at the felf-fame time the lowermoft taketh it in, though it be an hundred fathom high.

XXI. *A Bucket Fountain.*

How to raife water conftantly, with two buckets only, day and

and night, without any other force than its own motion, uſing not ſo much as any force, wheel, or ſucker, nor more pulleys than one, on which the cord or chain rolleth with a bucket faſtened at each end. This, I confeſs, I have ſeen and learned of the great mathematician Claudius his ſtudies, at Rome, he having made a preſent thereof unto a cardinal; and I deſire not to own any other men's inventions, but if I ſet down any, to nominate likewiſe the inventor.

XXII. *An ebbing and flowing River.*

To make a river in a garden to ebb and flow conſtantly, though twenty foot over, with a child's force, in ſome private room or place out of ſight, and a competent diſtance from it.

XXIII. *An ebbing and flowing Caſtle-clock.*

To ſet a clock in a caſtle, the water filling the trenches about it; it ſhall ſhow, by ebbing and flowing, the hours, minutes and ſeconds, and all the comprehenſible motions of the heavens, and counterlibration of the earth, according to Copernicus.

XXIV. *A Strength-increaſing Spring.*

How to increaſe the ſtrength of a ſpring to ſuch an height, as to ſhoot bumbaſſes, and bullets of an hundred pound weight a ſteeple height, and a quarter of a mile off and more, ſtone-bow-wiſe, admirable for fire-works and aſtoniſhing of beſieged cities, when without warning given by noiſe they find themſelves ſo forcibly and dangerouſly ſurpriſed.

XXV. *A double drawing Engine for Weights.*

How to make a weight that cannot take up an hundred pound, and yet ſhall take up two hundred pound, and at the ſelf-ſame diſtance from the centre; and ſo proportionably to millions of pounds.

XXVI. *A to-and-fro Lever.*

To raiſe weight as well and as forcibly with the drawing back of the lever, as with the thruſting it forwards; and by that means to loſe no time in motion or ſtrength. This I ſaw in the arſenal at Venice.

XXVII. *A moſt eaſy Level Draught.*

A way to remove to and fro huge weights, with a moſt inconſiderable ſtrength, from place to place. For example, ten ton with ten pounds, and leſs; the ſaid ten pounds not to fall lower than it makes the ten ton to advance or retreat upon a level.

XXVIII. *A*

XXVIII. *A portable Bridge.*

A bridge, portable in a cart with ſix horſes, which in a few hours time may be placed over a river half a mile broad, whereon with much expedition may be tranſported horſe, foot, and cannon.

XXIX. *A moveable Fortification.*

A portable fortification able to contain five hundred fighting men, and yet in ſix hours time may be ſet up, and made cannon proof, upon the ſide of a river or paſs, with cannon mounted upon it, and as complete as a regular fortification, with half moons and counterſcarps.

XXX. *A riſing Bulwark.*

A way in one night's time to raiſe a bulwark twenty or thirty foot high, cannon proof, and cannon mounted upon it, with men to overlook, command and batter a town; for, though it contain but four pieces, they ſhall be able to diſcharge two hundred bullets each hour.

XXXI. *An approaching Blind.*

A way how ſafely and ſpeedily to make an approach to a caſtle or town wall, and over the very ditch, at noon day.

XXXII. *An univerſal Character.*

How to compoſe an univerſal character methodical and eaſy to be written, yet intelligible in any language; ſo that, if an Engliſhman write it in Engliſh, a Frenchman, Italian, Spaniard, Iriſh, Welſh, being ſcholars; yea, Grecian or Hebrean, ſhall as perfectly underſtand it in their own tongue as if they were perfect Engliſh, diſtinguiſhing the verbs from nouns, the numbers, tenſes, and caſes, as properly expreſſed in their own language as it was written in Engliſh.

XXXIII. *A Needle Alphabet.*

To write with a needle and thread, white, or any colour upon white, or any other colour, ſo that one ſtitch ſhall ſignificantly ſhow any letter, and as readily and as eaſily ſhow the one letter as the other, and fit for any language.

XXXIV. *A knotted String Alphabet.*

To write by a knotted ſilk ſtring, ſo that every knot ſhall ſignify any letter with comma, full point, or interrogation, and as legible as with pen and ink upon white paper.

XXXV. *A Fringe Alphabet.*

The like by the fringe of gloves.

XXXVI. *A Bracelet Alphabet.*

By ſtringing of bracelets.

XXXVII. *A Pincked Glove Alphabet.*

By pincked gloves.

XXXVIII. *A Sieve Alphabet.*

By holes in the bottom of a ſieve.

XXXIX. *A Lantborn Alphabet.*

By a lattin or plate lanthorn.

XL. *An Alphabet by the Smell*—XLI. *Taſte*—XLII. *Touch.*

By the ſmell—by the taſte—by the touch.—By theſe three ſenſes as perfectly, diſtinctly, and unconfuſedly, yea, as readily, as by the ſight.

XLIII. *A Variation of all and each of theſe.*

How to vary each of theſe, ſo that ten thouſand may know them, and yet keep the underſtanding part from any but their correſpondent.

XLIV. *A Key-piſtol.*

To make a key of a chamber door, which to your ſight hath its wards and roſe-pipe, but paper-thick, and yet at pleaſure, in a minute of an hour, ſhall become a perfect piſtol, capable to ſhoot through a breaſt-plate, commonly of carabine-proof, with prime, powder, and firelock, undiſcoverable in a ſtranger's hand.

XLV. *A moſt conceited Tinder-box.*

How to light a fire and a candle at what hour of the night one awaketh, without riſing or putting one's hand out of the bed. And the ſame thing becomes a ſerviceable piſtol at pleaſure; yet by a ſtranger, not knowing the ſecret, ſeemeth but a dextrous tinder-box.

XLVI. *An artificial Bird.*

How to make an artificial bird to fly which way and as long as one pleaſeth, by or againſt the wind, ſometimes chirping, other times hovering, ſtill tending the way it is deſigned for.

XLVII. *An Hour Water-ball.*

To make a ball of any metal, which thrown into a pool or pail of water ſhall preſently riſe from the bottom, and conſtantly ſhow, by the ſuperficies of the water, the hour of the day or night, never riſing more out of the water than juſt to the minute it ſhoweth of each quarter of the hour; and if by force kept under water, yet the time is not loſt, but recovered as ſoon as it is permitted to riſe to the ſuperficies of the water.

XLVIII. *A ſcrewed Aſcent of Stairs.*

A ſcrewed aſcent, inſtead of ſtairs, with fit landing places to the beſt chambers of each ſtory, with back ſtairs within the noell of it, convenient for ſervants to paſs up and down to the inward rooms of them unſeen and private.

XLIX. *A Tobacco-tongs Engine.*

A portable engine, in way of a tobacco-tongs, whereby a man may get over a wall, or get up again being come down, finding the coaſt proving unſecure unto him.

L. *A Pocket Ladder.*

A complete light portable ladder, which taken out of one's pocket, may be by himſelf faſtened an hundred foot high to get up by from the ground.

LI. *A Rule of Gradation.*

A rule of gradation, which with eaſe and method reduceth all things to a private correſpondence, moſt uſeful for ſecret intelligence.

LII. *A myſtical Jangling of Bells.*

How to ſignify words and a perfect diſcourſe by jangling of bells of any pariſh church, or by any muſical inſtrument within hearing, in a ſeeming way of tuning it; or of an unſkilful beginner.

LIII. *An Hollowing of a Water-ſcrew.*

A way how to make hollow and cover a water-ſcrew as big and as long as one pleaſeth, in an eaſy and cheap way.

LIV. *A tranſparent Water-ſcrew.*

How to make a water-ſcrew tight and yet tranſparent, and free from breaking; but ſo clear, that one may palpably ſee the water, or any heavy thing, how and why it is mounted by turning.

LV. *A double Water-ſcrew.*

A double water-ſcrew, the innermoſt to mount the water, and the outermoſt for it to deſcend more in number of threads, and conſequently in quantity of water, though much ſhorter than the innermoſt ſcrew by which the water aſcendeth; a moſt extraordinary help for the turning of the ſcrew to make the water riſe.

LVI. *An advantageous Change of Centres.*

To provide and make that all the weights of the deſcending ſide of a wheel ſhall be perpetually further from the centre, than thoſe of the mounting ſide, and yet equal in number and

and heft to the one fide as the other. A moft incredible thing, if not feen, but tried before the late king (of bleffed memory) in the Tower, by my directions, two extraordinary ambaffadors accompanying his majefty, and the duke of Richmond and duke Hamilton, with moft of the court, attending him. The wheel was fourteen foot over, and forty weights of fifty pounds apiece. Sir William Balfour, then lieutenant of the Tower, can juftify it, with feveral others. They all faw, that no fooner thefe great weights paffed the diameter-line of the lower fide, but they hung a foot further from the centre, nor no fooner paffed the diameter-line of the upper fide, but they hung a foot nearer. Be pleafed to judge the confequence.

LVII. *A conftant Water-flowing and ebbing Motion.*

An ebbing and flowing water-work in two veffels, into either of which, the water ftanding at a level, if a globe be caft in, inftead of rifing it prefently ebbeth, and fo remaineth until a like globe be caft into the other veffel; which the water is no fooner fenfible of, but that veffel prefently ebbeth, and the other floweth, and fo continueth ebbing and flowing until one or both of the globes be taken out, working fome little effect befides its own motion, without the help of any man within fight or hearing; but if either of the globes be taken out, with ever fo fwift or eafy a motion, at the very inftant the ebbing and flowing ceafeth; for if during the ebbing you take out the globe, the water of that veffel prefently returneth to flow, and never ebbeth after, until the globe be returned into it, and then the motion beginneth as before.

LVIII. *An often-difcharging Piftol.*

How to make a piftol to difcharge a dozen times with one loading, and without fo much as once new priming requifite, or to change it out of one hand into the other, or ftop one's horfe.

LIX. *An efpecial Way for Carabines.*

Another way as faft and effectual, but more proper for carabines.

LX. *A Flafk-charger.*

A way with a flafk appropriated unto it, which will furnifh either piftol or carabine with a dozen charges in three minutes time, to do the whole execution of a dozen fhots, as foon as one pleafeth, proportionably.

LXI. *A Way for Mufkets.*

A third way, and particular for mufkets, without taking them from their refts to charge or prime, to a like execution, and as faft as the flafk, the mufket containing but one charge at a time.

LXII. *A Way for a Harquebufs—a Crock.*

A way for a harquebufs, a crock, or fhip-mufket, fix upon a carriage, fhooting with fuch expedition, as without danger one may charge, level, and difcharge them fixty times in a minute of an hour, two or three together.

LXIII. *For Sakers and Minyons.*

A fixth way, moft excellent for fakers, differing from the other, yet as fwift.

LXIV. *For the biggeft Cannon.*

A feventh, tried and approved before the late king (of ever bleffed memory) and an hundred lords and commons, in a cannon of eight inches half quarter, to fhoot bullets of 64 lbs. weight, and 24 lbs. of powder, twenty times in fix minutes; fo clear from danger, that after all were difcharged, a pound of butter did not melt being laid upon the cannon-breech, nor the green oil difcoloured that was firft anointed and ufed between the barrel thereof and the engine, having never in it, nor within fix foot, but one charge at a time.

LXV. *For a whole Side of Ship Mufkets.*

A way that one man in the cabin may govern the whole fide of fhip-mufkets, to the number (if need require) of 2 or 3000 fhots.

LXVI. *For guarding feveral Advenues to a Town.*

A way that againft feveral advenues to a fort or caftle, one man may charge fifty cannons playing, and ftopping when he pleafeth, though out of fight of the cannon.

LXVII. *For Mufketoons on Horfeback.*

A rare way likewife for mufketoons faftened to the pommel of the faddle, fo that a common trooper cannot mifs to charge them with twenty or thirty bullets at a time, even in full career.

"When firft I gave my thoughts to make guns fhoot often, I thought there had been but one only exquifite way inventible, yet by feveral trials, and much charge, I have perfectly tried all thefe."

LXVIII. *A Fire Water-work.*

An admirable and moft forcible way to drive up water by fire, not by drawing or fucking it upwards, for that muft be as the philofopher calleth it, *intra fphæram activitatis*, which is but at fuch a diftance. But this way hath no bounder, if the veffels be ftrong enough; for I have taken a piece of a whole

whole cannon, whereof the end was burst, and filled it three quarters full of water, stopping and screwing up the broken end; as also the touch-hole; and making a constant fire under it, within 24 hours it burst and made a great crack: so that having a way to make my vessels so that they are strengthened by the force within them, and the one to fill after the other. I have seen the water run like a constant fountain-stream forty foot high; one vessel of water rarefied by fire, driveth up forty of cold water. And a man that tends the work is but to turn two cocks, that one vessel of water being consumed, another begins to force and refill with cold water, and so successively, the fire being tended and kept constant, which the self-same person may likewise abundantly perform in the interim between the necessity of turning the said cocks.

LXIX. *A triangle Key.*

A way how a little triangle screwed key, not weighing a shilling, shall be capable and strong enough to bolt and unbolt round about a great chest an hundred bolts through fifty staples, two in each, with a direct contrary motion, and as many more from both sides and ends, and at the self-same time shall fasten it to the place beyond a man's natural strength to take it away; and in one and the same turn both locketh and openeth it.

LXX. *A Rose Key.*

A key with a rose-turning pipe, and two roses pierced through endwise the bit thereof, with several handsomely-contrived wards, which may likewise do the same effects.

LXXI. *A square Key with a turning Screw.*

A key perfectly square, with a screw turning within it, and more conceited than any of the rest, and no heavier than the triangle screwed key, and doth the same effects.

LXXII. *An Escocheon for all Locks.*

An escocheon to be placed before any of these locks with these properties.

1. The owner (though a woman) may with her delicate hand vary the ways of coming to open the lock ten millions of times, beyond the knowledge of the smith that made it, or of me who invented it.

2. If a stranger openeth it, it setteth an alarm a-going, which the stranger cannot stop from running out; and besides, though none should be within hearing, yet it catcheth his hand, as a trap doth a fox; and though far from maiming him, yet it leaveth such a mark behind it, as will dis-

cover him if suspected; the escocheon or lock plainly showing what monies he hath taken out of the box to a farthing, and how many times opened since the owner had been in it.

LXXIII. *A transmittible Gallery.*

A transmittible gallery over any ditch or breach in a town-wall, with a blind and parapet cannon proof.

LXXIV. *A conceited Door.*

A door whereof the turning of a key, with the help and motion of the handle, makes the hinges to be of either side, and to open either inward or outward, as one is to enter or to go out, or to open in half.

LXXV. *A Discourse woven in Tape or Ribbon.*

How a tape or ribbon-weaver may set down a whole discourse without knowing a letter, or interweaving any thing suspicious of other secret than a new fashioned ribbon.

LXXVI. *To write in the Dark.*

How to write in the dark as straight as by day or candle-light.

LXXVII. *A flying Man.*

How to make a man to fly; which I have tried with a little boy of ten years old in a barn, from one end to the other, on an hay-mow.

LXXVIII. *A continually going Watch.*

A watch to go constantly, and yet needs no other winding from the first setting on the cord or chain, unless it be broken, requiring no other care from one than to be now and then consulted with concerning the hour of the day or night; and if it be laid by a week together, it will not err much, but the oftener looked upon, the more exact it showeth the time of the day or night.

LXXIX. *A total Locking of Cabinet Boxes.*

A way to lock all the boxes of a cabinet (though never so many) at one time which were by particular keys appropriated to each lock opened severally, and independent the one of the other, as much as concerneth the opening of them, and by these means cannot be left opened unawares.

LXXX. *Light Pistol Barrels.*

How to make a pistol barrel no thicker than a shilling, and yet able to endure a musket proof of powder and bullet.

LXXXI. *A Comb-conveyance for Letters.*

A comb-conveyance carrying of letters without suspicion, the head being opened with a needle-ſcrew drawing a ſpring towards them; the comb being made but after an uſual form carried in one's pocket.

LXXXII. *A Knife, Spoon, or Fork Conveyance.*

A knife, ſpoon, or fork, in an uſual portable caſe, may have the like conveyances in their handles.

LXXXIII. *A Raſping Mill.*

A raſping-mill for hartſhorn, whereby a child may do the work of half a dozen men, commonly taken up with that work.

LXXXIV. *An Arithmetical Inſtrument.*

An inſtrument whereby perſons ignorant in arithmetic may perfectly obſerve numerations and ſubſtractions of all ſums and fractions.

LXXXV. *An untoothſome Pear.*

A little ball, made in the ſhape of plum or pear, being dextrouſly conveyed or forced into a body's mouth, ſhall preſently ſhoot forth ſuch and ſo many bolts of each ſide and at both ends, as without the owner's key can neither be opened or filed off, being made of tempered ſteel, and as effectually locked as an iron cheſt.

LXXXVI. *An impriſoning Chair.*

A chair made *à-la-mode*, and yet a ſtranger being perſuaded to ſit down in it, ſhall have immediately his arms and thighs locked up beyond his own power to looſen them.

LXXXVII. *A Candle-mold.*

A braſs mold to caſt candles, in which a man may make 500 dozen in a day, and add an ingredient to the tallow which will make it cheaper, and yet ſo that the candles ſhall look whiter and laſt longer.

LXXXVIII. *A Brazen Head.*

How to make a brazen or ſtone head in the midſt of a great field or garden, ſo artificial and natural, that though a man ſpeak never ſo ſoftly, and even whiſpers into the ear thereof, it will preſently open its mouth, and reſolve the queſtion in French, Latin, Welſh, Iriſh, or Engliſh, in good terms uttering it out of his mouth, and then ſhut it until the next queſtion be aſked.

LXXXIX. *Primero Gloves.*

White ſilk knotted in the fingers of a pair of white gloves, and ſo contrived without ſuſpicion, that playing at primero at cards, one may, without clogging his memory, keep reckoning of all ſixes, ſevens, and aces, which he hath diſcarded.

XC. *A Dicing Box.*

A moft dexterous dicing box, with holes tranfparent, after the ufual fafhion, with a device fo dexterous, that with a knock of it againft the table, the four good dice are faftened, and it loofeneth four falfe dice made fit for his purpofe.

XCI. *An artificial Ring-horfe.*

An artificial horfe, with faddle and caparifons fit for running at the ring, on which a man being mounted, with his lance in his hand, he can at pleafure make him ftart, and fwiftly to run his career, ufing the decent pofture with bon grace, may take the ring as handfomely, and running as fwiftly, as if he rode upon a barbe.

XCII. *A Gravel Engine.*

A fcrew made like a water-fcrew, but the bottom made of iron plate fpadewife, which at the fide of a boat emptieth the mud of a pond, or raifeth gravel.

XCIII. *A Ship-raifing Engine.*

An engine whereby one man may take out of the water a fhip of 500 tons, fo that it may be caulked, trimmed, and repaired, without need of the ufual way of ftocks, and as eafily let it down again.

XCIV. *A Pocket Engine to open any Door.*

A little engine, portable in one's pocket, which placed to any door, without any noife but one crack, openeth any door or gate.

XCV. *A double Crofs-bow.*

A double crofs-bow, neat, handfome, and ftrong, to fhoot two arrows, either together or one after the other, fo immediately that a deer cannot run two fteps but, if he mifs of one arrow, he may be reached with the other, whether the deer run forward, fideward, or ftart backward.

XCVI. *A Way for Sea Banks.*

A way to make a fea bank fo firm and geometrically ftrong, fo that a ftream can have no power over it; excellent likewife to fave the pillar of a bridge, being far cheaper and ftronger than ftone-walls.

XCVII. *A perfpective Inftrument.*

An inftrument whereby an ignorant perfon may take any thing in perfpective, as juftly and more than the fkilfulleft painter can do by his eye.

XCVIII. *A femi-omnipotent Engine.*

An engine fo contrived, that working the *primum mobile* forward or backward, upward or downward, circularly or cornerwife,

cornerwife, to and fro, ftraight, upright or downright, yet the pretended operation continueth, and advanceth none of the motions above mentioned, hindering, much lefs ftopping the other; but unanimoufly, and with harmony, agreeing, they all augment and contribute ftrength unto the intended work and operation: and therefore I call this a *femi-omnipotent engine,* and do intend that a model thereof be buried with me.

XCIX. *A moft admirable Way to raife Weights.*

How to make one pound weight to raife an hundred as high as one pound falleth, and yet the hundred pound defcending, doth what nothing lefs than one hundred pounds can effect.

C. *A ftupendous Water-work.*

Upon fo potent a help as thefe two laft-mentioned inventions, a water-work is, by many years experience and labour, fo advantageoufly by me contrived, that a child's force bringeth up, an hundred foot high, an incredible quantity of water, even two foot diameter, fo naturally, that the work will not be heard even into the next room; and with fo great eafe and geometrical fymmetry, that though it work day and night from one end of the year to the other, it will not require forty fhillings reparation to the whole engine, nor hinder one's day-work, and I may boldly call it the moft ftupendous work in the whole world: not only with little charge to drain all forts of mines, and furnifh cities with water, though never fo high feated, as well to keep them fweet, running through feveral ftreets, and fo performing the work of fcavingers, as well as furnifhing the inhabitants with fufficient water for their private occafions; but likewife fupplying rivers with fufficient to maintain and make them portable from town to town, and for the bettering of lands all the way it runs; with many more advantageous and yet greater effects of profit, admiration, and confequence. So that defervedly I deem this invention to crown my labours, to reward my expenfes, and make my thoughts acquiefce in way of further inventions: this making up the whole century, and preventing any further trouble to the reader for the prefent, meaning to leave to pofterity a book, wherein under each of thefe heads the means to put in execution and vifible trial all and every of thefe inventions, with the fhape and form of all things belonging to them, fhall be printed by brafs plates.

In bonum publicum, et majorem Dei gloriam.

XII. *Ob-*

XII. *Obſervations on the Magnetic Property of Cobalt and Nickel. Extracted from a Memoir read in the French National Inſtitute by* B. G. Sage, *Director of the firſt School of Mines* *.

HAVING reſolved to repeat the experiments by which Klaproth, Taſſaert, and Haüy determined that cobalt and nickel are ſuſceptible of acquiring magnetic properties, I proceeded to refine theſe ſemi-metallic ſubſtances by means which I ſhall here deſcribe, and by which I extracted from cobalt the arſenic, iron, biſmuth, and ſilver; ſubſtances with which it is almoſt always combined.

Having diſengaged the arſenic, by torrefaction, from cobalt ore of a whitiſh gray colour, I mixed pounded charcoal with the oxide or browniſh calx which remained in the teſt. I then torrefied it a ſecond time, in order to diſengage the arſenical acid.

I then mixed this oxide of cobalt with two parts of vitreous flux † and a little pulverized charcoal. I fuſed this mixture, and obtained a button of cobalt, which I again fuſed with borax: after theſe two fuſions the cobalt exhibited a homogeneous grain, though it contained iron, biſmuth ‡, and particularly ſilver, in the ratio of nearly a fourth.

I pulverized this cobalt, and, having mixed it with an equal part of ſal-ammoniac, ſubjected it to diſtillation: cauſtic volatile alkali was diſengaged, and there was afterwards ſublimed in the neck of the retort ſal-ammoniac coloured yellow by a little iron. The next ſublimated portion had a pale green tint, a colour which aroſe from the cobalt. The retort having been kept in a red heat for an hour, ſalt or muriate of biſmuth was ſublimated in white foliaceous cryſtals. This ſalt, when put into diſtilled water, was decompoſed, and rendered it milky.

I mixed the muriate of cobalt which remained in the retort with ſal-ammoniac, and proceeded to diſtillation: the ſal-ammoniac, which was ſublimated, contained neither iron nor muriate of biſmuth, and was coloured of a delicate green by a little cobalt.

I fuſed the ſalt or muriate of cobalt which remained in the retort with equal parts of black flux and a fiftieth of pulverized charcoal: in this alkaline flux I found the cobalt

* From the *Journal de Phyſique*, Floreal, an. 10.

† Compoſed of equal parts of white glaſs and fixed alkali.

‡ If this metal be in the ratio of a third, it diffuſes itſelf around the button of cobalt, and incloſes it as if it were ſet in it.

and

and silver in contact with each other, but without adhesion*.

It was this purified cobalt which I employed to discover whether it was susceptible of acquiring polarity by the magnet; and to ascertain it fully, I begged our colleague Coulomb, who is so familiar with these experiments, to have the goodness to assist me. I carried to him the ingots of purified cobalt and nickel, which he endeavoured to magnetize; but, as they did not indicate any magnetic property in a satisfactory manner, he desired me to fuse them into thin plates, which I accordingly did. They were then easily magnetized, and, being suspended merely by a silk thread, indicated the poles in a perfect manner. These facts prove that these two semi-metallic substances have, as well as iron, the faculty of retaining the magnetic fluid introduced into their pores.

XIII. *Experiments and Observations on the Heat and Cold produced by the mechanical Condensation and Rarefaction of Air.* By JOHN DALTON †.

IF a thermometer be inclosed in a receiver and the air suddenly condensed, the thermometer rises a few degrees above the temperature of the atmosphere; and if the air be exhausted from a receiver inclosing a thermometer, the mercury sinks a few degrees immediately; but in both cases after some time it resumes its former station. These facts are well known to philosophers of the present age, but they do not all agree in the explanation of them. Thinking the subject worthy of elucidation, I was induced to institute a series of experiments for the purpose, which I apprehend have led to a clear demonstration of the cause of the phænomena, and moreover make the facts themselves appear in a somewhat different point of view from what they are seen in at the first moment.

One circumstance is very remarkable, that whether the mercury rises or falls in these instances, it is done very rapidly; whereas in the open air, if a thermometer be only two or three degrees above or below the temperature, it moves very slowly. This seems to have suggested to every one the idea that the elasticity of the glass bulb of the thermometer has a principal share in producing the effect, by

* I purified the nickel from the iron it contained by sublimation with sal-ammoniac, and reduced it by fusing it with black flux.

† From the *Manchester Memoirs*, vol. v. part 2.

causing

causing the bulb to yield a little to the pressure of the air. It has however been found upon trial that the same effects take place whether the thermometer is sealed or not. My experiments accord with this, having made a thermometer and left it unsealed for the express purpose: in all the experiments with condensed and rarefied air, there was no sensible difference observed to arise from the inequality of pressure on the external and internal surfaces of the bulbs, the sealed and open thermometers varying the same in kind and also in degree, except from circumstances to be noticed hereafter.

It being certain then that a real change of temperature takes place, it remained to determine the quantity and manner of that change. Having chosen a small and consequently sensible thermometer, with a scale of degrees sufficiently large to admit of distinguishing one-tenth of a degree, I proceeded to ascertain several facts experimentally.

Exp. I. Took a receiver, the capacity of which was about 120 cubic inches, and suspended the thermometer with its clear bulb in the central part of it; then letting the whole acquire the temperature of the room, which was without a fire, I exhausted the air and afterwards restored it, marking the effects upon the thermometer. The medium of several trials nearly agreeing with each other was as under:

The thermometer in the air of the room stood at - 36°.8
———————— sunk upon exhaustion to - 34 .7
———————— rose when the air was restored to 38 .9

The suddenness of the fall and rise puzzled me most: after reflecting upon it for some time, I conjectured that the real change of temperature of the air or medium was much greater than the thermometer indicated, but that the inequality existed only for a few seconds of time, because the receiver, &c. immediately impart heat to, or abstract it from, so small a quantity of air as 120 cubic inches, which are only equal to 40 grains in weight. The phænomena of the thermometer seemed very well to accord with the supposition of great heat or cold acting upon it for a few seconds only.

Exp. II. Pursuing this idea, I imagined that if two thermometers whose bulbs were very unequal in magnitude were inclosed together, the smaller bulb ought to give the greater variation: accordingly I inclosed two, the diameters of their bulbs being .35 and .65 of an inch respectively; and having exhausted the air and restored it again repeatedly in succession, and found a mean of the variations, that of the small bulb was 2°.8, and that of the large, 2 .2.

Exp. III. Repeated the exhaustion with the small thermometer inclosed in three different circumstances successively:

fively: 1ft, with the bulb in the centre of the receiver; 2d, with the bulb refting on the wet leather of the plate; and, 3d, with the bulb refting againft the fide of the receiver.

1ft cafe; reduced by exhauftion	-	2°.45
2d cafe - - -	-	2 .15
3d cafe - - -	-	1 .2
1ft cafe; raifed by reftoring the air	-	4 .05
2d cafe - - -	-	2 .25
3d cafe - - -	-	2 .8

Exp. IV. Inclofed a wine glafs with about a cubic inch of water in it, containing the bulb of a thermometer, in a receiver; and, exhaufting the air, the thermometer funk half a degree fuddenly, and then continued ftationary; upon reftoring the air, it fuddenly rofe half a degree.

All thefe experiments confirmed my conjecture of a much greater degree of heat and cold being produced in thefe cafes than the thermometer points out, but that its continuance is fo fhort as not to effect a material change in the temperature of the mercury. The following experiments were made to afcertain what may be the *real* degree of heat and cold generated in thofe operations.

Exp. V. The fame receiver and fmall thermometer as above being ufed, I found the exhauftion was effected by working the pump one minute. The thermometer funk nearly 2° in the firft half minute, and the remainder, a few tenths of a degree, in the latter half minute. The operation being ftopped, and things remaining in the fame ftate, it required fome minutes of time before the thermometer recovered one degree of the heat loft. Upon opening the cock, the receiver filled with air in five feconds, and the greateft velocity of the rifing mercury was about the end of that time. The rifing continued for 30 or 40 feconds from its commencement, but 3-4ths of the effect were produced in the firft ten feconds. The greateft velocity of the rifing mercury is 1° in $3\frac{1}{2}$ feconds. After the thermometer had attained its utmoft height, it began to fall again at the rate of $\frac{1}{10}$th of a degree in a minute.

Exp. VI. Took the fame thermometer and heated it to 50° above the temperature of the air; then let it be cooled by the medium of air, and it began to fall at the rate of 1° in $3\frac{1}{2}$ feconds.

The two laft experiments feem to prove that when air is let in to the receiver in the ordinary way, *an increafe of temperature of* 50° *is produced in the medium within the receiver for* $3\frac{1}{2}$ *feconds.* This high temperature is reduced *in a few*

few seconds, by the receiver and surrounding bodies, to their own temperature.

Exp. VII. *On condensed Air.*—Took a large spherical glass receiver, the capacity of which was something more than twice that of the former (above one gallon), and suspended a thermometer in the centre of it, of a larger bulb than that before used; the receiver had a brass cap and stop-cock adapted to it: then doubled the density of the air within it by a condenser. The thermometer rose 2° or more. Let out the air suddenly, and the thermometer immediately sunk each time from 3° to 3°.5; at the same time an exceedingly dense mist was produced in the receiver, which soon subsided.

Suspecting that aqueous vapour, which always exists in the atmosphere, and is liable to assume the liquid or aërial form according to circumstances, might be the principal agent in the production of heat and cold by condensation and rarefaction, I thought that an increase of it might produce a greater effect, and that cold air, which contains less vapour, might have a less effect. The reverse however was the fact, as appears by the following

Exp. VIII. and IX. In a cold morning last winter when the air was clear and the thermometer without stood at 20°, I took the receiver and condenser into the open air, and let them stand for 15 minutes to acquire its temperature; then repeatedly condensed the air to a double density, and suddenly liberated it again. On a medium of five trials, the mercury fell 3°.3 on opening the cock. The vapour precipitated was whiter than usual, and not nearly so dense.

Again, took the receiver and condenser into a dyer's stove where the temperature was about 100°, and the air abounded with vapour in a transparent state: after some time, condensed the air and liberated it as before, when on a medium of five trials the mercury sunk only 3°, and a very copious mist was precipitated, so dense that one could but just distinguish the degree of the thermometer through it.

These experiments show that the greater the quantity of vapour condensed, the less is the change of temperature; and that consequently, if air was entirely free from vapour, the change of temperature would be a maximum. Indeed this is clearly consistent with the known law, that, when vapour is condensed, heat is given out. Any process to cool the air must be retarded by the condensation of part of the vapour it contains. Suppose, for instance, that a portion of the atmosphere contained $\frac{1}{70}$th of its weight of aqueous vapour, and that $\frac{3}{5}$ths of this vapour were condensed by 50° of cold; that is, is, $\frac{1}{100}$th of the whole elastic mass was converted into water; then the heat given out would be sufficient to raise the temperature of the remaining mass of air and vapour 6 or 8°; which sufficiently accounts for the small difference observed in the results upon warm vapoury air and cold dry air. Hence vapour, far from producing the change of temperature in question, tends to diminish the effect.

If any doubt remained with me respecting the *real* change of temperature that takes place in the operations related above, it was completely removed by the results of the two following experiments.

Exp. X. Inclosed a small graduated glass tube, of $\frac{1}{15}$th of an inch internal diameter, and ten inches long, with a short column of mercury in it, in the large receiver; the tube was sealed at one end and open at the other, so that a portion of air of given capacity was confined by the mercurial column, which was near the open end of the tube, and subject to rise or fall by any variation of elasticity of the air on either side, being a proper manometer: then doubled the density of the air in the receiver, and, opening the stop-cock, the mercurial column soon ran up to its former station; but instantly turning the cock again, the mercurial column returned or fell down gradually for five or ten seconds, to the amount of nearly $\frac{1}{10}$th of the whole aërial column, and then became stationary. Again opening the cock, a quantity of air rushed out, and the mercury resumed its original station. These effects were always the same, on a repetition of the experiment.

Exp. XI. Let the mercurial column of the manometer down by a wire to $\frac{1}{4}$th of the length of the tube from the sealed end; then exhausted $\frac{3}{4}$ths of the air from the receiver, which was seen by the mercury rising to the top of the tube; and upon opening the cock the mercury fell to its former station, but then suddenly turning the cock, the mercury gradually rose, for the space of five or ten seconds, to *more* than $\frac{1}{10}$th of its original height above the stationary point, and remained there till the cock was opened; after which it resumed its proper station.

The phænomena in the two last experiments can be explained only on the following principle:—The air in the receiver and in the manometer is subject to a like degree of rarefaction and condensation in those experiments, or very nearly so. When the equilibrium of heat in the air is disturbed by the operations of condensation and rarefaction, it is restored in the manometer instantly by reason of the contiguity of the glass to the air; but in the large receiver it requires

quires a fenfible time of ten feconds or more to reftore the equilibrium throughout the whole internal capacity. It is this reftoration that increafes or diminifhes the elafticity of the air confined in the receiver, and thereby caufes the retrogradation of the mercurial column. Now I have found by former experiments that a change of 50° in temperature effects a change of $\frac{1}{10}$th nearly, in the capacity or bulk of air. It follows therefore that in the cafe of reftoring the equilibrium in condenfed air, about 50° of cold is produced; and in letting in air to an exhaufted receiver, fomething more than 50° of heat is produced. The fmall difference feems to arife from this, that the condenfation of vapour in the former cafe diminifhes the effect, and in the latter, if any there be, increafes the effect, that would arife from operating upon purely dry air.

The experiments and obfervations hitherto related go principally to afcertain facts without any reference to the theory of them: this, however, may be given in a few words, and is the fame that is afcribed to Mr. Lambert by Meffrs. Sauffure and Pictet, and by them adopted. He conceives that a vacuum has its proper capacity for heat, the fame as air, or any other fubftance; and that the capacity of a vacuum for heat is lefs than that of an equal volume of atmofpherical air; alfo that the denfer air is, the lefs is its capacity for heat: upon thefe principles the phænomena are eafily referable to that clafs of chemical facts where heat and cold are generated by the mixture of two different bodies. If this theory be right, and I think there is little doubt of it, we may hence be led into a train of experiments, by which the abfolute capacity of a vacuum for heat may be determined; and likewife the capacities of the different gafes for heat, by a method wholly new: but this muft be left to future inveftigation.

XIV. *Some Account of Dr.* Olbers, *the celebrated Aftronomer.*

William Olbers, M. D. and member of different learned focieties, was born on the 11th of October 1758, at Arbergen, a village in the duchy of Bremen, where his father was a clergyman. His father having been promoted to a living in Bremen in 1760, young Olbers received his education in that city; but in 1772 he loft his father, who, befides being a man of great general learning, was a good mathematician, and had a great attachment to astronomy. About the same period young Olbers, then in his 14th year, conceived at once a great taste for that science. During an evening walk in the month of August, having observed the Pleiades or seven stars, he became very desirous of knowing to what constellation they belonged. He therefore purchased some charts and books, and began to study astronomy with the greatest diligence. He read with the utmost avidity every astronomical work he was able to procure, and in a few months made himself acquainted with all the constellations.

He, however, soon observed, that without a knowledge of the mathematics it would be impossible for him to be an astronomer, or to understand the necessary operations: he therefore applied to the mathematics, and devoted all his leisure time to the study of these sciences. In the year 1777, when a student of medicine at the university of Göttingen, he had made himself master of every thing that could be learned from Wolf's Elements, and had read also a considerable part of the works of Euler and Lambert.

At Göttingen he had the good fortune to study mathematics under the celebrated Kästner, whose lectures he attended. The method to which that eminent master accustomed his scholars was excellent; and Dr. Olbers considers himself indebted to him for what he has hitherto been able to do in regard to the solution of difficult problems. In consequence of Kästner's well-known readiness to promote the progress of his pupils, Dr. Olbers had free access to his extensive library, and also to the observatory of which Kästner was then director. The study of medicine, however, which was the principal object of his attention, and which he pursued with a success equal to his zeal, allowed him very little time for the study of practical astronomy.

In the year 1779 he observed at Göttingen, and calculated, the first comet. An account of this labour was published by Kästner in the Berlin Astronomical Calendar for the year 1782, and in the *Göttinger Anzeigen* of May 31, 1799; where it is mentioned that Olbers made his construction one night while attending a patient. Kästner here observes, with great justice, that under such circumstances the orbit of a comet could hardly be determined. But it was afterwards seen that Olbers's determination of this orbit corresponded with the most accurate elements of the comet which were calculated. Since that period the astronomy of comets has been his favourite study; and how much he has distinguished himself in this department, and how much he has enlarged the theory, is seen by his new method of calculating the orbit of a comet

 from

from obſervations, which was publiſhed, with a preface by the editor, at Weimar, in the year 1797.

Newton himſelf conſidered the calculation of the orbit of a comet as exceedingly difficult, and for this reaſon he calls the problem *longè difficillimum.* The greateſt and moſt ingenious mathematicians of the laſt century employed their talents, with various ſucceſs, on this difficult ſubject; ſuch as La Caille, Euler, La Grange, Lambert, Boſcovich, Du Sejour, Condorcet, Hennert, Tempelhof, Laplace, &c.: all the reſources of genius and all the formulæ of the higher analyſis have been tried; but none of the methods deviſed can be ſimpler, and at the ſame time more elegant, than that of Dr. Olbers. It can indeed be ſaid, that the whole was effected by his own genius; for the conciſeneſs and eaſineſs of his method are chiefly founded on ſome happy ideas, and on a ſuppoſition which approaches very near the truth. But it required no little ingenuity and practice in calculation to apply theſe ideas to the ſolution of the problem.

In the year 1780 he wrote his inaugural diſſertation, *De Oculi Mutationibus internis*; that is, on the Method in which the Eye changes to ſee diſtinctly near and diſtant Objects. Moſt phyſiologiſts have adopted his theory on this ſubject; and it has lately been placed beyond all doubt by Ramſden's and Home's experiments, publiſhed in the Tranſactions of the Royal Society.

From Göttingen Olbers proceeded to Vienna, in 1781, to acquire a more extenſive knowledge of medicine under Stoll, Quarin, Störk, and other eminent maſters. Recommendations which he carried with him from Käſtner procured him a favourable reception from father Hell the aſtronomer, and from many of the Vienna literati; but he could not turn it to much advantage, as his application to the principal object of his ſtudy, and attendance at the hoſpitals, left him very little leiſure for aſtronomy. He was the firſt, however, who obſerved the Georgian planet, or Uranus, on the 17th of Auguſt of the above year: on the 19th he perceived its motion; and on that account entered into a more intimate friendſhip with father Hell, as this new planet had not then been ſeen from the Imperial obſervatory. He obſerved it at Vienna till the end of September; and, under the erroneous opinion of its being a comet, calculated its orbit in a parabola.

Between the years 1785 and 1788, much was expected from a comet which had appeared in 1532 and 1661, and which it was ſuppoſed would return about the year 1789. Some aſtronomers ſpoke of this expected phænomenon with the ſame confidence as if it had been an eclipſe of the

ſun,

fun, or an occultation of a fixed ftar. Dr. Olbers was the firft who proved, in 1787, that the comets of 1532 and 1661 were totally different; confequently, that neither of them could be expected in the year 1789. Aftronomy, therefore, is indebted to Dr. Olbers for having cleared up this point of fo much importance. He fhowed how uncertain the return of thefe comets is; and that it is no fault in the exalted fcience of aftronomy, if predictions, which aftronomers ought never to have ventured to make, are not accomplifhed.

From Vienna Dr. Olbers proceeded to Prague and Drefden, and returned thence to Bremen, where he fettled as a phyfician, and where he foon acquired the confidence of his fellow-citizens, both on account of his fuccefsful practice and of the integrity and affability of his character. Since that time aftronomy has been only the amufement of his leifure hours, or a fort of recreation, to relieve and unbend the mind after the fatigue of his profeffional duties.

We fhall add to this fhort fketch, that Dr. Olbers lately difcovered another planet, or, perhaps, comet, for the point feems not yet determined, of which fome account was given in the laft two numbers of the Philofophical Magazine.

XV. *Experiments on Charcoal.* By CLEMENT *and* DESORMES *.

IT is generally believed that the charcoal obtained by the decompofition of organic matters ftill contains, notwithftanding the action of the ftrongeft heat to which it can be fubjected, fome remains of the volatile principles to which it was united.

This opinion is founded upon this circumftance, that by the combuftion of charcoal water is fometimes obtained, which feems to prove the prefence of hydrogen; and that to form carbonic acid with charcoal lefs oxygen is required than with the diamond; which might induce a belief that fome of it exifted already in the charcoal.

The memoir publifhed by us in the 115th number of the *Annales de Chimie*, and of which the refults are nearly the fame as thofe obtained by Mr. Cruikfhank, announces the gafeous oxide of carbon as free from hydrogen.

Several chemifts, convinced of the prefence of hydrogen in charcoal, have fuppofed that this gas is a triple combination of carbon, oxygen, and hydrogen, and that its inflammability arifes from the laft-mentioned principle.

* From the *Annales de Chimie*, No. 125.

It

It appeared to us of importance to make fome experiments on this fubject, and we propofed the following queftions:

Does hydrogen exift in charcoal when properly made? Are the various kinds of charcoal indebted for their differences to the quantities of oxygen which they contain?

We employed two methods to come to the folution of thefe problems: the action of oxygen, and that of fulphur.

First Method.

Action of Oxygen.

In our memoir on the gafeous oxide of carbon we gave an account of experiments on the combuftion of charcoal in clofe veffels in which no water was depofited. It is, however, poffible that fome was produced, but that it became diffolved in the carbonic acid gas, in which a great diffolving power is generally obferved.

In repeating the combuftion of different kinds of charcoal properly made, but of which fome remained expofed to the air, we remarked that the latter fuffered a great deal of water to evaporate merely by the action of the heat, and that during their combuftion it was not produced in fufficient quantity to be depofited. Thofe which had been carefully protected from the action of humidity exhibited no traces of it.

This proved to us that the water obferved during the combuftion of charcoal previoufly exifted, and that it had been taken up by that fubftance, the hygrometric property of which, long known, has been confirmed by C. Guyton in the *Encyclopédie Méthodique.*

We again affured ourfelves that charcoal of white wood well made*, weighing 4 grammes, by remaining expofed to the atmofphere even during dry weather, increafed in weight 0·2 grammes. When heated, the water is expelled; which may be weighed, and which forms more than three-fourths of that augmentation. The remainder is air, which may be difengaged either by heat or by expofure of the charcoal in a vacuum. It may be readily conceived that thefe phænomena, which depend on the ftate of the atmofphere, the texture of the charcoal, and the time of its expofure to the air, muft be exceedingly variable.

It is then certain that, if water is produced in the combuftion of charcoal, it can exift only in the ftate of vapour in the gafes which refult from it.

It became a matter of importance to know what quantity of water thefe gafes might contain. M. de Sauffure

* We confider charcoal to be fo, when, after a firft carbonization, it has been expofed for an hour to the action of a ftrong furnace.

 announces,

announces *, that, the temperature and pressure being equal, atmospheric air, hydrogen and carbonic acid gas, when moist affect the hair hygrometer in the same manner; but as this instrument indicates only the degree of saturation, and not the quantity of water, we thought it our duty to make some experiments for the purpose of ascertaining this quantity.

The property which concrete muriate of lime has to take moisture from the gases without altering them, induced us to make choice of it as the means of desiccation.

We made use of the apparatus generally employed. It consists of a glass tube containing the concrete muriate of lime, the weight of which is known, and through which the gas is made to pass. In order to be certain of their complete saturation, we made them pass through a jar filled with water, and placed immediately before the muriate of lime, the temperature of which was the same as that of the atmosphere and of the gases. It was always 12 or 13 degrees of the centigrade thermometer, and the pressure from 762 to 765 millimetres: the other circumstances were also as equal as possible.

The following is a table of the desiccations which we made:

Gases desiccated.	Water deposited by 36 Litres.	Water which would be deposited by a Cubic Foot.	
	Grammes.	Grammes.	Grains.
Atmospheric Air	0·33	0·313	5·89
Oxygen Gas -	0·34	0·323	6·08
Hydrogen - -	0·34	0·323	6·08
Azote - - -	0·33	0·313	5·89
Carbonic Acid	0·33	0·313	5·89

The carbonic acid, passing through the flask of water destined to moisten it as much as possible, would have been there dissolved; but we had previously saturated it, so that there really passed upon the muriate of lime as much of that gas as of the others.

It is here seen that the quantities of water deposited by each kind of gas were nearly the same, and the differences can be ascribed only to the unavoidable imperfection of the process. Thus it is certain that equal volumes of very different gases deposit the same quantity of water.

It remained to know whether the quantities of water which cannot be taken from gases by desiccation are equal; but it was almost impossible to ascertain this point by a direct

* *Essai sur l'Hygrometrie*. chap. ix. of the second essay.

direct experiment, ſince the gaſes cannot be obtained perfectly dry.

From analogy we were inclined to think, that if the gaſes abſolutely contained the ſame quantity of water, they ought alſo to contain equal quantities of the liquids which are volatilized by their contact, ſuch as alcohol and ether.

The action of the elaſtic fluids on the latter being very great, it was eaſy to form an exact opinion of it. We therefore made experiments, from which it reſults, that, temperature, preſſure, and other circumſtances, being the ſame, all the gaſes of which we have here ſpoken, hydrogen as well as the carbonic acid, equally favour the evaporation of ether; that is to ſay, that in equal ſpaces occupied by any gas whatever, the ſame quantity of this liquid may be there reduced to the elaſtic ſtate, and produce the ſame expanſion. The caſe is the ſame with alcohol, but the quantity evaporated is much leſs than that of ether *.

The nature of the gas, then, has no influence on the property which they have of vaporizing ether and alcohol, as it depends only on the temperature and preſſure. It is probable that the caſe is the ſame with the evaporation of water. If it were poſſible, indeed, to exerciſe on the ethereal or alcoholized gaſes an action ſimilar to that of the muriate of lime on humid gaſes; that is to ſay, if the ether or alcohol could be taken away by ſimilar means, they might be equally deprived of it; but, as we took from the gaſes the ſame quantity of water, there is great reaſon to preſume that it is abſolutely the ſame.

This being the caſe, it appears to us that if well made charcoal, not moiſt, be burned with dried oxygen, and if the gas produced by the combuſtion ſhould not contain more water than what the abſorbing ſalt had left in the oxygen before its being employed; that is to ſay, if it ſhould paſs upon a ſimilar quantity of ſalt without augmenting its weight, we ſhould be almoſt certain that the combuſtion of charcoal would produce no water: we therefore made the following experiment:

Into a very long glaſs tube placed upon a ſmall furnace we introduced 4·50 grammes of charcoal of common wood heated in a furnace for an hour, and not yet cooled. To the extremities of the tube we adjuſted two others containing the ſame quantity of muriate of lime: the latter were im-

* The intereſting phænomena exhibited by the action of gaſes on the liquids induced us to make experiments, which we ſhall give an account of in another memoir.

merſed

merfed in a mixture of ice and marine falt kept conftantly at 7 or 8 degrees below zero of the centigrade thermometer. To one of them was adapted an empty bladder, and to the other a fecond containing 12 litres of oxygen.

The great tube being heated, at the place where the charcoal was the gas was made to pafs; and, when the combuftion was completed, a fingle atom of water was not depofited. The tube containing the muriate of lime, which had traverfed the oxygen before it was employed, having been weighed, was found to be increafed 0·13 grammes; that is, 0·02 more than it ought to have been according to the above table of deficcations; which arofe from the cold experienced by the gas. The muriate of lime traverfed by the product of the combuftion, which ought to have contained water, was not increafed more than 0·02 grammes. This was ftill owing to the moifture taken by the charcoal from the atmofphere at the time of its introduction into the tube. But, if we fhould choofe to believe that this quantity was produced by the combuftion, as it contained only 0·003 grammes of hydrogen, arifing from 4·50 grammes of charcoal, there would exift in 100 grammes but 0·065 grammes; that is to fay, $\frac{1}{1500}$, a quantity inappreciable.

C. Berthollet, in a letter printed in the *Bibliotheque Britannique**, fixes at 0.0902 grammes, or 1·7 grain, the hydrogen contained in 1·9683 litres, or 100 cubic inches of inflammable gas, arifing from the reduction of the oxide of zinc by charcoal. But this quantity of gafeous oxide of carbon weighs nearly 2·278 grammes, and contains 1·139 grammes of charcoal, and as much oxygen. This charcoal ought to contain, therefore, the 0·0902 grammes of hydrogen; that is to fay, in 100 parts there ought to be 7·91 of hydrogen. C. Berthollet, then, has fixed higher than is indicated by experiment the quantity of hydrogen contained in carbonic acid gas, and confequently in charcoal. We have, indeed, feen that we can fuppofe in the latter body at moft 0·065 per cent.

This experiment, made with the greateft exactnefs poffible, ftill proves that 100 parts of carbonic acid confift nearly of 28 parts of carbon and 72 of oxygen—a refult given by the celebrated Lavoifier; and if he obtained water in that combuftion, it ought not to occafion any error in the fractions of the refult, its exiftence being, as we have already faid, anterior to the act of combuftion.

Being defirous to know whether all kinds of charcoal, like that of wood, might be freed by fire from all the hydrogen combined with them, we found that the charcoal of fugar,

* No. 142.

wax, and animal matters, after being subjected to the action of a strong heat, were perfectly similar to common charcoal, for, like it, they produced no water by combustion. Our intention in making these experiments not only was to ascertain whether these kinds of charcoal were united with hydrogen, but also to determine the relative quantities of oxygen they might contain above that necessary to convert them into carbonic acid.

But all those kinds of charcoal above mentioned, as well as coak, plumbago, and anthracite, required nearly the same quantity of oxygen. The following is the result of the experiments:

The apparatus was the same as that employed for the combustion of the charcoal of wood. It will, perhaps, not give complete satisfaction, on account of the suspicion generally entertained of the permeability of bladders: we shall, however, observe, that those which we employed were prepared in such a manner as not to suffer the gas contained in them to escape. Besides, the results which we obtained, and of which we shall give an exact account, are so agreeable to those of Lavoisier, and to that given to us by the combustion of the charcoal of wood in a balloon filled with oxygen, that they may with certainty be depended on.

Kinds of Charcoal burnt.	Quantities employed.		Carbonic Acid,		Loss neglected.	A hundred Parts of Carbonic Acid are composed of	
	Charcoal	Oxygen.	which ought to have resulted.	which actually resulted.		Charcoal	Oxygen.
	Gram.	Gram.	Gram.	Gram.	Gram.		
Charcoal of Sugar	1·63	3·93	5·56	5·46	0·10	29·3	70·7
Of Wax	1·05	2·72	3·77	3·65	0·12	27·8	72·2
Plombago	2·44	6·36	8·80	8·80	0·00	27·8	72·2
Anthracite	2·05	5·16	7·21	7·21	0·00	28·4	71·6
Animal Charcoal	1·55	4·08	5·63	5·68	0·00	26·9	73·1

The combustion of plumbago was the most interesting. The whole was not burnt. The portion which remained had become of a pale black colour exactly like charcoal: at some parts of its surface it appeared that the texture of its parts had become less compact, and that the black colour was entirely owing to this attenuation.

Many

Many substances which have a fine splendour become tarnished when scraped: oxygen, by scratching, as we may say, the plumbago, produces in it small vacuities which disperse the rays of light, and suffering them no longer to be reflected towards the eye but in a small quantity: they therefore produce only a weak sensation, and the body is judged to be tarnished.

Besides this experiment, in which the black colour generally observed in the carbonaceous principle seems to us to be owing to its division and its texture, we have had occasion to see the charcoal of turpentine and wax, which are commonly so black and dull, become brilliant like plumbago when their parts became more compact.

It is known that Priestley, that illustrious observer, was acquainted with this charcoal of turpentine, and which he positively called white charcoal.

Thus charcoal, whatever be its texture or colour, if it has been heated, is always the same, contains no hydrogen, and requires for its combustion the same quantity of oxygen. The alkaline or earthy matters, which may vary the carbonaceous principle without making any change in it, is not considered.

These experiments, indeed, do not prove that the diamond does not make an exception; but they give us reason to wish for a new combustion of that body, which is too dear to be subjected to this process on a large scale.

[To be continued.]

XVI. *Notices respecting New Books.*

Philosophical Transactions of the Royal Society of London for the Year 1802. Part i.

THE present part, which is extremely interesting, contains as follow:—1. The Croonian Lecture. On the Power of the Eye to adjust itself to different Distances when deprived of the Crystalline Lens. By Everard Home, Esq. F.R.S.—2. The Bakerian Lecture. On the Theory of Light and Colours. By Thomas Young, M.D. F.R.S. Professor of Natural Philosophy in the Royal Institution.—3. An Analysis of a mineral Substance from North America, containing a Metal hitherto unknown. By Charles Hatchett, Esq. F.R.S.—4. A Description of the Anatomy of the *Ornithorynchus paradoxus*. By Everard Home, Esq. F.R.S.—5. On the Independence of the analytical and geometrical Methods of Investigation; and on the Advantages to be derived

rived from their Separation. By Robert Woodhouse, A.M. Fellow of Caius College, Cambridge.—6. Observations and Experiments upon oxygenized and hyperoxygenized Muriatic Acid; and upon some Combinations of the Muriatic Acid in its three States. By Richard Chenevix, Esq. F.R.S. and M.R.I.A.—7. Experiments and Observations on certain Stony and Metalline Substances which at different Times are said to have fallen on the Earth; also on various Kinds of Native Iron. By Edward Howard, Esq. F.R.S.—Appendix. —Meteorological Journal kept at the Apartments of the Royal Society by Order of the President and Council.

Transactions of the Linnean Society, Vol. vi. London 1802.

THIS respectable Society, to whom the public have been already indebted for many valuable papers on different objects of natural history, continue their labours with unabated zeal. The present volume, which is illustrated with thirty-one plates, several of them elegantly coloured, contains the following articles:—1. A Dissertation on two Natural Genera hitherto confounded under the Name of Mantis. By Anthony Augustus Henry Lichtenstein, D.D. F.M.L.S. Translated from the German by Thomas Young, M.D. F.R.S. and L.S.—The Botanical History of the Genus Ehrharta. By Olof Swartz, M.D. F.M.L.S.—3. Account of a Microscopical Investigation of several Species of Pollen, with Remarks and Questions on the Structure and Use of that Part of Vegetables. By Luke Howard, Esq. of Plaistow, in Essex. —4. Observations on Aphides, chiefly intended to show that they are the principal Cause of Blights in Plants, and the sole Cause of the Honey-dew. By the late Mr. William Curtis, F.L.S.—5. Remarks on the Genera of Pæderota, Wulfenia, and Hemimeris. By James Edward Smith, M.D. F.R.S. P.L.S.—6. An Illustration of the Genus Solandra. By Richard Anthony Salisbury, Esq. F.R.S. and L.S.—7. Observations on some remarkable Strata of Flint in a Chalk-pit in the Isle of Wight, in a Letter from Sir Henry Charles Englefield, Bart. F.R.S., to John Latham, M.D. F.R.S. and L.S.—8. Remarks on some British Species of Salix. By James Edward Smith, M.D. F.R.S. P.L.S.—9. Descriptions of four new Species of Fucus. By Dawson Turner, M.A. F.L.S.—10. Description of Callicocca Ipecacuanha. By Felix Avellar Brotero, Professor of Botany in the University of Coimbra, F.M.L.S.—11. Observations on the Curculio Trifolii, or Clover Weevil, a small Insect which infests the Heads of the cultivated Clover, and destroys the Seed, In a Letter to Thomas Marsham, Esq. Tr. L.S., by William

 Markwick,

Markwick, Esq. F.L.S. With additional Remarks by Mr. Marsham.—12. Further Observations on the Curculio Trifolii. In a Letter to William Markwick, Esq. F.L.S. by Martin Christian Gottlieb Lehmann, M.A. of Göttingen.—13. Description of Brotera persica and Mustelia eupatoria, two new Plants cultivated in the Botanic Garden of Halle, by Curt Sprengel, M.D. Professor of Botany in the University of Halle.—14. Observations on the Hinges of British Bivalve Shells. By Mr. William Wood, F.L.S.—15. Catalogue of the more rare Plants found in the Environs of Dover, with occasional Remarks. By Mr. Lewis Weston Dillwyn, F.L.S.—16. Descriptions of some singular Coleopterous Insects. By Charles Schreibers, M.D. Deputy Professor of Natural History in the University of Vienna.—17. Description of Menura superba, a Bird of New South Wales. By Major-General Thomas Davies, F.R.S. and L.S.—18. On the Doryanthes, a new Genus of Plants from New Holland, next a-kin to the Agave. By Joseph Correa de Serra, LL.D. F.R.S. and L.S.—19. Observations on several Species of the Genus Apis, known by the Name of Humble-bees, and called Bombinatrices by Linnæus. By Mr. P. Huber, of Lausanne, in Swisserland.—20. Botanical Characters of four New-Holland Plants, of the Natural Order of Myrti. By James Edward Smith, M.D. F.R.S. P.L.S.—21. Additional Observations on some remarkable Strata of Flint in the Isle of Wight. In a Letter from Sir Henry Charles Englefield, Bart. F.R.S., to John Latham, M.D. F.R.S. and L.S. of Romsey.—22. Description of a new Species of Viola. By Thomas Furly Forster, Esq. F.L.S.—23. Description of the Fruit of Cycas revoluta. By James Edward Smith, M.D. F.R.S. P.L.S.—24. Species of Erica. By Richard Anthony Salisbury, Esq. F.R.S. and L.S.

Remarks upon Chemical Nomenclature, according to the Principles of the French Neologists. By RICHARD CHENEVIX, *Esq. F.R.S. M.R.I.A., &c.* 12*mo.*

THIS little work, which every one who studies chemistry ought to be possessed of, contains:—1. An Introduction.—2. General Observations and Rules.—3. Faults which are the most commonly found in the Periodical Publications, and proceeding chiefly from Inattention, but partly from Misapplication of the Rules.—4. Observations upon such Terms in our Language as do not seem to be the most apposite to render the French Expression.—5. Observations upon certain Denominations which in the Original are not conformable to the Principles of the System.—6. Observations

tions upon such Parts of the Systematic Nomenclature as appear to have been left defective by its Authors.—7. Remarks upon an Essay on Chemical Nomenclature by Dr. Dickson.—8. Remarks upon a Paper on Chemical and Mineralogical Nomenclature, by Mr. Kirwan.—9. Observations on some Parts of Chemical Language which do not properly come under the Head of Nomenclature.—10. On the System of Chemical Signs.—11. Observations on the System of Chemical Nomenclature proposed by Brugnatelli.

Afhandling rörande Mechaniquen med Tillämpning i Synnerhet til Bruk ach Bergwerk, &c. A Treatise of Mechanics, with the Application of them to Mining and Iron-works in particular. By SVENO RINMANN, Knight of the Order of Vasa, &c. Vol. ii. 4to. Stockholm 1798.

Afhandling rörande Mechaniquen med Tillämpning i Synnerhet til Bruk ach Bergwerk, &c. A Treatise on Mechanics, with the Application of them to Mining and Iron-works in particular. By ERIK NORDWALL, &c. vol. i. 4to. Stockholm 1800.

THE society of the proprietors of mines and iron-works in Sweden gave such liberal encouragement and support to Mr. Rinmann, who has been of so much service to mining in Sweden, that he was enabled in the year 1772 to publish an Introduction to the Art of Improving the Manufactory of Iron and Steel; in 1782, his History of Iron, since translated into German; and, in 1789, his large Dictionary of Mining, in quarto. The society so early as 1784 had engaged him to undertake, with the assistance of Mr. Nordwall, a system of mechanics applicable to the working of mines, or a theoretical and practical treatise on all the apparatus and water-works, a knowledge of which is necessary to iron-masters and those who superintend iron manufactories. Mr. Rinmann undertook the practical part of this work which we have here announced, and which comprehends the following chapters:—1st, On the general construction of dams or dykes, of their height and breadth, with a description of more than twelve different kinds, and the method of constructing them: 2d, Of canals and cisterns: 3d, On the construction of water-wheels, and particularly those used for working hammers: 4th, Of the manufacturing bar iron: 5th, Of hammers and other apparatus for blacksmiths: 6th, Of the tilting hammer, where weight is not so much considered as the greater frequency of the stroke: 7th, Of rolling and splitting iron: 8th, Of wire-drawing: 9th, Of machines for

for boring cannon to work both horizontally and vertically, the whole apparatus belonging to them, and the method of improving them. The detailed descriptions which the author gives of all these machines, constructed under his own inspection, are illustrated by accurate engravings, to each of which a proper scale is added. Most of the plates were engraved from drawings executed under his own eye, or by his sons. The invention, delineation, and construction of a steel hammer of cut granite, belongs, however, exclusively to his younger son, who was appointed by the College of Mines to supply his father's place during his long illness. The drawings respecting dams and dykes are by Mr. Nordwall, who has invented a new and advantageous method of constructing canals of cut granite for hammer-works.

The theoretic part, announced also as above, is the work of Mr. Nordwall, and was not published till 1800. The experiments made on a small scale, in regard to the motion and power of water, are not sufficient for establishing a general theory, as it is not yet known with certainty what results would be given by experiments on a large scale. For establishing the theory of the action of water on water-wheels, a peculiar machine was invented by the late Polhem, the object of which was to determine the power of water according to the different heights from which it falls, the best method of constructing float-boards, and to determine according to the different depths the size of the troughs. Some experiments made on this subject by the late Wallerius may be found in Triewald's Lectures on Natural Philosophy, in Elvius's Treatise on the Action of the impelling Power of Water, and here and there in the papers of the Academy of Sciences at Stockholm. In the years 1752 and 1753 the late ingenious Mr. Smeaton made similar experiments, which were published in 1794 under the following title: Experimental Inquiry concerning the natural Powers of Wind and Water to turn Mills and other Machines. Some newer experiments have been given by the abbé Bossut in his excellent work on Hydrodynamics. By all these, however, the subject has not been illustrated so fully as its importance and extent required. It has been found, indeed, by experiment, that the moving momentum of the power of water is very different according to the nature of the wheels driven by it, the more or less oblique situation of the troughs, the different position of the float-boards, and their distance from each other; but it has never yet been sufficiently examined what variations may be produced by the different pressure of the water in the trough; the different forms and construction of the float-boards in overshot,

overshot, half-overshot, and undershot wheels; by the different depths, curvature, and breadth of the troughs; the different breadth of the float-boards in regard to the diameter of the wheel; the height and thickness of the column of water by which it is impelled; the greater or less velocity with which the wheel revolves; its height as compared with that from which the water falls upon it; the effect which the water produces by its weight or its impulse alone on the wheel, &c. All these points must be explained in a theoretical treatise to render it sufficiently useful, and before this can be done it will be necessary to make a great many researches, not merely founded on mathematical principles and demonstrations, which may often mislead the practical mechanician, but on incontestable experiments; and even if this should be fully accomplished, it would still be necessary to examine what ratio the results arising from experiments on a small scale bear to those made on a large scale. This ratio the author has here endeavoured to determine with as much accuracy as possible. In regard to the small difference which is sometimes observed in experiments with small overshot wheels, on account of the attraction of the water by the float-boards, and in consequence of which the action is somewhat greater on a large scale, the author, in order to obtain a certain formula, made various experiments on a large scale, and compared them with those of Polhem, Smeaton, and Bossut, and his formulæ with those of Karsten, Kästner, Desaguliers, Belidor, Fabre, Elvius, &c.

The whole work consists of three parts.—I. *Mechanics*. The author here treats of the weight of bodies, and gives a table of the weight of an ell of the different kinds of bar iron, the weight of a cubic foot of water being $62\frac{1}{2}$ pounds: of the different powers, and their action; accelerated motion, and the motion of falling bodies; the equilibrium of powers that counteract each other: of compound motion; the resolution and composition of powers; the motion of bodies on an inclined plane: of the motion of the pendulum; the centre of percussion or point of oscillation; the circular motion of a body, and particularly the fly-wheel; of the centre of gravity, the lever, the pulley, the axle and wheel, the inclined plane, the wedge, friction, the stiffness of ropes; of the power of bodies in a state of motion; on the motion of bodies which impinge directly against each other; on the impinging of hard and elastic bodies; of the motion of hard and elastic bodies, which impinge on each other obliquely; and on estimating the power of bodies which put machines in motion.—II. *Hydrostatics*. This part treats on the pressure of of fluids; on their equilibrium with solid bodies immersed in them, with a table of the specific gravities of some fluids and solids; on the utility of being acquainted with the specific gravity of bodies; on the equilibrium of elastic bodies, and particularly the air; on pumps; on conveying water and levelling.—III. *Hydraulics.* The contents of this part are: on the motion of water in general, when it flows from apertures in the vessel which contains it; of the velocity of its efflux; on the quantity of water which issues when the velocities are equal; on the quantity of the water which issues through lateral apertures when the velocity is not uniform; on the quantity of water which issues from pipes; on the motion of water in dams and canals; on the different methods of determining the velocity of running water; on the motion of water in streams; on the impinging force of water; on the fall of water; on the different method of applying float-boards to wheels, and the action of the moving power of the water thence depending; on the proper form of troughs for overshot, half overshot, and undershot wheels; on the proper diameter of the wheels; on the greatest possible action of the moving power of water on the different kinds of wheels; on the action of the compound moving force of water, and on the effect of the moving power of water on horizontal wheels.—This work shows that the author is not a mere theorist, and that he has united the principles of sound theory with very extensive practice.

Histoire des Mathematiques, dans laquelle on rend Compte de leur Progrès depuis leur Origine jusqu'à nos Jours, &c. A History of the Mathematics, containing an Account of their Progress from their Origin to the present Time; in which a View is given of the principal Discoveries in every Branch of the Mathematical Sciences, of the Disputes which have arisen among the Mathematicians, and of the principal Circumstances in the Lives of the most celebrated. A new Edition, considerably augmented, and continued to the present Period. By J. E. MONTUCLA, of the National Institute. Vols. iii. and iv. 4to. completed and published by Jerome Delalande, of the National Institute, with nineteen Plates, and the Portraits of Montucla and Delalande.

MONTUCLA, above thirty years ago, published the two first volumes of this work, which contain the history of the mathematics to the end of the seventeenth century. This part was incomplete; and the author made considerable additions

ditions to these two volumes, which were republished about two years ago.

The third and fourth volumes, now published, contain the history of the mathematics since the commencement of the eighteenth century to the present period. This century is more fertile than any of the preceding, having produced a great many men of eminence in the mathematical sciences; as Euler, Maclaurin, the two Simpsons, Dalembert, Condorcet, La Grange, Landen, De la Place, Delalande, &c. Montucla died while employed in putting the last hand to this part, by which means the end of the third volume, and great part of the fourth, were left imperfect. Delalande undertook to supply the deficiency, as a testimony of respect to the memory of his friend; and the result of his labour is now presented to the public. Delalande has prefixed to the third volume a preface, and added to the fourth a life of Montucla; with an index to the two last volumes, like that given by Montucla with the first and second.

XVII. *Proceedings of Learned Societies.*

ROYAL INSTITUTION OF GREAT BRITAIN.

AT a meeting of the managers and visitors of the Royal Institution of Great Britain, held at the house of the Institution, on the 26th day of April 1802, the following report, relative to the present state of the Institution, was laid before them by Count Rumford.

On the 25th of May last year I had the honour to lay before the managers an account, which by their directions was published in the journals of the Institution on the 13th of June, respecting the progress that had been made in the arrangement of the Institution at that time, and of the works that were then going on at the house of the Institution; and I shall now briefly state to the managers and visitors what has since been accomplished, and what still remains to be done to complete this great and interesting establishment in all its details.

The new lecture-room has been finished, and is acknowledged to be one of the most beautiful and most convenient scientific theatres in Europe. It is so favourable to the propagation of sound, that though it is sufficiently capacious to contain 900 persons, a whisper may be distinctly heard from one extremity of it to the other, and no echo is ever perceived in it on any occasion. It is so contrived, that day-light may be be entirely excluded in a moment, by lowering the moveable ceiling of the lantern, by which the light enters the room from above, and allowing it to rest on the cornice which makes the finish of the lower part of the lantern, just above the level of the flat part of the ceiling of the room.

The form of the room is semicircular, with an addition of a parallelogram, equal in length to the diameter of the circular part of the room (60 feet), and 15 feet wide; and there are eleven rows of seats rising one above the other below, and three rows of seats in the gallery: and there is a covered circular passage, eight feet wide, all round the room, without, under the higher rows of seats, next the wall, and four convenient openings or *vomitoria*, with light doors with two wings, which shut of themselves without noise, forming so many passages of communication between the lower part of the theatre or pit, and the arched gallery or passage without.

The floor and seats of this theatre are painted of a dark green colour; and the seats are all covered with green moreen cushions. The floor of the circular passage without, which surrounds the pit, and the stairs belonging to the *vomitoria*, are all covered with green cloth to prevent the noise of the footsteps from being heard of those who come in or go out of the theatre during the lecture.

The windows which form the lantern (which is 15 feet in diameter) are all double, which not only renders the temperature of the room very equal and pleasant, but also prevents so effectually all noises from without disturbing the silence which reigns in the room, that even the rumbling of the carriages which pass in the neighbouring streets is never heard in it.

This theatre is warmed in cold weather by steam, which coming in covered and concealed tubes, from the lower part of the house, circulates in a large semicircular copper tube, eight inches in diameter, and above 60 feet long, which is concealed under the rising seats of the pit.

Adjoining to this new theatre is the apparatus room, which communicates with it by a door which is on one side of the large open chimney fireplace within the theatre, and just behind the lecturer's table, which chimney fireplace serves for placing the furnaces that are occasionally used in the chemical experiments.

The repository, which is 44 feet long, and 33 feet wide, (the ceiling of which, and the floor of the theatre, which is above it, being supported by two rows of handsome columns,) is finished, and already contains a considerable number of specimens of new and useful mechanical contrivances.

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The chemical laboratory, in which there is provision made for placing and using no less than sixteen furnaces of different kinds at the same time, is quite finished, and has been furnished, under the direction of the committee of chemistry (which has been formed since the last year), with a very complete chemical apparatus, and also with a considerable provision of materials necessary in making chemical experiments.

All the workshops of the Institution are now quite finished; and they have been furnished with the most complete sets of tools that could be procured; and several excellent workmen are now employed in them; and a great variety of useful articles, designed as models for imitation, have already been manufactured in the house, and are ready to be delivered to any of the proprietors or subscribers to the Institution who may be disposed to purchase them.

The great kitchen at the house of the Institution has been finished, and now contains a variety of new and useful utensils, and implements of cookery, many of which are in daily use, and others which are not are so exposed to view as to be easily understood, and their merit appreciated.

The dining-room and the managers room, which is adjoining to it, have both been quite finished and furnished.

The conversation-room has been finished, and every thing has been prepared for its being used as a coffee-room. It is now set apart for the reading of the domestic newspapers, of which no less a number than ten are regularly taken in; and it has been furnished with a set of the best geographical maps and charts that were to be procured. In selecting them, the advice and assistance of that able geographer major Rennell, were obtained. The maps are fitted up according to a new method, which has been found to be very convenient, and at the same time to contribute much to the economy of space, and to the preservation of the maps.

The first reading-room (that nearest to the great hall) has lately been appropriated exclusively to the reading of foreign newspapers. It is lighted up, as formerly, every evening; and on the table are found seven foreign gazettes, from different parts of the continent, in the French and German languages, which are regularly taken in, and which, coming by the post, constantly arrive at the earliest periods.

Mr. Stanhope, of the general post-office, has generously undertaken to manage the whole business of procuring these foreign newspapers, and to cause them to be delivered at the house of the Institution free of all expenses for postage.

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The second, or principal reading-room, which is 26 feet long, by 24 wide, has been fitted up in a very complete and elegant manner, and furnished with neat book-cases, which now extend round three sides of the room, affording space for more than 3800 volumes. This arrangement has rendered it possible to allow the second lecture-room (which at some future period is to become the library) to remain for some time longer in its present state; and it will no doubt be found very useful for giving, occasionally, lectures on particular subjects, unconnected with the general courses of lectures that are regularly given in the great lecture-room by the professors and lecturers of the Institution. This second lecture-room will likewise be found very convenient for the meetings of the committees of the Institution, and for exhibiting new experiments to select meetings of scientific men.

But to return to the principal reading-room. The accommodations for those who frequent this room have been greatly augmented since the last year. There are now two long mahogany tables (each 11 feet in length, and 3 feet 10 inches wide), covered with green cloth, which are placed parallel to each other, on opposite sides of the room; and each of these tables is well lighted at night by an elegant Grecian lamp of three branches, suspended by a chain from the ceiling of the room, and covered with a shade of white silk.

On these tables are found no less than 54 foreign and domestic, scientific and literary periodical publications, which are regularly taken in.

The books in the library of the Institution have been considerably increased during the last year, both by presents and by new purchases.

The principal reading-room has been ornamented by an elegant bust of his majesty, our most gracious sovereign, patron of the Institution; and by the busts of those great luminaries of science, Bacon, and the immortal Newton.

With regard to the public opinion respecting the Institution, I have the most sensible satisfaction in being able to lay before the managers and visitors indisputable proofs of its growing reputation. The reading-rooms and lectures at the house of the Institution are considerably more frequented this year than they ever have been before; and, although the prices of proprietors' shares, and of life and annual subscriptions, have been considerably raised, the lists of proprietors and subscribers have, during the last ten months, been augmented by no less than 154 new names, as will appear by the following statement.

There were belonging to the Royal Institution

	On the 5th June, 1801.	On the 26th April, 1802.	Augmentation.
Proprietors - - - -	325	341	16
Life subscribers - -	268	284	16
Annual subscribers -	527	649	122
Total	1120	1274	154

The income and pecuniary resources of the Institution have, of course, kept pace with the increase of its proprietors and subscribers; and its expenses, though they have necessarily been very heavy, while so great and extensive a plan has been carrying into execution, yet they have been regulated with so much order and economy, that the proprietors will, no doubt, be satisfied with the accounts that will be laid before them at their next annual meeting, which will be held in a few days.

It will still be fresh in the recollection of the managers and visitors, that, when, in the year 1800, it was finally determined by the proprietors to undertake the additional buildings at the house of the Institution, it was then thought to be quite impossible to complete so great and expensive an undertaking without a loan of at least 5000 l.; and it will likewise be remembered that, on opening a subscription for that purpose, no less a sum than 7000 l. was generously offered, by a comparatively small number of the proprietors, in a very short time. It will also be recollected that I took the liberty in the report which I had the honour to lay before the managers last year, on the 25th of May, to express a hope that not only the expenses of the new buildings above-mentioned, but of others also which were wanted, and of all the alterations and additions that would be necessary to be made to finish the house in the most complete manner, and to furnish it elegantly, might, perhaps, with due care and attention, be defrayed without calling for any part of that sum of 7000 l., which had been subscribed to enable the managers to complete this great undertaking.

I have now, in common with my two colleagues of the committee of expenditure (Lord Pelham and Mr. Sulivan), who with myself have been specially charged by the managers of the Institution with the superintendance and control of these expenses, the pleasure to state that these hopes have not been disappointed.

By

By the accounts which have been laid before the viſitors it appears,

That the whole of the ſums that have from time to time become due to Mr. Hancock, who contracted with the managers for completing the new buildings, have been regularly paid. That his work having been finiſhed, and regularly examined by the ſurveyor of the Inſtitution, his accounts have been cloſed, and the balance due to him from the Inſtitution has been ſettled.

That the inſtalments agreed to be advanced to him, on his ſeparate contract for completing the attic ſtory, have likewiſe been regularly paid, and that no more than about 500l. will be due to him, on his laſt contract, when he ſhall have completed the whole of that work; which will be finiſhed in a few weeks.

It appeared likewiſe, by theſe accounts, that all the carpenters, plumbers, painters, and glaziers bills, for extra work at the houſe of the Inſtitution,—not included in Mr. Hancock's contracts,—have been brought to account: that the ſalaries and wages of thoſe who conſtitute the eſtabliſhment of the Inſtitution have been regularly paid; and that all the tradeſmens bills have been duly checked, and regularly diſcharged.

And, laſtly, that all the ſums due from the Inſtitution on current accounts, including every demand that can be brought againſt the Inſtitution, even after all the new works now carrying on at the houſe of the Inſtitution ſhall have been completed, amounts to about 3900l.; while the ſums belonging to the Inſtitution in the hands of their different bankers, added to thoſe ſums which are due to the Inſtitution from proprietors and ſubſcribers, and from ſome other perſons, amounts to about 8100l.

From this ſtatement it is evident that the Inſtitution has been completed without any debt being incurred; and, by an account which has been laid before the managers and viſitors, it appears that the preſent annual income of the Inſtitution is quite ſufficient to defray all the expenſes of keeping it. The Royal Inſtitution of Great Britain may therefore be conſidered as finiſhed and firmly eſtabliſhed. That it may long continue to flouriſh is, no doubt, the ardent wiſh of thoſe who are connected with it; and alſo of all thoſe who are acquainted with the principles on which it is founded, and who know how powerfully it muſt contribute to the general diffuſion of an active ſpirit of inquiry and uſeful improvement among all ranks of ſociety.

LINNEAN SOCIETY OF LONDON.

On Tuefday, the 11th of May, this fociety held their firft meeting under a royal charter of incorporation, wherein the following firft fifteen fellows are appointed to form the council for the year enfuing, viz.

George earl of Dartmouth, F. R. S.
James Edward Smith, M. D. F. R. S. prefident.
Thomas Marfham, efq. treafurer.
Alexander M'Leay, efq. fecretary.
Jonas Dryander, efq.
The Rev. Samuel Goodenough, LL. D.
A. B. Lambert, efq. F. R. S.
R. A. Salifbury, efq. F. R. S.
W. G. Maton, M. D. F. R. S.
William Lewis, efq.
Thomas Furley Forfter, efq.
Charles Hatchett, efq. F. R. S.
The Rev. Thomas Rackett, M. A.
John Symmons, efq. F. R. S.
Thomas Young, M. D. F. R. S.

LITERARY AND PHILOSOPHICAL SOCIETY, NEWCASTLE.

This fociety, inftituted only a few years ago, is now in fo flourifhing a ftate, that it has at this time under confideration a plan for eftablifhing a lectur efhip on the fubject of natural and experimental philofophy. A paper on the fubject, drawn up by Mr. Thomas Biggs, one of the members, has been printed and circulated by the fociety; and fuch exertions are making, that we hope foon to be able to announce that a fufficient fund has been obtained for carrying this defirable meafure into effect.

PHYSIOLECTICAL SOCIETY.

A fociety under the above title has juft been inftituted at Birmingham "for the purpofe of improving its members in natural philofophy by lecture, experiment, and difcuffion." A fuitable apparatus is to be provided at the expenfe of the members, each of whom during the feffions is to lecture, in his turn, upon a fubject in natural philofophy chofen by himfelf, but approved by a quorum of the fociety, and vifiting auditors are to be admitted to the fittings under certain regulations. This is as it ought to be, and does much credit to thofe fcientific gentlemen who planned and have united for fuch objects. This will not only infure their own improvement,

provement, but tend to ſpread a taſte for philoſophical ſtudies, which cannot fail to prove eventually highly beneficial even in a commercial point of view, as leading to ſcientific improvements in the various manufactures of the neighbourhood. We wiſh ſimilar inſtitutions were more general.

ROYAL ACADEMY OF INSCRIPTIONS, FINE ARTS, HISTORY, AND ANTIQUITIES, AT STOCKHOLM.

As the ſociety received no anſwer to the following queſtion: A hiſtorico-critical treatiſe on the printed and manuſcript works written by individuals of the royal family; it has been again propoſed for the year 1802.

The following prize queſtions have alſo been propoſed:

Foreign languages.—An examination of the advantages or diſadvantages of the new methods invented in modern times for facilitating the ſtudy of the ſciences; and whether theſe methods are prejudicial to real learning. The prize is a gold medal of the value of twenty-ſix ducats.

Antiquities.—An eſſay on the origin of the arts and manufactures in Sweden, and on the progreſs of them, to the acceſſion of Guſtavus I.; with a general view of the laws and regulations which relate to trades and companies. The prize is a gold medal of fifteen ducats.

Inſcriptions and Devices.—Sketch of epitaphs for king Charles VIII.; Knutſon, Birger Jarl, and Terkel Knutſon, regents of the kingdom during the minority of king Birger. Sketch of medals on the moſt remarkable events which took place in Sweden in the courſe of the 18th century, to be choſen at the pleaſure of the author. The prize is a gold medal of twelve ducats.

The papers muſt be tranſmitted to the academy, in the uſual manner, before the 20th of January 1803.

ACADEMY OF SCIENCES AT BERLIN.

On the 28th of January 1802 the academy held a public ſitting, which was opened by M. Merian with a diſcourſe in French; after which he read the eulogy of M. Selle, the late director of the philoſophic claſs. He announced alſo that his intimate friend M. Gerhard had diſcovered that, in galvanic experiments, nickel combined with zinc produces the ſame effect as ſilver and copper.

Profeſſor Bode read a hiſtory of the diſcovery of the new planet Ceres, obſerved by him on the 15th, 23d, 25th, and 26th of January.

Klaproth, in a memoir on galvaniſm, gave ſome details on the laſt experiments made on a large ſcale on that ſubject by

Van Marum, of Haarlem, comparing them with analogous experiments made with the Tylerian electric apparatus.

The fame chemift made fome experiments with the Voltaic pile conftructed, according to the directions of Van Marum, with 52 plates of zinc and copper, each five inches fquare, in two divifions: the principal phænomenon obferved was the combuftion of metals.

PHILOMATIC SOCIETY.

C. Pictet read a notice on the ftate of agriculture in the environs of Alicant. The foil in the neighbourhood of Alicant is in general light; on the heights it is formed almoft entirely of the wrecks of rocky and calcareous mountains, while in the valleys it is fandy, with beds of clay and marl: but in a climate fo warm, this difference in the nature of the foil is of lefs importance to agriculture than that which refults from the drynefs or moiftnefs of the ground. C. Pictet defcribes feparately the agriculture of the dry lands and that of thofe which are watered.

The tree referved almoft exclufively for the dry land is the almond-tree, with a hard or foft fhell: it flowers in the month of February. The green bark of the almonds is employed in the manufacturing of foap, on account of the alkali which it contains.

The caroub-tree, the fruit of which ferves as food to the mules, is alfo cultivated, and that variety of the olive-tree which produces fmall black olives: the oil of them is of a bad quality, becaufe the olives are left heaped upon each other for a long time before the oil is made.

The date-tree at Alicant rifes to the height of 60 feet; the fruit is inferior in quality to that of Barbary. The leaves of this tree are employed for a very fingular purpofe: they are blanched, and being then bleffed by the priefts, are fold to individuals, who place them in the balconies of their houfes as prefervatives from all kinds of danger. Thefe blanched leaves are exported alfo to Italy. The leaves of the male or barren date are employed for this purpofe. A perfon climbs up to the top of the tree, turns up the exterior leaves which have fhot forth, and they are furrounded by a cord which is gradually drawn tighter, after which they are covered with a bundle of ftraw to fecure them from the light. The bundle of ftraw is not entirely clofed over them till the month of Auguft. This operation may be repeated every three years on the fame tree.

The land is cultivated in the neighbourhood of Alicant by two mules yoked to a plough. After the land is ploughed, the

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the farmers endeavour to level the ground, that it may be watered in a more uniform manner. For this operation they employ a box open before, and having a concave bottom; it is drawn by a mule: the driver holds it behind by means of a handle, and, making it enter the ground when the latter is too high, tranfports what it has pared off to fome other place where the foil is too low.

The ufual rotation for dry land is as follows:—The land is fuffered to reft for a year, after which it is ploughed and dunged: it is then fown with the foda plant, then with wheat, and, in the laft place, with barley.

The foda is extracted from a great number of maritime plants; but the two exclufively cultivated at Alicant for that purpofe are the *Parilla* (*Salfola fativa*, Linn.), and the *Soffa* (*Salfola foda*, Linn.). The method of cultivating them is the fame; but the former requires a better foil, and produces much better foda.

After the land has been ploughed feveral times, and dunged, it is fown with barilla in the month of December: it is fcarcely covered with earth, and the days when the weather feems moft difpofed for rain are chofen for that operation. About the end of winter the field is weeded as often as is neceffary to deftroy the weeds. The barilla is ready to be collected in September: that intended for feed is left in the ground for a month longer. The plant is eafily torn up, becaufe it has very fmall roots: when pulled it is depofited in heaps, and left for a month to dry. About the middle of October it is burnt. Spherical holes capable of containing about thirty hundred weight of foda are made in the earth, above each cavity are placed two bars of iron which fupport the plants to be burnt, and which are mixed with reeds or ftraw. Care is taken to make choice of a day when the wind is not too ftrong, otherwife the foda would burn too rapidly, and be reduced with more difficulty to a folid mafs: it is neceffary alfo that the air fhould not be entirely calm; for in that cafe the fmoke, by not being carried off, dirties the foda. The barilla in burning experiences a kind of fufion, and is reduced to a red mafs, which refembles a fufed metal, and which is ftirred once or twice, in order that the fufion fhould be more complete. When the pits are full, which generally requires a whole night, the matter is covered with earth, and it is fuffered to cool for ten or twelve days: the cake formed is then uncovered, and it is broken into large fragments with hammers; after which it is carried to warehoufes. While the barilla is burning, the fweepings left the preceding year are thrown into the pits in order that they

they may be fufed with the reft. The *foffa* and *barilla* are cultivated not only on the coaft, but at the diftance of nearly forty leagues. The foda, however, is of an inferior quality with that of Alicant.

The cultivation of wheat and barley prefents nothing remarkable except the defective method of threfhing them. The grain is fpread out on a plat of ground well covered with grafs, and mules yoked two and two are made to trot over it. Thefe mules are often yoked alfo to an inftrument called *trillo*, on which the driver places himfelf: this *trillo* is compofed of two planks joined by two crofs pieces, and turned up before. This operation detaches the grain and breaks the ftraw. When a gentle wind blows, advantage is taken of it to feparate them; they are thrown into the air wih a fhovel; the ftraw is carried to a diftance, and nothing remains but the grain mixed with earth, which is afterwards feparated by means of a fieve.

The environs of Alicant are watered either by wells, from which the water is drawn up by a wheel that moves a rope furnifhed with buckets, or by running water brought entirely from a large refervoir called *Pantano di Tili.* This refervoir, begun by the Moors and finifhed by the Spaniards, is a defile between the mountains, fhut by a ftrong wall. The water is fold to individuals: each proprietor generally receives fome of it twice every year to water his land, and every fortnight to water his garden.

It is in the diftricts thus watered that lucern is cultivated; it produces thirteen or fourteen crops annually: but the moft important production cultivated in the watered diftricts is the vine.

The vineyards are divided into fquares with elevated edges that they may be watered with more effect. The vines are pruned in the month of January: they are not ftripped of their leaves, nor are they ever raifed up, and they are dunged only when the whole vineyard is renewed: they are dug once in winter and once in fummer. The vines are watered once or twice every year, and more copioufly when young. When the grapes are very ripe, they are cut, and fpread out in a dry place on hurdles made of reeds. When they have loft their humidity they are preffed above large ftone jars, covered with boards which join badly. The grapes are mixed with a little lime, the probable effect of which, according to C. Pictet, is to neutralize the acid, and fix or feven men, almoft naked, prefs them down with their feet. The ftalks are then feparated, and the hufks are thrown into the jars to colour the wine. At the end of eight or ten days the liquor is drawn off and put into cafks.

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The wine made at Alicant is divided into several kinds: 1st, *Moscatel* or *Malmsy*, which is white and sweet: 2d, *Aloque*, which is red, &c. and employed in the country for common use: 3d, *Fendellon*, which is that sweet wine known in foreign countries under the name of *Alicant wine*.

SOCIETY OF EMULATION AT ROUEN.

This society has proposed the following question:—To indicate for dyeing spun cotton of a red colour similar to that called Indian red, a process which shall require only six deficcations.

The dyed specimens will be subjected to the same proofs as those dyed in the best dye-houses of Rouen; like them they must withstand the action of soap and that of the nitric acid.

The prize will be a gold medal of the value of 600 francs (25l. sterling), and will be adjudged in the public sitting of Thermidor 7, year 11 (July 26, 1803).

The memoirs, written in French or in Latin, must be transmitted, post paid, to C. Auber, secretary for correspondence, at the Central School, before the 25th of Messidor, year 11 (July 14, 1803).

XVIII. *Intelligence and Miscellaneous Articles.*

ASTRONOMY.

THE planet discovered by Mr. Olbers, of Bremen, on the 28th of March has been calculated by C. Burckhardt, who, after long and laborious operations, has found the elements of this planet in the following manner:—Ascending node, 172° 28′ 57″; perihelion, 122° 3′ 2″; mean longitude March 31st, 162° 51′ 14·2″; inclination, 34° 50′ 40″; mean distance from the sun or greater semi-axis, 2·791; eccentricity, 0·2463; diurnal sidereal motion, 12′ 40·84″: sidereal revolution, 1703 days 7-tenths. C. Burckhardt has been obliged to calculate the perturbations which this planet experiences from the attraction of Jupiter, and which occasioned very sensible differences in the observed places: but these calculations are very complex, on account of the great inclination and great eccentricity of that planet. LALANDE.

The orbit of the planet of Olbers, calculated by C. Burckhardt, the elements of which we have published, agrees within a few seconds with the observation made on the 26th by

Meſſier and Mechain, ſo that this new planet may be conſidered as already well known. Its revolution is 1703 days, or 4 years 8 months and 3 days. That of Piazzi's planet is 4 years 7 months and 10 days: but their diſtances are different on account of the difference of their eccentricities. The planet of Olbers varies from 21 to 35, and that of Piazzi from 27 to 28, the diſtance of the ſun from the earth, being ten. When I publiſhed the two laſt volumes of Montucla's Hiſtory of the Mathematics, I was not able to give the elements of the latter planet: this article will therefore ſerve as a ſupplement. LALANDE.

ANTIQUITIES.

A letter from Naples of a late date contains the following information:—In the muſæum of Portici, belonging to the king of Naples, there have been for a long time nearly eighteen hundred manuſcripts on papyrus, which were found among the ruins of Herculaneum. All the attempts hitherto made to take advantage of this valuable diſcovery have procured only a very inſignificant work of Philodemus on Muſic*. The prince of Wales lately requeſted the court of Naples to authorize Mr. Haiter, one of his librarians, to examine the manuſcripts of Herculaneum, in order to diſcover on what ſubjects they treat, and to publiſh ſuch works as appear moſt intereſting.

Mr. Haiter has entered upon this reſearch with a courage and zeal of which no idea can be formed but by thoſe who have witneſſed the almoſt inſurmountable difficulties he has had to ſurmount in unrolling manuſcripts reduced to charcoal, and ſo brittle, that they break and fall into duſt by the effect of the leaſt breath.

Mr. Haiter has been ſo fortunate as to diſcover, a few days ago, a work of Epicurus entitled *Of the Nature of Things*, which was known only from the mention made of it by ſome writers of antiquity, and which appears to have ſerved as the baſis for the poem of Lucretius on the ſame ſubject. A copy is now making of this manuſcript, and when tranſcribed it will be printed.

Mr. Haiter has employed ten perſons to unroll the ſame number of manuſcripts on papyrus; and there is reaſon to expect from this laudable activity diſcoveries of the more importance, as he will not grow weary like father Anthony, formerly charged with the like labour on works of little importance,

* There appears to be here a ſmall error. A manuſcript on the Virtues and Vices, *de Virtutibus et Vitiis*, has alſo been unrolled; and, if we are not miſtaken, a third, the name of which we do not recollect.

portance, as he propoſes to collect only thoſe which relate to poetry or hiſtory, or which are in ſome meaſure intereſting in conſequence of the celebrity of their authors.

BABYLONIAN INSCRIPTIONS.

Some time ago we gave a ſhort account of Dr. Hager's ingenious Diſſertation on the Inſcriptions found on ſome bricks, brought to this country at the expenſe of the Eaſt India Company, from the ruins of a city on the Euphrates ſuppoſed to be the ſite of the antient Babylon. We now learn that M. Lichtenſtein, intendant-general of Helmſtadt, in the duchy of Brunſwick, having ſtudied one of theſe inſcriptions, (the one of which we gave a copy in our eleventh volume,) has ſucceeded in decyphering the hieroglyphical characters which it exhibited, and that he means to lay before the learned world an explanation of the principles on which his diſcovery reſts. This diſcovery, if well founded, will be of immenſe advantage to hiſtory, as the characters which diſtinguiſh the monuments of Perſepolis and the interior of Aſia, and which have hitherto baffled every attempt of the learned to decypher them, ſeem nearly allied to thoſe of Babylon, from which they are probably derived.

GEOGRAPHY, VOYAGES, AND TRAVELS.

According to the laſt letters from Mr. Humboldt, dated November 26, 1801, he was then on his way to Quito, and in January 1802 intended to proceed to Lima, thence in the month of May to Acapulco and Mexico, from which he propoſed taking a paſſage to the Philippines, and then to return to Europe by the Cape of Good Hope.

The following account is extracted from a letter dated Leghorn, March 22, 1802, addreſſed to the editor of the *Magazin Encyclopedique*:—" I have found here a large packet of letters from Ceylon, addreſſed to me by lord Glenbervie. I learn from the letters of M. de I. that he has ſent to London a work on that iſland. Colonel North, the governor of Ceylon, had ſo good an opinion of it that he took the trouble himſelf to correct the Engliſh tranſlation. It contains information of every kind reſpecting this famous iſland. M. de I., having learned the Portugueſe and Cingueſe, which are the languages of the country, was enabled to acquire information reſpecting the antient hiſtory of the country, and other branches of antiquity entirely new: this part of the work, therefore, has been ſent to the ſociety at Calcutta to be inſerted in the *Aſiatic Reſearches*. It ſhows that Ceylon had for a legiſlator Boudhoo, whoſe laws are older, perhaps, than thoſe of Brahma in the peninſula of India, and differ

differ from them in feveral important points, fuch as the mortality of the foul, which Boudhoo admits after a multitude of tranfmigrations; whereas the Brachmans admit the fame tranfmigrations, and conclude with eftablifhing the immortality of the purified foul. The work, then, contains a defcription of the manners, cuftoms, and government of the ifland; account of an embafſy to Candia, the capital of the kingdom, in the interior of the ifland, on which occafion M. de I. ferved as interpreter; a letter to the governor on captain Symes's embaffy to Ava; a differtation on the agriculture, natural hiftory, mineralogy, botany, &c. of the ifland; with an account of 3000 infects and other animals prepared and dried, and a collection of 500 drawings of plants and animals fent to the Eaft India company. This work contains alfo different memoirs on the operations of the governor in regard to labours with which M. de I. was charged. That on the cultivation of the cinnamon ftates, that a wood 15 miles in circumference became a garden in 18 months: it produced 800 bales of cinnamon: at prefent it produces 3000, which are worth to the Eaft India company 60,000l. fterling. A memoir on the pearl fifhery in the gulph of Mannar, where M. de I. fuperintended the extraction of the pearls laft year in the month of March. Two hundred and fifty boats, with divers, were employed in the fifhery: thefe boats bring the oyfters every day on fhore, where they are fuffered to rot for about a week; they are then wafhed, after which the fifh is boiled and expofed to dry. This matter is then winnowed by women, and the pearls are extracted. In the midft of this air, which might be expected to be rendered poifonous by the ftench, the people employed find no more inconvenience than if they breathed the pureft air. A memoir on the hunting of elephants, which fhows, that of 200 of thefe animals caught during one of thefe hunting excurfions, 160 perifh by difagreeable accidents in confequence of the bad method employed: no more than forty remain to be tamed, though, by fimpler means, the lofs might be reduced to eight or ten. A journey to the fouthward part of the ifland to examine the faline marfhes it contains, and to difcover the beft method of improving the production of falt. In confequence of the topographical obfervations made by M. de I. during the courfe of this journey he has been appointed furveyor-general of the ifland; and fifteen furveyors, in five divifions, are now employed in making plans, and in other operations neceffary for the conftruction of a general map, which is to be finifhed in two years.

EARTHQUAKES.

A French officer of dragoons, now in garrifon at Lodi, in a letter to his father, dated the 9th of May, gives the following account:—" I write in hafte to inform you, that an earthquake has been felt here, but that I have met with no accident. We were fitting quietly at breakfaft, when our houfe gave a terrible crafh, that fhook us on our feats. We ran out and flew to the barracks. Every thing was overturned; the cloaks and portmanteaus rolled about, and the dragoons were tumbled down in attempting to defcend the ftairs. Some chimneys were thrown down; all the people were at prayers in the ftreets. The fhock commenced at forty minutes paft ten in the morning, and lafted about three feconds. We have efcaped with the fright. We might now laugh were we not much affected, when we learned that about ten miles diftance (three French leagues) the town of Crema was almoft demolifhed by the earthquake. The inhabitants faved themfelves by flight; and no people were remaining there, except the chaffeurs of the 15th regiment, to prevent plunder. At 40 miles diftance (about 12 French leagues) the village of Menguin, where there was a fine lake of about ten miles circumference, has been fwallowed up in the lake; and not a fingle perfon has been faved, nor does a fingle veftige of that village remain."

Letters from Verona ftate, that they experienced an earthquake there on the 12th of May, which extended alfo to the Venetian territories, where, however, it was lefs violent than at Crema and Brefcia. In the latter city, three churches and twelve houfes were thrown down. Bergamo fuftained fome damage alfo.

After the earthquake, which was felt in the ftates of Parma, feveral fiffures were formed on the heights and in the environs of the town of Bardi, from which a quantity of petroleum iffued. This circumftance has already produced a fall in the price of all the common oils, as it affords light at a much cheaper rate.

DEAF AND DUMB.

Some interefting experiments were lately made in the Deaf and Dumb Inftitute at Paris. It has been long known that moft deaf and dumb perfons, when near large cannon which are fixed, or near churches when the bells are rung, give fome indications of hearing. It has, however, not yet been determined with certainty, whether the impreffions made on fuch occafions are produced merely by the violent motion or concuffion of the air. The experiments lately made by C. Beyer on this fubject, leave no doubt refpecting this problem. The inftruments which he employed did not emit very ftrong tones:

tones: he produced the moft acute tones in the diatonic fcale; and thefe were found to be the beft calculated for exciting the organs of hearing. In the fitting of March 31ft laft, the fociety were defirous of afcertaining whether the fenfation produced on the deaf and dumb by mufical inftruments was an indefinite and obfcure perception, or if they were capable of diftinguifhing gradations in the tones prefented to their ears. For this purpofe they were blindfolded, and different inftruments which had been before employed were then made to found. The perfons who were the objects of this experiment not only fhowed by uniform movements that they heard thefe founds, but they indicated by particular figns the kind of inftruments employed; which was a certain proof that they were able to diftinguifh the different tones. In regard to one of them, the following remarkable phænomenon was obferved: a fingle tone made no impreffion upon him, and it was neceffary to repeat it feveral times before he was fenfible of it, and able to diftinguifh it. It was thence concluded that it would be neceffary for this young man to *learn to hear*, as perfons born blind who recover their fight in confequence of a chirurgical operation muft gradually learn to fee and to diftinguifh objects.

In confequence of the experiments on deafnefs lately made at Paris by C. Beyer, from which it is concluded that the degree of deafnefs is to be afcribed to a relaxation or too great diftenfion of the membranum tympani, Dr. Gall, of Vienna, has examined the fame fubject, and, by anatomical refearches on heads of feveral deaf and dumb perfons, has found that the organs of hearing are in general obftructed in confequence of fwelled glands. He is therefore of opinion that antimony may be employed with advantage on perfons whofe deafnefs has not attained to a very high degree.

DISCOVERY NEAR ROME.

During the latter end of April, fome workmen employed in digging a trench for the purpofe of planting a new vineyard at the feat of the chevalier Petrini, in the neighbourhood of Rome, found the fkeleton of an animal, to which they paid little attention till they obferved fome bones of a monftrous fize. A thigh bone which was meafured was two Paris feet four inches in circumference. Some teeth were found fix inches in length, and which had a great refemblance to others found in Siberia, and near the Ohio in America. Through the negligence of the workmen this interefting object of natural hiftory was nearly deftroyed, great part of it having crumbled into duft when expofed to the air. There is reafon to believe that this fkeleton belonged to fome of the monftrous race of animals now extinct, fuch as the mammouth.

XIX. *PREMIUMS*

PREMIUMS offered by the SOCIETY, *instituted at* London, *for the Encouragement of Arts, Manufactures, and Commerce, for the Year* 1802.

TO THE PUBLIC.

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

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

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

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

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

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

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

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

PREMIUMS IN AGRICULTURE.

THE public are requested to take notice that the SOCIETY abide by the premiums offered in the 18th volume of their Transactions, for the setting of acorns, and planting of timber-trees, although such premiums are not here reprinted.

Class 1. FOREST-TREES.

To the person who shall have inclosed and planted, or set, the greatest number of acres (not less than ten) of land, that is incapable of being ploughed, such as the borders of rivers, the sides of precipices, and any land that has too many rocks, or that is not calculated to repay the expence of tillage, owing to the stiffness or poverty of the soil, the surface being too hilly, mountainous, or otherwise unfit for tillage, with the best sorts of forest-trees, namely, oak, Spanish chesnuts, ash, elm, beech, alder, willow, larch, spruce and silver fir, with or without screens of Scotch fir, adapted to the soil, and intended for timber trees, between the 1st of October, 1801, and the 1st of April, 1802, the gold medal.

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

3. For the third greatest quantity of land, not less than five acres, the silver medal. A particular *account* of the methods used in making and managing the plantations, the nature of the soil, the probable number of each sort of plants, together with proper *certificates* that they were in a healthy and thriving state two years at least after making the plantation, to be delivered to the SOCIETY on or before the first Tuesday in November, 1805.

4, 5, 6. The same premiums are extended

one year further. *Certificates* to be produced on or before the first Tuesday in Nov. 1806.

7. Ascertaining the best method of raising Oaks. To the person who shall ascertain in the best manner, by actual experiments, the comparative merits of the different modes of raising oaks for timber, either from acorns set on land of the foregoing description properly dug or tilled, from acorns set by the spade or dibble, without digging or tillage, either on a smooth surface, or among bushes, fern, or other cover; or from young plants previously raised in nurseries, and transplanted; regard being had to the expense, growth, and other respective advantages of the several methods; the gold medal. The *accounts* and proper *certificates* that not less than one acre has been cultivated in each mode, to be produced to the Society on or before the first Tuesday in November, 1802,

8. The same premium is extended one year farther. The *accounts* and *certificates* to be produced on or before the first Tuesday in November, 1803.

9. Osiers. To the person who shall have planted, between the 1st of October, 1801, and the first of May, 1802, the greatest quantity of land, not less than five acres, with those kinds of willows, commonly known by the names of osier, Spaniard, new-kind, or French, fit for the purpose of basket-makers, not fewer than twelve thousand plants on each acre; the gold medal, or thirty guineas.

10. For the second greatest quantity of land, not less than three acres; the silver medal, or ten guineas. *Certificates* of the planting, and that the plants were in a thriving state five months at least after the planting, to be produced to the Society on or before the last Tuesday in November, 1802.

11. The same premiums are extended one year farther. *Certificates* to be produced on or before the last Tuesday in Nov. 1803.

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

12. Securing Plantations of Timber-trees, and Hedge-rows. To the person who shall give to the Society the most satisfactory account, founded on experience, of the most effectual and least expensive method of securing young plantations of timber-trees, and hedge-rows, from hares and rabbits, as well as sheep and larger cattle, which at the same time shall be least subject to the depredations of wood-stealers, the silver medal, or twenty guineas. The *accounts* and *certificates* of the efficacy of the method to be produced to the Society on or before the first Tuesday in November, 1802.

13. The same premium is extended one year farther. The *accounts* and *certificates* to be produced on or before the first Tuesday in Nov. 1803.

14. Preventing the Blight, or Ravages of Insects, on Fruit-trees and Culinary Plants. To the person who shall discover to the Society the most effectual method of preventing the blight, or ravages of insects, on fruit-trees and culinary plants, superior to any hitherto known or practised, and verified by actual and comparative experiments; the gold medal, or thirty guineas. The *accounts*, with proper *certificates*, to be delivered to the Society on or before the second Tuesday in November, 1802.

15. The same premium is extended one year farther. The *accounts* and *certificates* to be delivered on or before the second Tuesday in November, 1803.

16. Removing the ill Effects of Blights, or Insects. To the person who shall discover to the Society the most effectual method of removing the ill effects of blights, or insects, on fruit-trees and culinary plants, superior to any hitherto known or practised, and verified by actual and comparative experiments; the gold medal, or thirty guineas. The *accounts* and *certificates* to be delivered to the Society on or before the first Tuesday in February, 1803.

17. Comparative Tillage. For the most satisfactory set of experiments, made on not less than eight acres of land, four of which to be trench-ploughed*, and four to be ploughed in the usual manner, in order to ascertain in what cases it may be adviseable to shorten the operations of tillage, by adopting one trench-ploughing, for the purpose of burying the weeds, instead of the method, now in common use, of ploughing and harrowing the land three or four times, and raking the weeds together and burning them; the gold medal, or forty guineas. It is required that every operation and expense attending each mode of culture be fully and accurately described, and that proper *certificates* of the nature and condition of the land on which the experiments are made, together with a circumstantial account of the appearance of the subsequent crops during their growth; and also of the quantity and weight of the corn and straw under each mode of culture, or, in case of a green crop, the weight of an average sixteen perches, be produced to the Society on or before the first Tuesday in Feb. 1803.

18. Comparative Culture of Wheat, broad-cast, drilled, and dibbled. For the best set of experiments made on not less than twelve acres, four of which to be sown broad-cast, four drilled, and four dibbled, the two latter in equi-distant rows, in order fully to ascertain which is the most advantageous mode of cultivating wheat; the gold medal, or forty guineas. It is required that every operation and expense of each mode of culture be fully described; and that proper *certificates* of the nature and condition of the land on which the experiments are made, to

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

gether with an *account* of the produce of the corn, the weight per bushel, and also of the straw, be produced to the Society on or before the first Tuesday in February, 1803.

19. Spring Wheat. To the person who, between the 10th of January and the 10th of April, 1802, shall cultivate the greatest quantity of wheat, not less than ten acres; the silver medal, or twenty guineas. It is required that the time of sowing and reaping be noticed; also a particular *account* of the species, cultivation, and expense attending it, with proper *certificates* of the nature and condition of the land on which the experiments were made, and the name of the crop, if any, which the same land bore the preceding year; together with an *account* of the produce, the weight per Winchester bushel; and a sample, not less than a quart, be produced to the Society on or before the second Tuesday in February, 1803,

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

20. Beans and Wheat. To the person who shall have dibbled or drilled, between the 1st of December, 1801, and the 1st of April, 1802, the greatest quantity of land, not less than ten acres, with beans, in equi-distant rows, and hoed the intervals twice or oftener, and shall have sown the same land with wheat in the autumn of the year 1802; the silver medal, or twenty guineas. It is required that an account of the sort and quantity of beans, the time of dibbling or drilling, and of reaping or mowing them, the produce per acre threshed, the expense of dibbling or drilling, hand or horse hoeing, the distance of the rows, and the quality of the soil, together with *certificates* of the number of acres, and that the land was afterwards actually sown with wheat, be produced on or before the second Tuesday in March, 1803.

21. Beans. To the person who, in the year 1801, shall discover and cultivate, either by the drill or dibbling-method, on not less than five acres, a species of horse-beans or tick-beans, that will ripen their seeds before the 21st of August; the silver medal, or twenty guineas. It is required that a particular account of the bean, the cultivation, and the expense attending it, with proper *certificates* of the nature and condition of the land on which the experiments are made, together with an *account* of the produce, the weight per Winchester bushel, and a sample of not less than a quart, be produced to the Society on or before the first Tuesday in December, 1802. It is apprehended that, if a bean should be brought into cultivation with the habits of the hotspur, or other early peas, that it would, in a great measure, escape the danger arising from the collier-insect, or other insects, and allow more time for the farmers to till the land for the subsequent crop of wheat. The *accounts* and *certificates* to be delivered on or before the first Tuesday in December, 1802.

22. The same premium is extended one year farther. The *accounts* and *certificates* to be delivered on or before the first Tuesday in Dec. 1803.

23. Comparative Culture of Turnips. For the best set of experiments made on not less than eight acres of land, four of which to be sown broad-cast, and four drilled, to ascertain whether it is most advantageous to cultivate turnips by sowing them broad-cast and hand-hoeing them, or by drilling them in equi-distant rows, and hand or horse-hoeing the intervals; the silver medal, or twenty guineas. It is required that every operation and expense of each mode of culture be fully described, and that proper *certificates* of the nature and condition of the land, on which the experiments were made, together with the weight of the turnips grown, on a fair average sixteen perches of land, under each mode of culture, be produced to the Society on or before the first Tuesday in March, 1803. The object which the Society have in view in offering this premium is experimentally to ascertain the most advantageous method of growing turnips. To do this in a satisfactory manner, both the drilled and broad-cast crops should have the advantage of the most perfect cultivation, consequently the drilled crops should have the intervals between the rows worked by the horse or hand-hoe, or by both these implements; and the rows should be either weeded or hand-hoed, or both weeded and hand-hoed. The broad-cast crop should have every advantage which weeding and hand-hoeing can give it, consistently with leaving the soil a flat surface.

24. The same premium is extended one year farther. *Certificates* to be produced on or before the first Tuesday in March, 1804.

25. Parsnips. To the person who, in the year 1802, shall cultivate the greatest quantity of land, not less than five acres, with parsnips, for the sole purpose of feeding cattle or sheep; the gold medal, or thirty guineas. *Certificates* of the quantity of land so cultivated, with a particular *account* of the nature of the soil and weight of the produce on sixteen perches, and also of the condition of the cattle or sheep fed with the parsnips, and the advantages resulting from the practice, to be produced to the Society on or before the second day in Nov. 1803.

26. Buck Wheat. To the person who shall cultivate the greatest quantity of land with buck wheat, not less than thirty acres; the gold medal. It is required that the time of sowing and reaping be noticed, also a particular *account* of the species, cultivation, and expense attending it, the manner of reaping it, thrashing it, and housing the grain, with proper *certificates* of the nature and condition of the land on which the experiments were made, and the name of the crop, if any, which the same land bore the preceding year, together with an *account* of the produce, and a sample of the seed, not less than a quart, be produced to the Society on or before the second Tuesday in January, 1803.

27. For the next greatest quantity, not less than fifteen acres, on similar conditions; the silver medal. Information respecting its application to the feeding of cattle, hogs, and poultry, and other of its uses, is also desired. It is known to be particularly serviceable in furnishing honey to bees.

28. RAISING GRASS SEEDS. To the person who shall raise the greatest quantity of each or any of the following named grass seeds, *viz.*—Meadow fox-tail (alopecurus pratensis), sweet scented vernal grass (anthoxanthum odoratum), Timothy grass, meadow Fescue grass, smooth-stalked meadow grass (poa pratensis) rough-stalked meadow grass (poa trivialis); the silver medal, or ten guineas. It is required that *certificates* from persons who have viewed them in a proper state, to identify that they are one or other of the seeds above-mentioned, indicating clearly the particular species, and noticing the quantity produced of such seeds, free from weeds or mixture of other grasses, together with proper samples of the seeds, be produced to the Society on or before the first day of February, 1803.

29. The same premium is extended one year farther. *Certificates* to be produced on or before the first day of February, 1804.

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

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

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

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

33. The same premium is extended one year farther. *Certificates* to be delivered on or before the first day of November, 1805.

34. PRESERVING TURNIPS. To the person who shall discover to the Society the best and cheapest method of preserving turnips perfectly sound, and in every respect fit for the purpose of supporting and fattening sheep and neat cattle, during the months of February, March, and April; the gold medal, or thirty guineas. It is required that a full and accurate *account* of the method employed, and the expense attending the process, together with *certificates* that the produce of four acres at the least have been preserved according to the method described, and applied to the feeding of sheep and neat cattle; that the whole were drawn out of the ground before the first day of February, in order to clear the greater part of it previous to its being prepared for corn, and to save the soil from being exhausted by the turnips; and also of the weight of an average sixteen perches of the crop; be produced to the Society on or before the first Tuesday in November, 1803.

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

35. For the next in quantity and merit, on not less than two acres, the silver medal, or fifteen guineas.

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

37. For the next in quantity and merit, on not less than two acres, the silver medal, or fifteen guineas. Conditions the same as for preserving turnips, *Cl.* 34. And the *accounts* to be produced on or before the first Tuesday in November, 1803.

38. PRESERVING CARROTS, PARSNIPS, OR BEETS. To the person who shall discover to the Society the best and cheapest method of preserving carrots, parsnips, or beets, perfectly sound, and in every respect fit for the purpose of supporting horses, and fattening sheep and neat cattle, during the months of February, March, and April; the silver medal, or fifteen guineas. Conditions the same as for preserving turnips, *Cl.* 34. and the *accounts* to be delivered in on or before the first day in November, 1803.

39. Preserving Potatoes. To the person who shall discover to the Society the best and cheapest method of preserving potatoes, two or more years, perfectly sound, without vegetating, and in every other respect fit for the purpose of sets and the use of the table, and, consequently, of supporting and fattening cattle; the silver medal, or twenty guineas. It is required, that a full and accurate *account* of the method employed, and the expense attending the process, with *certificates* that one hundred bushels at the least have been preserved according to the method described, and that one or more bushels of the same potatoes have been set, and produced a crop without any apparent diminution of their vegetative power; and also that they have been used at table, with entire satisfaction to the person who eat of them, together with a sample of one bushel; be sent to the Society on or before the first Tuesday in November, 1804.

40. Making Meadow-Hay in wet Weather. To the person who shall discover to the Society the best and cheapest method, superior to any hitherto practised, of making meadow-hay in wet weather; the gold medal, or thirty guineas. A full *account* of the method employed, and of the expense attending the process, with not less than fifty-six pounds of the hay; and *certificates* that at least the produce of six acres of land has been made according to the method described, and that the whole is of equal quality with the samples; to be produced on or before the first Tuesday in January, 1803.

41. Harvesting Corn in wet Weather. To the person who shall discover to the Society the best and cheapest method, superior to any hitherto practised, of harvesting corn in wet weather; the gold medal, or thirty guineas. A full *account* of the method employed, and of the expense attending the process, with not less than two sheaves of the corn, and *certificates* that at least the produce of ten acres has been harvested according to the method described, and that the whole is of equal quality with the samples, to be produced on or before the first Tuesday in January, 1803.

42. Ascertaining the component Parts of arable Land. To the person who shall produce to the Society the most satisfactory set of experiments to ascertain the due proportion of the several component parts of rich arable land, in one or more couuties in Great Britain, by an accurate analysis of it; and who having made a like analysis of some poor arable land, shall, by comparing the component parts of each, and thereby ascertaining the deficiencies of the poor soil, improve a quantity of it, not less than one acre, by the addition of such parts as the former experiments shall have discovered to be wanting therein, and therefore probably the cause of its sterility; the gold medal, or forty guineas. It is required that the manurings, ploughings, and crops, of the improved land, be the same after the improvement as before; and that a minute *account* of the produce in each state, of the weather, and of the various influencing circumstances, together with the method made use of in analysing the soils, be produced, with proper *certificates* and the chemical results of the analysis, which are to remain the property of the Society, on or before the last Tuesday in November, 1803.

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

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

44. For the next greatest quantity, not less than thirty acres, the silver medal, or twenty guineas. It is required that the land before such improvement be absolutely uncultivated, and in a great measure useless, and that, in its improved state, it be enclosed, cultivated, and divided into closes. *Certificates* of the number of acres, of the quality of the land so improved, with a full *account* of every operation and expense attending such improvement, the state it is in as to the proportion of grass to arable, and the average-value thereof, to be produced on or before the first Tuesday in February, 1803.

45. Manures. For the most satisfactory set of experiments, to ascertain the comparative advantages of the following manures, used as top-dressings on grass or corn land, viz. soot, coal-ashes, wood-ashes, lime, gypsum, night-soil, or any other fit article; the gold medal, or the silver medal and twenty guineas. It is required that the above experiments be made between two or more of the above-mentioned manures, and that not less than two acres of land be dressed with each manure. An *account* of the nature of the soil, quantity and expense of the manure and crops, with *certificates*, to be produced on or before the last Tuesday in February, 1803.

46. The same premium is extended one year farther. The *accounts* and *certificates* to be produced on or before the last Tuesday in February, 1804.

47. Gaining Land from the Sea. To the person who shall produce to the Society an account of the best method, verified by actual experiment, of gaining land from the sea, not less than twenty acres, on the coast of Great Britain or Ireland; the gold medal. *Certificates* of the quantity of land, and that the experiments were begun after the 1st of January, 1796, to be produced to the Society on or before the first Tuesday in October, 1802.

48. The same premium is extended one year farther. *Certificates* to be produced on or before the first Tuesday in October, 1803.

49. The same premium is extended one year farther. *Certificates* to be produced on or before the first Tuesday in October, 1804.

50. Machine for dibbling Wheat. To the person who shall invent a machine, superior to any hitherto known or in use, to answer the purpose of dibbling wheat, by which the holes for receiving the grain may be made at equal distances and proper depths; the silver medal,

or twenty guineas. The *machine*, with *certificates* that at least three acres have been dibbled by it, to be produced to the Society on or before the second Tuesday in January, 1803. Simplicity and cheapness in the construction will be considered as principal parts of its merit.

51. MACHINE FOR REAPING OR MOWING CORN. For inventing a machine to answer the purpose of mowing or reaping wheat, rye, barley, oats, or beans, by which it may be done more expeditiously and cheaper than by any method now practised, provided it does not shed the corn or pulse more than the methods in common practice, and that it lays the straw in such a manner that it may be easily gathered up for binding; the gold medal, or thirty guineas. The *machine*, with *certificates* that at least three acres have been cut by it, to be produced to the Society on or before the second Tuesday in December, 1802. Simplicity and cheapness in the construction will be considered as principal parts of its merit.

52. THRESHING-MACHINE. To the person who shall invent a machine by which corn of all sorts may be threshed more expeditiously, effectually, and at a less expense, than by any method now in use; the gold medal, or thirty guineas. The *machine* or a model with proper *certificates*, that such a machine has been usefully applied, that at least thirty quarters have been threshed by it, and of the time employed in the operation, to be produced to the Society on or before the last Tuesday in February, 1803.

53. DESTROYING THE GRUB OF THE COCKCHAFER. To the person who shall discover to the Society an effectual method, verified by repeated and satisfactory trials, of destroying the grub of the cockchafer, or of preventing or checking the destructive effects which always attend corn, peas, beans, and turnips, when attacked by those insects; the gold medal, or thirty guineas. The *accounts*, with proper *certificates*, to be produced on or before the first Tuesday in January, 1803.

54. DESTROYING WORMS. To the person who shall discover to the Society an effectual method, verified by repeated and satisfactory trials, of destroying worms, or of preventing the destructive effects they occasion on corn, beans, peas, or other pulse; the gold medal, or thirty guineas. The *accounts*, with proper *certificates*, to be produced to the Society on or before the first Tuesday in January, 1803.

55. DESTROYING THE FLY ON HOPS. To the person who shall discover to the Society an easy and efficacious method of destroying the fly on hops, superior to any hitherto known or practised, on not less than four acres of hop ground, the gold medal or thirty guineas. *Accounts* and *certificates* to be delivered to the Society on or before the first Tuesday in February, 1803.

56. CURE OF THE ROT IN SHEEP. To the person who shall discover to the Society the best and most effectual method of curing the rot in sheep, verified by repeated and satisfactory experiments; the gold medal, or fifty guineas. It is expected that the candidates furnish accurate *accounts* of the symptoms and cure of the disease, together with the imputed cause thereof, and the actual or probable means of prevention, which, with proper *certificates*, must be delivered to the Society on or before the first Tuesday in February, 1803.

57. PREVENTING THE ILL EFFECTS OF FLIES ON SHEEP. To the person who shall discover to the Society the most effectual method of protecting sheep from being disturbed and injured by flies; the silver medal, or twenty guineas. It is required that the method be ascertained by repeated experiments, and that a *certificate* of its efficacy be delivered to the Society on or before the first Tuesday in December, 1802.

58. PROTECTING SHEEP. To the person who, in the year 1802, shall protect the greatest number of sheep, not fewer than one hundred, by hovels, sheds, or any other means, and give the most satisfactory account, verified by experiment, of the advantages arising from the practice of protecting sheep from the inclemency of the weather, by hovels, sheds, or any other means; the silver medal, or twenty guineas. A particular *account* of the experiments made, with the advantages arising therefrom, together with the expense, and *certificates* of its utility, to be produced to the Society on or before the first Tuesday in March, 1803.

59. The same premium is extended one year farther. The *accounts* and *certificates* to be delivered on or before the first Tuesday in March, 1804.

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

60. IMPROVING THE CONDITION OF THE LABOURING POOR, BY ERECTING COTTAGES, AND APPORTIONING LAND. To the person who, in the year 1801, shall erect the greatest number of cottages for the accommodation of the labouring poor, and apportion not less than two acres of land to each cottage; the gold medal. The *accounts* and *certificates* to be delivered to the Society on or before the first Tuesday in February, 1803.

61. The same premium is extended one year farther. The *accounts* and *certificates* to be delivered to the Society on or before the first Tuesday in February, 1804.

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

63. IMPROVING THE CONDITION OF THE LABOURING POOR BY APPORTIONING LAND TO COTTAGES. To the person who, in the year 1802, shall apportion to the greatest number of cottages, already built upon his or her estate, any quantity of land, not less than two acres to each cottage, for the better accommodation of the respective inhabitants; the gold medal. The *accounts* of the number of cottages, and of the quantity of land apportioned to each, to be delivered to the Society, with proper *certificates*, on or before the first Tuesday in February, 1803.

64. The same premium is extended one year farther. The *accounts* and *certificates* to be de-

livered on or before the first Tuesday in February, 1804.

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

66. RAISING WATER FOR THE IRRIGATION OF LAND. To the person who shall discover to the Society the cheapest and most effectual method of raising water in quantities sufficient to be beneficially employed for the purposes of irrigating land, superior to and cheaper than any other method now in use; the gold medal, or thirty guineas. A model on a scale of one inch to a foot, with *certificates* that a machine at large on the same construction has been used, specifying the quantity of water delivered in gallons per hour, and the height to which it was raised, to be produced to the Society on or before the first of March, 1803.

The same premium is extended one year farther. *Certificates* to be produced on or before the first of March, 1804.

67. CULTURE OF HEMP IN CERTAIN PARTS OF SCOTLAND. The Society for the Encouragement of Arts, Manufactures, and Commerce wishing to encourage the growth of hemp for the use of the navy, in certain parts of Scotland, comprehending the whole county of Argyle, that part of Perthshire situated to the north of the river Tay, and west of the Military Road (see Ainslie's Map of Scotland) leading from Logierait to the County of Inverness, and such other parts of Scotland as lie north of Inverness-shire, offers to the person who shall sow with hemp, in drills at least eighteen inches asunder, the greatest quantity of land in the above mentioned district, not less than fifty acres statute measure, in the year 1802, and shall at the proper season cause to be plucked the summer hemp (or male hemp bearing no seed) and continue the winter hemp (or female hemp bearing seed) on the ground until the seed is ripe; the gold medal, or fifty guineas.

67*. To the person who shall sow with hemp, (in drills at least eighteen inches asunder) the next greatest quantity of land in the same above-mentioned district, not less than twenty-five acres statute measure, in the year 1802, and shall at the proper season cause the same to be plucked as above-mentioned; the silver medal, or twenty-five guineas. *Certificates* of the number of acres, of the distance of the drills, of the plucking of the hemp, with a general account of the soil, cultivation, and produce, to be delivered to the Society, along with fourteen pounds of the hemp, and two quarts of the seed, on or before the second Tuesday in January, 1803.

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

68. PRESERVING SEEDS OF VEGETABLES. For the best method of preserving the seeds of plants in a state fit for vegetation a longer time than has hitherto been practised, such method being superior to any known to the public, and verified by sufficient trial, to be communicated to the Society on or before the first Tuesday in December, 1802; the gold medal, or thirty guineas.

69. PREVENTING THE DRY-ROT IN TIMBER. To the person who shall discover to the Society the cause of the dry-rot in timber, and disclose a certain method of prevention superior to any hitherto known; the gold medal, or thirty guineas. The *accounts* of the cause, and method of prevention, confirmed by repeated experiments, to be produced to the Society on or before the second Tuesday in December, 1802.

70. PRESERVING SALTED PROVISIONS FROM BECOMING RANCID OR RUSTY. To the person who shall discover to the Society the best, cheapest, and most efficacious method of preserving salted provisions from growing rancid or rusty; the gold medal, or thirty guineas. A full description of the method, with proper *certificates* that it has been found, on repeated trials, to answer the purpose intended, to be produced to the Society on or before the first Tuesday in February, 1803.

71. CLEARING FEATHERS FROM THEIR ANIMAL OIL. To the person who shall discover to the Society the best and most expeditious method, superior to any hitherto practised, of clearing goose-feathers from their offensive animal oil, for the use of upholders, in making beds, cushions, &c. the silver medal, or twenty guineas. A quantity of such feathers unstripped and so cleared, not less than forty pounds weight, with a full *account* of the process, to be produced to the Society on or before the first Tuesday in February, 1803.

72. REFINING WHALE OR SEAL OIL. For disclosing to the Society an effectual method of purifying whale or seal oil from the glutinous matter that incrusts the wicks of lamps and extinguishes the light, though fully supplied with oil; the gold medal, or fifty guineas. It is required that the whole of the process be fully and fairly disclosed, in order that satisfactory experiments may be made by the Society to determine the validity of the claim; and *certificates* that not less than twenty gallons have been purified according to the process delivered in, together with two gallons of the oil, in its unpurified state, and two gallons so refined, be produced to the Society on or before the second Tuesday in February, 1803.

73. MANUFACTURING TALLOW-CANDLES. To the person who shall discover to the Society a method of hardening or otherwise preparing tallow, so that candles may be made of it which will burn as clear and with as small a wick as wax candles, without running, and may be afforded at a less expense than any at present made with spermaceti; the gold medal, or thirty guineas. *Certificates* that 112lb. of such tallow have been made into candles, and 12lb. of the candles made thereof, to be produced to the Society on or before the second Tuesday in January, 1803.

74. CANDLES FROM RESIN OR OTHER SUBSTANCES. To the person who shall discover to

the Society the best method of making candles of resin, or any other substance, fit for common use, at a price much inferior to those made of tallow only; the gold medal, or thirty guineas. Six pounds at least of the candles so prepared, with an *account* of the process, to be delivered to the Society on or before the first Tuesday in December, 1802.

75. METHOD OF SEPARATING SUGAR IN A SOLID FORM FROM TREACLE. To the person who shall discover to the Society the best method of separating sugar from treacle in a solid form, at such an expense as will render it advantageous to the public; the gold medal, or fifty guineas. A quantity of the sugar so prepared in a solid form, not less than thirty pounds weight, with an *account* of the process, and *certificates* that not less than one hundred weight has been prepared, to be produced to the Society on or before the first Tuesday in February, 1803.

76. PROOF-SPIRIT. To the distiller who, in the year 1802, shall make the greatest quantity, not less than one hundred gallons, of a clean marketable spirit, from articles not the food of man or cattle, equal in strength or quality to the proof-spirit now in use, and at a rate not higher than the spirit produced from corn or melasses; the gold medal, or one hundred guineas. Ten gallons of the spirit, together with proper *certificates*, and a full *account* of the expense and mode of making it, to be produced to the Society on or before the first Tuesday in January, 1803.

77. INCREASING STEAM. To the person who shall invent and discover to the Society a method, verified by actual experiments, of increasing the quantity or force of steam, in steam-engines, with less fuel than has hitherto been employed, provided that in general the whole amount of the expenses in using steam-engines may be considerably lessened; the gold medal, or thirty guineas. To be communicated to the Society on or before the first Tuesday in Jan. 1803.

78. SUBSTITUTE FOR TAR. To the person who shall invent and discover to the Society the best substitute for Stockholm tar, equal in all its properties to the best of that kind, and prepared from materials the produce of Great Britain; the gold medal, or one hundred guineas. A quantity of the substitute, not less than one hundred weight, with *certificates* that at least one ton has been manufactured, and that it can be afforded at a price not exceeding that of the best foreign tar, together with an *account* of the process, to be delivered to the Society on or before the first Tuesday in March, 1803.

79. PREPARATION OF TAN. To the person who shall prepare in the most concentrated form, so as to be easily portable, and at a price applicable to the purposes of manufactures, the largest quantity, not less than one hundred weight of the principle called by the French *tannin*, which abounds in oak-bark and many other vegetable substances; the gold medal, or fifty guineas. *Certificates* of the above quantity having been prepared, and a sample of not less than 28 lb. to be produced to the Society on or before the last Tuesday in January, 1803.

80. PREPARATION OF A RED STAIN FOR COTTON CLOTH. To the person who shall communicate to the Society, the cheapest and most effectual method of printing or staining cotton cloths with a red colour, by an immediate application of the colouring-matter to the cloth, equally beautiful and durable with the red colours now generally procured from decoctions of madder; the gold medal, or thirty guineas. *Certificates* that the above process has been advantageously used on ten pieces of callico, each twenty-one yards or upwards in length, one piece of the callico so printed, a quart of the colour in a liquid state, and a full *account* of the preparation and application, to be produced to the Society on or before the second Tuesday in January, 1803.

81. PREPARATION OF A GREEN COLOUR FOR PRINTING COTTON CLOTH. To the person who shall communicate to the Society the best and cheapest method of printing with a full green colour on cotton cloth, by an immediate application of the colouring-matter from a wooden block to the cloth, equally beautiful and durable as the colours now formed from the complicated process of the decoction of weld on alumine and the solutions of indigo by earths or alcaline salts; the gold medal, or thirty guineas. *Certificates* and conditions as for premium 80.

82. SUBSTITUTE FOR THE BASIS OF PAINT. To the person who shall produce to the Society the best substitute, superior to any hitherto known, for the basis of paint, equally proper for the purpose as the white lead now employed; such substitute not to be of a noxious quality, and to be afforded at a price not materially higher than that of white lead; the gold medal, or one hundred guineas. A quantity of the substitute, not less than 50 lb. weight, with an *account* of the process used in preparing it, and *certificates* that at least one hundred weight has been manufactured, to be produced to the Society on or before the first Tuesday in January, 1803.

83. RED PIGMENT. To the person who shall discover to the Society a full and satisfactory process for preparing a red pigment, fit for use, in oil or water, equal in tone and brilliancy to the best carmines and lakes now known or in use, and perfectly durable; the gold medal, or thirty guineas. One pound weight of such colour, and a full disclosure of its preparation, to be produced to the Society on or before the first Tuesday in February, 1803.

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

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

85. ANALYSIS OF BRITISH MINERALS. To the person who shall communicate to the Society,

the most correct analysis of any mineral production of Great Britain, hitherto either unexamined or not examined with accuracy; the gold medal. The analysis and sufficient specimens to be produced to the Society on or before the first Tuesday in January, 1803.

86. Preparation of sulphuric Acid from Sulphur without the Use of any nitric Salt. To the person who shall prepare the largest quantity (not less than one ton) of sulphuric acid from sulphur, without any nitric salt, of a specific gravity, not inferior to the best sulphuric acid of commerce; the gold medal, or fifty guineas. *Certificates* that not less than the above quantity of such an acid has been prepared, together with a sample, to be produced to the Society on or before the first Tuesday in January, 1803.

87. Preparation of any alkaline or earthy Nitrate. To the person who shall prepare, in Great Britain, the largest quantity, not less than one hundred weight, of any salt of nitric acid, with either earths or alkalies, by a method superior to those hitherto practised; the gold medal, or one hundred guineas. *Certificates* of the above quantity having been prepared, and a sample of not less than 28lb. to be produced to the Society on or before the last Tuesday in January, 1803.

88. Fine Bar-iron. To the person, in Great Britain, who shall make the greatest quantity of bar-iron, not less than ten tons, with coak, from coak-pigs, equal in quality to the best iron imported from Sweden or Russia, and as fit for converting into steel; the gold medal, or fifty guineas. Samples, not less than one hundred weight, with *certificates* that the whole quantity is of equal quality, to be produced to the Society on or before the first Tuesday in January, 1803.

89. Preserving Iron from Rust. To the person who shall invent and discover to the Society a cheap composition, superior to any now in use, which shall effectually preserve wrought iron from rust, the gold medal, or fifty guineas. A full description of the method of preparing the composition, with *certificates* that it has stood at least two years unimpared, being exposed to the atmosphere during the whole time, to be produced to the Society, with ten pounds weight of the composition, on or before the first Tuesday in January, 1803.

90. Refining Block-tin. To the person who shall discover to the Society the best method of purifying or refining block-tin, so as to render it fit for the finest purposes to which grain-tin is now applied, and not higher in price; the gold medal, or fifty guineas. *Certificates* that not less than three tons have been refined or purified, with a full detail of the process, and a quantity, not less than one hundred weight, of the tin so refined, to be produced to the Society on or before the first Tuesday in January, 1803.

91. Glazing Earthen-Ware without Lead. To the person who shall discover to the Society the cheapest, safest, most durable, and most easily-fusible, composition, fit for the purpose of glazing the ordinary kinds of earthenware, without any preparation of lead, and superior to any hitherto in use; the gold medal, or thirty guineas. Specimens of the ware so glazed, with proper *certificates* of its having succeeded, and a sample of the materials made use of, to be produced to the Society on or before the first Tuesday in February, 1803.

92. Refining Copper from the Ore. To the person who shall discover to the Society the best method of separating, purifying, and refining copper from the ore, so as to render it fit for the finest purposes to which fine copper is now applied, and by a process superior to any hitherto known or in use, and not higher in price; the gold medal, or fifty guineas. *Certificates* that not less than three tons have been so prepared or refined, and a quantity not less than one hundred weight of the copper so refined, to be produced to the Society on or before the first Tuesday in February, 1803.

93. Mineralogical Map of England and Wales. To the person who shall complete and publish an accurate mineralogical map of England and Wales, on a scale of not less than ten miles to an inch, containing an account of the situation of the different mines therein, and describing the kinds of minerals thence produced; the gold medal, or fifty guineas. *Certificates* of the accuracy of such map, together with the map, to be produced to the Society on or before the first Tuesday in February, 1804. The map to remain the property of the Society.

94. Mineralogical Map of Ireland. The same premium is offered for a mineralogical map of Ireland on similar conditions.

95. Mineralogical Map of Scotland. The same premium is offered for a mineralogical map of Scotland on similar conditions.

96. Natural History. To the author who shall publish, in the year 1802, the natural history of any county in England or Wales; the gold medal, or fifty guineas. It is required that the several natural productions, whether animal, vegetable, or mineral, peculiar to the county, or found therein, be carefully and specifically arranged and described, in order that the public may be enabled to judge what arts or manufactures are most likely to succeed in such county. The work to be delivered to the Society on or before the last Tuesday in January, 1803.

PREMIUMS IN POLITE ARTS.

97. Honorary Premiums for Drawing, by Nobility. For the best drawing, of any kind, made with water-colours, crayons, chalk, black lead, pen, Indian ink, or bister, by young gentlemen under the age of twenty-one, sons or grandsons of peers, or peeresses in their own right, of Great Britain or Ireland, to be produced on or before the first Tuesday in March, 1803; the honorary medal of the Society in gold.

98. The same in silver for the next in merit.

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

101. HONORARY PREMIUMS FOR DRAWING, BY GENTLEMEN. For the best drawing, of any kind, made with water-colours, crayons, chalk, black-lead, pen, Indian ink, or bister, by young gentlemen under the age of twenty-one; to be produced on or before the first Tuesday in March, 1803; the gold medal.

102. For the next in merit, the silver medal.

103, 104. The same premiums will be given for drawings by young ladies.

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

105. DRAWINGS OF OUTLINES. For the best outline, after an original group or cast, in plaster, of human figures, by persons of either sex, under the age of sixteen, the principal figure not less than twelve inches; to be produced on or before the third Tuesday in February, 1803; the greater silver pallet.

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

N. B. These drawings are to be made on paper, and the original either to be produced to the Society, or to be referred to for their examination.

107. DRAWINGS OF LANDSCAPES. For the best drawing of a landscape after nature, by persons of either sex, under twenty-one years of age, to be produced on or before the third Tuesday in February, 1803; the greater silver pallet.

108. For the next in merit, the lesser silver pallet. Each candidate must mention, on the front of the drawing, whence the view was taken; and the drawings must be made with chalk, pen, Indian ink, water-colours, or bister.

109. HISTORICAL DRAWINGS. For the best historical drawing, being an original composition, of five or more human figures; the height of the principal figure not less than eight inches; to be made with crayons, chalk, black lead, pen, Indian ink, water-colours, or bister, and to be produced on or before the third Tuesday in February, 1803; the gold pallet.

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

111. CHINTS PATTERNS FOR CALICO-PRINTERS. For the best original pattern in a new taste, of light or dark ground chints for garment-work, fit for the purposes of calico-printers, by persons of either sex; the gold medal. To be produced to the Society on or before the second Tuesday in January, 1803; the pattern to which the premium is adjudged to remain the property of the Society.

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

113. COPPER-PLATE PATTERNS FOR CALICO-PRINTERS. For the best pattern, in a new stile, fit for the purposes of calico-printers for garment work; the silver medal. To be produced to the Society on or before the second Tuesday in January, 1803. The pattern to which the premium is adjudged to remain the property of the Society.

114. LINE ENGRAVINGS OF LANDSCAPES. For the best line engraving of a landscape, published in the year 1803, the size of the engraving not less than eighteen inches by fourteen; the gold medal. To be produced to the Society on or before the last Tuesday in January, 1804; and the impression to which the premium is adjudged to remain the property of the Society.

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

116. LINE ENGRAVINGS OF HISTORICAL SUBJECTS. For the best line engraving published in the year 1802, of an historical subject, the size of the engraving not less than eighteen inches by fourteen; the gold medal.

117. For the next in merit; the silver medal. Conditions, &c. the same as in classes 114 and 115.

118 MODEL IN CLAY OR PLASTER. For the best model in clay or plaster of an ornamental design for the purpose of embellishing works of Architecture; the silver medal, or twenty guineas. To be produced to the Society on or before the last Tuesday in January, 1803. The model not to be less than thirty inches by twelve.

THE FOLLOWING PREMIUM (CLASS 119,) IS OFFERED IN CONFORMITY TO THE WILL OF THE LATE JOHN STOCK, OF HAMPSTEAD, ESQ.

119. ORNAMENTAL DRAWINGS FOR ARCHITECTURAL DESIGNS. For the best ornamental drawing for the purpose of embellishing architectural designs; a silver medallion with the following engraved inscription: *The Premium given by the Society for the Encouragement of Arts, Manufactures, and Commerce, in conformity to the Will of John Stock, of Hampstead, Esq.* The drawing to which the premium is adjudged to remain the property of the Society.

120. For the best model in clay or plaster of a design for the same purpose; the silver medal. The performances in these two classes not to be less than thirty inches by twelve, to be made by persons under the age of twenty-one years. To be produced to the Society on or before the last Tuesday in January, 1803.

121. PERSPECTIVE DRAWINGS OF MACHINES. For the best perspective drawing of machines by persons under eighteen years of age; the greater silver pallet. To be produced to the Society on or before the last Tuesday in January, 1803.

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

123. ENGRAVING ON WOOD, OR METAL

BLOCKS. For the best engraving on wood, or metal blocks, of a subject or allegorical decoration for a volume of the Society's Transactions, proper to be prefixed to the premiums offered by the Society, and capable of being worked with the letter press; the gold medal. The engraved wood or metal block, and two or more impressions from it, to be produced to the Society on or before the second Tuesday in February, 1803, and the engraved wood or metal block to which the premium is adjudged to remain the property of the Society. The engraving to be of a proper size to form an octavo page in the volume.

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

125. STATUARY MARBLE. To the person who shall discover, within Great Britain or Ireland, a quarry of white marble fit for the purposes of statuary, and equal in all respects to those kinds now imported from Italy; the gold medal, or one hundred pounds. A block of at least three feet in length, two in height, and two in width, with an account of the situation of the quarry, and *certificates* of its possessing considerable extent, to be produced to the Society on or before the first Tuesday in February, 1803.

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

126. BRONZES. For the best drapery-figure or group cast in bronze; if a single figure, not less than twelve inches high; and, if a group, not less than nine inches; and which will require the least additional labour to repair; the gold medal, or the silver medal and twenty guineas. The cast to be exhibited to the Society before it is begun to be repaired, with the original figure or group, on or before the first Tuesday in February, 1802, together with a full explanation of the whole process.

PREMIUMS FOR ENCOURAGING AND IMPROVING MANUFACTURES.

127. MACHINE FOR CARDING SILK. For the best machine, superior to any now in use, for carding waste silk equally well as by hand; to be produced, together with a specimen of the cardings, on or before the first Tuesday in November, 1802; the silver medal, or twenty guineas.

128. CLOTH FROM HOP-STALKS, &c. To the person who shall produce to the Society the greatest quantity, not less than thirty yards of cloth at least twenty-seven inches wide, made in Great Britain, of hop-stalks or bines, or other raw vegetable substances, the produce of Great Britain or Ireland, superior to any hitherto manufactured from such substances, and which can be generally afforded as cheap as cloth of equal quality and appearance now made from hemp, flax, or cotton, and much finer in quality than any hitherto manufactured in England from hop-stalks, &c. the gold medal, or thirty guineas. One pound of the thread of which the cloth is made, and thirty yards of the cloth, together with proper *certificates* that the whole is manufactured from hop-stalks or bines, &c. to be produced to the Society on or before the first Tuesday in December, 1802.

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

129. WICKS FOR CANDLES OR LAMPS. To the person who shall discover to the Society a method of manufacturing hop-stalks or bines, or any other cheap material, the growth of Great Britain, so as to render them equally fit for the purpose of supplying the place of cotton, for wicks of candles or lamps; twenty guineas. Samples, not less than five pounds weight, of the wicks so prepared to be produced to the Society, with *certificates* that the whole quantity is equal in quality to the sample, on or before the second Tuesday in January, 1803.

130. PAPER FROM RAW VEGETABLE SUBSTANCES. To the person, in Great Britain, who shall, between the first of January, 1802, and the first of January, 1803, make the greatest quantity, and of the best quality, (not less than ten reams) of good and useful paper, from raw vegetable substances, the produce of Great Britain or Ireland, of which one hundred weight has not been used in manufacturing paper previous to January, 1801, superior to any hitherto manufactured from such substances, and which can be generally afforded as cheap as paper of equal quality and appearance now made from rags; twenty guineas.

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

Certificates of the making such paper, and one ream of the paper, to be produced on or before the second Tuesday in January, 1803.

131. TRANSPARENT PAPER. To the person who shall discover to the Society a method of making paper from the pulp that shall be perfectly transparent, and of a substance and body equal to fools-cap, that shall take and bear common writing ink with the same facility and correctness as writing paper generally in

use; the silver medal, or twenty guineas. *Certificates* of the making such paper, an *account* of the process, and one ream of the paper, to be produced on or before the second Tuesday in January, 1803.

132. TAKING PORPOISES. To the people in any boat or vessel, who, in the year 1802, shall take the greatest number of porpoises on the coast of Great Britain, by gun, harpoon, or any other method, not fewer than thirty, for the purpose of extracting oil from them; the gold medal, or thirty pounds. *Certificates* of the number, signed by the persons to whom they have been sold or delivered for the purpose of extracting the oil, to be produced to the Society on or before the last Tuesday in January, 1803.

133. OIL FROM PORPOISES. To the person who shall manufacture the greatest quantity of oil from porpoises taken on the coast of Great Britain, in the year 1802, not less than twenty tons; the gold medal, or thirty pounds. *Certificates* of the oil having been made from porpoises actually caught on the coast of Great Britain, and two gallons of the oil as a sample, to be produced to the Society on or before the last Tuesday in February, 1803.

PREMIUMS IN MECHANICS.

134. GUNPOWDER-MILLS. To the person who, in the year 1802, shall invent and bring to perfection the most effectual method of so conducting the works of gunpowder-mills, in the business of making gunpowder, as to prevent explosion; the gold medal, or one hundred guineas. *Certificates* and *accounts* of the method having been put in practice in one or more gunpowder-mills in this kingdom, and that it promises, in the opinion of the best judges concerned in such works, to answer the purpose intended, to be produced to the Society on or before the first Tuesday in Feb. 1803.

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

135. TRANSIT-INSTRUMENT. To the person who shall invent and produce to the Society a cheap and portable transit-instrument, which may easily be converted into a zenith-sector, capable of being accurately and expeditiously adjusted for the purpose of finding the latitudes and longitudes of places, and superior to any portable transit-instrument now in use; the gold medal, or forty guineas. To be produced on or before the last Tuesday in Jan. 1803.

136. TAKING WHALES BY THE GUN-HARPOON. To the person who, in the year 1802, shall strike the greatest number of whales, not fewer than three, with the gun-harpoon; ten guineas. Proper *certificates* of the striking such whales, and that they were actually taken in the year 1802, signed by the master, or by the mate when the claim is made by the master, to be produced to the Society on or before the last Tuesday in December, 1802.

137. FAMILY MILL. To the person who shall invent and produce to the Society the best constructed mill for grinding corn for the use of private families, or parish-poor; the construction to be such as to render the working of the mill easy and expeditious, and superior to any hitherto in use; the gold medal, or thirty guineas. The mill, and *certificates* of its having been used to good effect, to be produced to the Society on or before the first Tuesday in February, 1803.

N. B. Cheapness and simplicity will be considered an essential parts of its merit; and the mill, or the model, to remain with the Society.

138. MACHINE FOR RAISING COALS, ORE, &c. &c. To the person who shall invent a machine for raising coals, ore, &c. from mines, superior to any hitherto known or in use, and which shall produce the effect at a less expense than those already known or in use; the gold medal, or fifty guineas. A model of the machine, made on a scale of not less than one inch to a foot, with a *certificate* that a machine at large on the same construction has been advantageously used, to be produced to the Society on or before the second Tuesday in February, 1803.

139. MACHINE FOR RAISING WATER. To the person who shall invent a machine on a better, cheaper, and more simple construction than any hitherto known or in use, for raising water out of wells, &c. from a depth of not less than fifty feet; the gold medal, or forty guineas. *Certificates* of the performance of the machine, and a model of it, on a scale of not less than one inch to a foot, to be produced to the Society on or before the first Tuesday in February, 1803.

140. MACHINE FOR MAKING BRICKS. To the person who shall invent the best and cheapest machine for making bricks, superior to any hitherto known or in use, whereby the labour and expense of making bricks in the usual mode, by hand, may be greatly diminished; forty guineas. A model, with *certificates* that a machine at large, on the same construction, has been used to good effect for the purpose of making bricks, and that at least one hundred thousand statute-bricks have been made therewith, to be produced to the Society on or before the first Tuesday in March, 1803.

141. BORING AND BLASTING ROCKS. To the person who shall discover to the Society a

more simple, cheap, and expeditious method than any hitherto known or in use of boring and blasting rocks in mines, shafts, wells, &c.; the gold medal, or thirty guineas. *Certificates* of the method having been practised with success, with a full description thereof, to be delivered to the Society on or before the first Tuesday in January, 1803.

142. Heating Rooms for the purposes of Manufacturers. To the person who shall invent and discover to the Society a method of heating rooms, superior to any hitherto known or in use, and at a moderate expense, for the purposes of painters, japanners, and other manufacturers, so as to avoid the necessity of iron or copper tunnels going through the rooms to convey the smoke, whereby the danger from such tunnels may be prevented; the gold medal, or forty guineas. A model, or complete drawing and description of the method, with *certificates* that it has been successfully practised, to be delivered to the Society on or before the last Tuesday in March, 1803.

143. Improved Ventilation. To the person who shall invent and produce to the Society a mode of permanently ventilating the apartments in hospitals, workhouses, and other crowded places, superior to any now known or used; the gold medal, or fifty guineas. A model of the apparatus, and a full account of the means by which the effect has been produced, with proper *certificates*, to be delivered to the Society on or before the last Tuesday in February, 1803.

144. Mill Stones. To the person who shall, between the first of February, 1802, and the first of February, 1803, prepare and bring into use the greatest number of mill stones, taken from any quarry in the United Kingdoms, equal in quality to the French burrs, not less than thirty pairs; the gold medal, or thirty guineas. *Certificates* that the said mill stones were all taken from the same quarry, with their prices and dimensions, that they are equal to the French burr, not less than three feet eight inches diameter, and are actually in use, to be produced to the Society on or before the third Tuesday in February, 1803.

145. For the next greatest quantity, not less than twenty-five pair; the silver medal, or fifteen guineas, on similar terms.

146. Preventing Accidents from Horses falling with two-wheeled Carriages. To the person who shall invent and produce to the Society a method superior to any hitherto known or in use, to prevent accidents from the falling of horses with two-wheel carriages, especially on steep declivities; the silver medal, or fifteen guineas. A model of the apparatus, and a full account of the means by which the effect has been produced, with proper *certificates* that the same has been used with success, to be delivered to the Society on or before the second Tuesday in Jan. 1803.

147. Clearing the Turnpike and other Roads in Winter from Mud, and in Summer from Dust. To the person who shall discover to the Society the most effectual and the cheapest method, verified by experiments, of clearing the turnpike and other roads of great resort, in winter from mud, and in summer from dust, or most effectually preventing the accumulation of either; the gold medal, or fifty guineas.

148. For the second best account; the silver medal, or twenty guineas. It is required that an accurate *account* of the method used, and every expense attending it, together with satisfactory *certificates* of its being effectual, be delivered to the Society on or before the first Tuesday in March, 1803.

PREMIUMS OFFERED FOR THE ADVANTAGE OF THE BRITISH COLONIES.

149. Nutmegs. For the greatest quantity of merchantable nutmegs, not less than ten pounds weight, being the growth of his Majesty's dominions in the West Indies, or any of the British settlements on the coast of Africa, or the several islands adjacent thereto, and equal to those imported from the islands of the East Indies; the gold medal, or one hundred guineas. Satisfactory *certificates*, from the governor, or commander in chief, of the place of growth, with an *account* of the number of trees, their age, nearly the quantity of fruit on each tree, and the manner of culture, to be produced on or before the first Tuesday in December, 1802.

150. Cloves. For importing into the port of London, in the year 1802, the greatest quantity of cloves, not less than twenty pounds weight, being of the growth of some of the islands of the West Indies subject to the crown of Great Britain, or any of the British settlements on the coast of Africa, or the several islands adjacent thereto, and equal in goodness to the cloves brought from the East Indies; the gold medal, or fifty guineas. Samples, not less than two pounds weight, with *certificates* that the whole quantity is equal in goodness, together with satisfactory *certificates* signed by the governor, or commander in chief, of the place of growth, with an *account* of the number of trees growing on the spot, their age, and the manner of culture, to be produced to the Society on or before the first Tuesday in January, 1803.

151. Plantations of Bread-Fruit-Trees. To the person who shall have raised in any of the islands of the West Indies subject to the crown of Great Britain, or in any of the British settlements on the coast of Africa, or

the several Islands adjacent thereto, between the 1st of January, 1801, and the 1st of January, 1802, the greatest number of bread-fruit-trees, not fewer than one hundred, and properly fenced and secured the same, in order to supply the fruit to the inhabitants; the gold medal, or thirty guineas. Proper *accounts* and *certificates*, signed by the governor, or commander in chief, of the methods made use of in cultivating the plants and securing the plantation, and that the trees are in a growing and thriving state at the time of signing such certificates, to be produced to the Society, with samples of the fruit, on or before the first Tuesday in January, 1803.

152. KALI FOR BARILLA. To the person who shall have cultivated, in the Bahama-Islands, or any other part of his Majesty's dominions in the West Indies, or any of the British settlements on the coast of Africa, or the several islands adjacent thereto, in the year 1801, the greatest quantity of land, not less than two acres, with Spanish kali, fit for the purpose of making barilla; the gold medal, or thirty guineas.

153. For the next greatest quantity, not less than one acre, the silver medal, or fifteen guineas. *Certificates*, signed by the governor, or commander in chief, for the time being, of the quantity of land so cultivated, and of the state of the plants, at the time of signing such certificates, to be delivered to the Society, with samples of the kali, on or before the second Tuesday in January, 1803.

154. The same premium is extended one year farther. *Certificates* to be produced on or before the second Tuesday in January, 1804.

155. DESTROYING THE INSECT COMMONLY CALLED THE BORER. To the person who shall discover to the Society an effectual method of destroying the insect commonly called the borer, which has, of late years, been so destructive to the sugar-canes in the West India islands, the British settlements on the coast of Africa, and the several islands adjacent thereto; the gold medal, or fifty guineas. The discovery to be ascertained by satisfactory *certificates*, under the hand and seal of the governor, or commander-in-chief, for the time being, and of some other respectable persons, inhabitants of the islands, or other place, in which the remedy has been successfully applied; such *certificates* to be delivered to the Society on or before the first Tuesday in January, 1803.

156. CULTIVATION OF HEMP IN UPPER AND LOWER CANADA. To the person who shall sow with hemp the greatest quantity of land in the province of Upper Canada, not less than six arpents (each four-fifths of a statute acre, in the year 1802, and shall at the proper season cause to be plucked the summer hemp (or male hemp bearing no seed) and continue the winter hemp (or female hemp bearing seed) on the ground until the seed is ripe; the gold medal, or one hundred dollars.

157. To the person who shall sow with hemp the next greatest quantity of land in the same province of Upper Canada, not less than five arpents, in the year 1802, in the manner above-mentioned; the silver medal, or eighty dollars.

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

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

160. For the next greatest quantity of land, in the same province, and in a similar manner, not less than one arpent; twenty dollars. *Certificates* of the number of arpents, the method of culture, of the plucking of the hemp, with a general *account* whether sown broad-cast or in drills, the expense, soil, cultivation, and produce to be transmitted to the Society, certified under the hand and seal of the governor or lieutenant-governor, together with 28 lb. of the hemp, and two quarts of the seed, on or before the first Tuesday in November, 1803.

161, 162, 163, 164, 165. The same premiums are extended one year farther. *Certificates*, &c. as before-mentioned, to be transmitted to the Society, on or before the last Tuesday in February, 1804.

166 to 176. Premiums exactly similar in all respects to those held out for the province of Upper Canada, are also offered for the province of Lower Canada, and are extended to the same period.

177. IMPORTATION OF HEMP FROM CANADA. To the master of that vessel, which shall bring to this country the greatest quantity of marketable hemp, not less than one hundred tons, in the year 1803, the produce of Upper or Lower Canada; the gold medal.

178. To the master of that vessel which shall bring the next quantity, not less than fifty tons; the silver medal. *Certificates* satisfactory to the Society to be produced by the master of the vessel on or before the first Tuesday in February, 1804, to testify that such hemp was grown and prepared in Canada.

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

179. BHAUGULPORE-COTTON. To the person who shall import into the port of London, in the year 1802, the greatest quantity, not less than one ton, of the Bhaugulpore-cotton, from which clothes are made in imitation of nankeen, without dying; the gold medal. A quantity of the cotton, not less than five pounds weight in the pod, and five pounds carded, to be produced to the Society, with proper *certi-*

ficates, signed by the secretary to the board of trade of Bengal or Bombay, on or before the last Tuesday in February, 1803.

180. ANNATTO. To the person who, in the year 1802, shall import into the port of London, from any part of the British settlements in the East Indies, the greatest quantity of annatto, not less than five hundred weight; the gold medal. A quantity of the annatto, not less than ten pounds weight, to be produced to the Society, with proper *certificates*, signed by the secretary of the board of trade of the respective settlement, that the annatto is the produce of such settlement, on or before the last Tuesday in February, 1803.

181. TRUE COCHINEAL. To the person who, in the year 1802, shall import into the port of London, from any part of the British settlements in the East Indies, the greatest quantity of true cochineal, not less than five hundred weight; the gold medal. A quantity of the cochineal, not less than ten pounds weight, with proper *certificates*, signed by the secretary of the board of trade of the respective settlement, that the cochineal is the produce of such settlement, to be produced to the Society on or before the first Tuesday in February, 1803.

CONDITIONS FOR THE POLITE ARTS.

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

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

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

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

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

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

To encourage real merit, and prevent attempts to impose on the Society, by producing drawings made or retouched by any other person than the candidate, the Society require a specimen of the abilities of each successful candidate in classes 97 to 122 inclusive, under the inspection of the Committee of Polite Arts, in every instance where such proof may appear necessary.

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

SOCIETY'S OFFICE, ADELPHI, JUNE 1st, 1802.

ORDERED,

That the several Candidates and Claimants to whom the Society shall adjudge Premiums or Bounties, do attend at the Society's Office in the Adelphi, on the last Tuesday in May 1803, at Twelve o'Clock at Noon precisely, to receive the same; that Day being appointed by the Society for the Distribution of their Rewards: And before that Time no Premium or Bounty will be delivered, excepting to those who are about to leave the kingdom.

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

GENERAL CONDITIONS.

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

It is required that the matters for which premiums are offered, be delivered in without names or any intimation to whom they belong; that each particular thing be marked in what manner each claimant thinks fit, such claimant sending with it a paper sealed up, having on the outside a corresponding mark, and, on the inside, the claimant's name and address; and all candidates are to take notice, that no claim for a premium will be attended to, unless the conditions of the advertisement are fully complied with.

No papers shall be opened, but such as shall gain premiums, unless where it appears to the Society absolutely necessary for the determination of the claim; all the rest shall be returned unopened with the matters to which they belong, if inquired after by the mark, within two years; after which time, if not demanded, they shall be publicly burnt, unopened, at some meeting of the Society.

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

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

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

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

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

The performances which each year obtain premiums or bounties are to remain with the Society until after the public distribution of rewards.

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

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

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

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

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

The Society desire that the Papers on different subjects sent to them may be full, clear, explicit, fit for publication, and rather in the form of Essays than of Letters.

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

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

By Order of the Society,

CHARLES TAYLOR, *Secretary.*

Society of Arts Manufactures and Commerce.

ADELPHI, *June 21st*, 1802.

ON Wednesday, the 2d Inst. the Society, held the last Meeting of that Session, and adjourned to the fourth Wednesday in October next.

On Tuesday the 25th of May last, agreeably to the Resolutions of the Society the Premiums and Bounties which had been then adjudged during the Session, were delivered to the Claimants from the Chair, by his Grace the Duke of Norfolk, the President, in presence of a very numerous and respectable Assembly. The Business was begun by an appropriate Speech from the Secretaty, noticing the Objects of the Society from its Institution, in the year 1754, to the present Time, and particularising the Rewards which had been then adjudged this Session.

The Rewards awarded, are arranged under the following Classes:

IN AGRICULTURE.

To John Hunter, esq. of Gubbins, in Hertfordshire, for having planted 40,000 Oaks, the Gold Medal.

To Thomas Johnes, esq. of Hafod, in Cardiganshire, for having planted 400,000 Forest Trees, the Gold Medal.

To John Christian Curwen, esq. of Workington Hall, in Cumberland, for having planted 84,900 Larch Trees, the Gold Medal.

To Henry Vernon, esq. of Hilton Park, near Wolverhampton, for planting 10,000 Silver Firs, the Gold Medal.

To James Beech, esq. of Shaw, near Cheadle, in Staffordshire, for his plantation of Timber Trees, the Silver Medal.

To the Rev. Richard Yates, of Chelsea, for his Essay on raising and promoting the growth of Oaks, the Silver Medal.

To Charles Gibson, esq. of Quermore Park, near Lancaster, for planting 6,000 Elms, the Silver Medal.

To William Fairman, esq. of Miller's House, near Sittingbourn, in Kent, for his Experiments on Extreme Branch Grafting of Fruit Trees, the Silver Medal.

To Robert Brown, esq. of Markle, near Haddington, in Scotland, for his Cultuie of Beans and Wheat in one year on the same Land, the Silver Medal.

To Mr. Frederic Clifford Cherry, of New Wood Farm, near Stoke d'Aubenton, in Surry, for planting 60 Acres with Osiers, the Sum of Thirty Guineas.

To Mr. Seth Bull, of Ely, in Cambridgeshire, for planting 8 Acres with Osiers, the Sum of Ten Guineas.

IN CHEMISTRY.

To Mr. Thomas Willis, of Lime-Street, London, for his preparation of the Bulbs of the Hyacinthus non scriptus, or common Field Blue Bells, as a substitute for Gum Arabic, the Silver Medal.

IN POLITE ARTS.

To George William Gent, esq. of Upper Guildford Street, for a Drawing of Lewes Castle, in Essex, the Gold Medal. Cl. 89.

To Miss Elizabeth Mac Dowall, of Brook Street, Holborn, for a Chalk Drawing of the Virgin and Child, the Gold Medal. Cl. 91.

To Miss Winifred Barrett, of Stockwell, in Surry, for a drawing of a Landscape, the Silver Medal. Cl. 91*.

To Miss Jackson, of Hanover Street, Hanover Square, for a drawing in Black Chalk, after an Engraving by Bartolozzi, the Silver Medal.

To Miss Blackburne, of Park Street, Westminster, for a Drawing of Demosthenes from a Bust, the Silver Medal.

To Miss Mary Anne Gilbert, of Devonshire Street, Portland Place, for a Miniature Drawing of an old Woman, after Nature, the Silver Medal.

To Miss Emma Farhill, of Mortimor Street, Cavendish Square, for a Drawing of Peasants in a Storm, the Silver Medal.

To William Stone Lewis, esq. of High Holborn, for a Drawing of Outlines of the Laocoon, from a Cast, the larger Silver Pallet. Cl. 92.

To George Jones, esq. of Great Portland Street, Mary-le-bone, for a Drawing of Outlines of Hercules and Antæus, from a Cast, the lesser Silver Pallet. Cl. 93.

To Richard Speare, esq. of Dean Street, Soho, for a Drawing, a View at Eltham, in Kent, the greater Silver Pallet. Cl. 94.

To Mr. Richard Cook, of Upper Charlotte Street, Fitzroy Square, for a Drawing of Mutius Scævola, before Porsenna, the Gold Pallet. Cl. 96.

To Mr. John Summerfield, of Packington, Coventry, for a Stroke Engraving, the subject Rubens and his Wife, the Gold Medal. Cl. 98.

To Mr. C. Nesbitt, of Fetter Lane, for Engravings on Wood, the Silver Medal. Cl. 103.

To Mr. Richard Austin, of Paul's Alley, Barbican, for Engravings on Wood, the Silver Medal.

To Mrs. Elizabeth Coppins, of St. Stephen's, Norwich, for a Drawing in Crayons of Belisarius, copied from a Painting of Salvator Rosa, the greater Silver Pallet.

To Miss Frances Talbot, of Wymondham, Norfolk, for a Painting of an Herb Girl, from Nature, the Silver Medal.

To Miss Beauchamp, of Langley Park, near Beccles, in Suffolk, for a Painting of a Landscape, copied from Both, the Silver Medal.

To Dr. John Evans, of Shrewsbury, for two Maps of North Wales, the Sum of Forty-five Guineas.

IN MANUFACTURES.

To Mr. Thomas Clulow, of Shoreditch, for his Invention of weaving Purses, Pockets, and Sacks, in a Loom, and improving the Construction of Looms in general, Twenty-five Guineas.

IN MECHANICS.

To Mr. Henry Greathead, of South Shields, in the Bishoprick of Durham, for his Construction of a Cork Boat, by which the Lives of many Persons shipwrecked have been preserved, the Gold Medal and Fifty Guineas.

To William Hall Timbrel, esq. of Streatly, in the County of Berks, for an improved herniary Truss and new invented Calico Cushion, the Gold Medal.

To Mr. Richard Knight, of Foster Lane, Cheapside, for his Method of clearing Land from Stumps of Trees, and rendering them in a proper State for Fuel, the Silver Medal.

To Mr. James Brownhill, of Alloa Mills, near Stirling, in Scotland, for his Discovery of a Quarry of Stone, proper for making Mill Stones, the Sum of One Hundred Pounds.

To Mr. John Webb, of Dorrington Street, for an Invention in Gun Locks, to prevent accidents in using Guns or Pistols, and to guard against their being improperly fired, the Sum of Twenty Guineas.

To Mr. James Woart, of Fulham, for securing Beams of Timber decayed by Time, or injured by Accidents, in Buildings, the Sum of Ten Guineas.

IN COLONIES AND TRADE.

To Dr. Alexander Anderson, of St. Vincent, for the Culture of Cloves and Cinnamon, the Gold Medal.

To the Hon. Joseph Robley, of Tobago, for a Plantation of Bread Fruit Trees, the Gold Medal.

An Account of the Number of Noblemen and Gentlemen elected Members since October last, whose Titles and Names are as follow:

The Most Noble the Marquis of Exeter, F. R. S. and S. A. the Right Hon. Lord Viscount Barrington, the Right Hon. Lord Carrington, Sir George Prescot, Bart. Hon. John Henniker Major, John Robinson, esq. M. P. Col. Peachy, M. P. Rowland Burdon, esq. M. P. Lieut. Gen. John Watson, James Brogden, esq. M. P. Mr. Sheriff William Rawlins, Thomas Myers, esq. Joseph Nollekins, esq. R. A. John Dixon, esq. George Prescott, esq. Thomas Calverly, esq. Thomas Taylor, esq. Mr. John Sowerby, John Scott, esq. William Gosling, esq. Alexander Scott, esq. Mr. William Woodburn, Mr. Vaughan Griffiths, Charles Tufton Blicke, esq. Mr. John Francis Desanges, William Irving, esq. Lieut. Col. Francis John Wilder, James Anderson, esq. LL. D. Daniel Moore, esq. Solomon Levien, esq. W.H. Pepys, jun. James Green, esq. Mr. John Fuller, David Pike Watts, esq. William Bridgman, esq. William Phillips, esq. Richard Sykes, esq. Mr. John Dutton, Henry Leader, esq. Rev. Mr. J. Clay, Josiah Robert Harrison, esq. John Gold, esq. Richard Varal, esq. Richard Godwin, esq. Thomas Edwards, esq. William Butler, esq. Mr. William Peter Whyte, Mr. Thomas Bish, Henry Decort, esq. Valentine Green, esq. Martin Bree, esq. James Kendrick, esq. Henry Gore Clough, esq. Mr. William Woodthorp, Charles Winstanley, esq. Joseph Ablett, esq. Dr. Clough, William Tooke, esq. William Coles, esq. Mr. William March, Mr. William Chapman, Joseph Williams, esq. Samuel Lovat, esq. Walter Bracebridge, esq. Henry Winstanley, jun. esq. Daniel Llewellin, esq. John M'Arthur, esq. William Minnitt, esq. Mr. Thomas Jones, David Forbes, esq. Joseph Martin, esq. William Lechmer, esq. Ambrose Pitman, esq. Mr. George Samuel, Col. William Tatham, J. S. Munnings, esq. Mr. Edward Vennor, George Lockett, esq. William Green, esq. Christopher Fowler, esq. Mr. Samuel John Neal, William Nethersole, esq. William Pierrie, esq. George Banastre Pix, esq. John Hunter, esq. Mr. Alexander Sheafe Birkett, Mr. Joseph Bunnell, Mr. William Marston, Mr. James Little, Stephen Scarbrow, esq. Col. William Gent, Dr. Ogilvie, William Breton, esq. Thomas Cartwright Slack, esq. John Watkin Phipps, esq. Mr. Thomas Courtney Devenish, Mr. William Bennett, Major Henry Eustace, William James, esq. Thomas Poynder, jun. esq. Henry Michele, esq. Samuel Gunnel, esq. Drewhurst Bilsborow, esq. Rev. William Phillips, Thomas Leys, esq. James St. Aubyn, esq. William Henry Cheek, esq. Thomas Stackhouse, esq. George Clark, esq. Philip Neill, esq. William Wills, esq. John Maud, esq. Thomas Windus, esq. Lewis Buckle, esq. Ralph Dodd, esq. Mr. Thomas Wilson, Charles Browning, esq. Mr. Henry Greathead, Mr. Richard Reeve, John Rowe, esq. Thomas Andrews, esq. Mr. Gilson Reeve, Edward Biven, esq. John Barnwell Murphy, esq. Peter Green, esq. John Abearn Palmer, esq. John Flamank, esq. Joseph Ivatt Harwood, esq. Mr. William Gedge, John Jones, esq. Robert Bevil, esq. Mr. John Fletcher, Robert Blake, esq. Capt. H. L. Frezill, Mr. Joseph Cooper, Benjamin Hall, esq. Cuthbert Sharp, esq. Robert Drury, esq. Captain F. M. Keith, Mr. George Arnoldi.

By Order,

CHARLES TAYLOR, Secretary.

XX. *An Attempt towards a Theory of the Resistance experienced by two and four-wheeled Carriages on different Kinds of Roads; and to determine the Circumstances under which the one are preferable to the other.* By NICHOLAS FUSS, *Professor of the higher Mathematics at Petersburgh, Member of the Imperial Academy of Sciences, &c.**

THE following paper was written in answer to a question proposed as the subject of a prize for the year 1797 by the Royal Academy of Sciences at Copenhagen, and obtained the first prize. To avoid confusion or mistake, we have adopted the author's notation, and have adhered as closely to the original as the nature of the subject would admit.—E.

Section 1.

The question, which I first saw in the 113th number of the Göttingen *Gelehrten Anzeigen* for the year 1796, was in the following words:—*Ex principiis mechanicis exponere rationem potentiæ motricis ad onera, tum plaustris quatuor rotarum, tum carris, qui sunt binarum rotarum, promovenda; ita quidem, ut ad impedimenta motus, frictionem scilicet, ac reliqua quæ in viis occurrere solent, obstacula à vi motrice superanda simul respiciatur. Quo in universum pateat, num et quando hoc illudve genus vehiculi commode et prudenter adhiberi possit.* That is: "To determine, from mechanical principles, the ratio of the moving power to the burthen both in four-wheeled and two-wheeled carriages, taking into account at the same time the impediments to motion, that is to say, friction, and the other obstacles to be overcome by the moving power which commonly occur in roads, that it may in general appear on what occasions either of these carriages can be employed with most advantage."

The general utility of this question induced me, last summer, to employ the leisure I then enjoyed in the country, in consequence of two months relaxation from my usual occupations, in examining it, with a view of submitting my labour to the inspection of the enlightened society who proposed it; and I shall be happy if the learned and celebrated men to whom the society have entrusted the power of adjudging the prize, should find in the following researches any thing to indemnify them for their trouble.

* From *Versuche einer Theorie des Widerstandes zweyund vierrädriger Fuhrwerke, auf Fahrwegen jeder art, &c.* Von Nicolaus Fuss, &c. Copenhagen 1798.

Section 2.

The roads and ways on which loaded carriages are drawn from one place to another by horses, oxen, and other animals, are so different in their nature, and the impediments which the moving power has to overcome are so numerous, that, on the first view, it appears very difficult to find general formulæ to indicate the resistance for every given kind of road, carriage and loading, and to determine the circumstances under which the one kind of carriage is to be preferred to the other. However, when we separate from constant impediments the action of which is nearly uniform, and which, properly speaking, characterize the nature of the way, but without excluding them from our research, those which occur on every road, but only occasionally, and which, consequently, can be overcome by a momentary exertion of the moving power, among which may be included single eminences and hollows, such as ridges, stones, channels, holes, pavements, bridges, &c.; all the different kinds of roads may be reduced to the three following classes:

1st, Solid and smooth, to which belong all level as well as inclined roads, crooked and straight; also hollow roads, with solid, broad, smooth ruts: in a word, all roads the surface of which is neither rugged nor yields to the impression of the wheels.

2d, Solid and uneven, which do not suffer the wheels to sink into them, but which, by their inequality, present a pretty uniform resistance. In this class are comprehended rough rugged roads, interspersed with ridges of rock, paved roads, and roads in which parts are covered with timber and the trunks of trees.

3d, Soft smooth roads which yield to the impression of the wheels, such as marshy or clayey roads, or roads covered with soft earth, sand, flints, or small stones.

Section 3.

As all roads, either in whole or in part, are comprehended in one of the above classes, I shall examine them according to these principal divisions, and determine for each in particular the resistance experienced by four as well as by two-wheeled carriages, and point out the conditions under which the one kind of carriage is to be preferred to the other for each kind of road. It appears, however, that a distinction ought to be made in regard to each of these three classes; that is to say, whether the road be horizontal or inclined, smooth or covered with small eminences, new or worn into circular inequalities. But, as level as well as inclined roads covered with ſmall eminences and interſected with circular depreſſions, as far as the comparative maximum of reſiſtance is concerned, belong to inclined roads, and may be conſidered as ſuch with an increaſed degree of inclination, the angle of inclination may be taken into the calculation without much difficulty; conſequently theſe properties require no particular diviſion.

Section 4.

But, though this natural diviſion of all the different kinds of roads into three principal claſſes will facilitate a compariſon between two-wheeled and four-wheeled carriages in regard to the reſiſtance which they oppoſe to the moving power on each kind of road propoſed, which is properly the object of this reſearch; it, on the other hand, appears difficult to give a ſatisfactory anſwer to the firſt part of the queſtion, and to deduce, from mechanical principles, the ratio of the moving power to the reſiſtance. The latter, indeed, can be determined *à priori* from ſtatical principles; but this is not the caſe with the former, which, on account of the endleſs difference in the ſtrength of animals, and the various modifications of this ſtrength on different roads, can be determined only by experiments, and even then the reſult will be merely an approximation.

Section 5.

In the following determinations, however, that I may be able in ſome meaſure to compare each kind of reſiſtance with the moving power, I ſhall premiſe the following principles:

1ſt, That the weight M, equal to one pound, (Plate II. fig. 1.) freely ſuſpended from a rope paſſing over the fixed pulley C, is the heavieſt that an animal ſtanding on the level plain AB can draw or ſuſtain during the period of *t* hours.

2d, That G is the greateſt velocity with which the above animal, without bearing any burthen or drawing any thing after it, can travel for the period of *t* hours along a road of any given nature; ſo that, in regard to this animal, the velocity G will be ſometimes greater and ſometimes leſs, according to the nature of the road.

Now, if M and G, in regard to the animal which we ſuppoſe to be employed, and in regard to the road on which the burthen is to be carried, be known by experiments, we ſhall have a determinate meaſure of the moving power, as we know that the propoſed animal can draw on the propoſed road during the period of *t* hours, with the velocity *g*, a freely suspended weight of M $\left(1 - \frac{g}{G}\right)^2$ pounds. This well known formula, however, is only empirical; but it agrees so far with experience as to answer all the purposes of practice.

Section 6.

Now if the resistance which, in regard to four-wheeled carriages we shall express by R, and for two-wheeled carriages by R′, has been found for both these kinds, we shall have,

$$M\left(1 - \frac{g}{G}\right)^2 = R; \text{ and } M\left(1 - \frac{g'}{G}\right)^2 = R';$$

from which we deduce the velocity with which each of these kinds of carriages is moved, namely,

For the four-wheeled $g = G\left(1 - \sqrt{\frac{R}{M}}\right)$;

For the two-wheeled $g' = G\left(1 - \sqrt{\frac{R'}{M}}\right)$.

Having thus established the means for estimating the moving power, I shall now proceed to determine the resistance itself in regard to the different kinds of carriages.

I. DIVISION.

Of the Resistance on solid and smooth Roads.

I. *Four-wheeled Carriages.*

Section 7.

If the road AB (fig. 2.), the inclination of which is the angle ABC $= \alpha$, be perfectly solid and smooth, the resistance to be overcome by the moving power OV will consist of two parts. The first arises from the friction of the wheels against the axle-tree. If the whole burthen resting on the fore and hind axle-trees be $= P$, that supported by each will be $\frac{1}{2}P$; consequently, when the vertical lines OQ and OF, proceeding from O the centre of the axis, the former of which intersects the circumference of the axis in D, and the latter in E, are drawn in the perpendicular direction BA, the pressure on the nave of the wheel in D is $= \frac{1}{2}P$, and in E $= \frac{1}{2}P \cos. \alpha$; consequently, the friction, which acts in the direction EA $= \frac{1}{2}\lambda P \cos. \alpha$, where, as is well known, λ represents a fraction, the quantity of which depends on the matter of the axle-tree and the nave, and on the substance with which they are besmeared. Now for the fore-wheels let OE $= m.$OF, and for the hind-wheels OE $= n.$OF. The resistance in in the direction FA is for the former $= \frac{1}{2} m \lambda P$ cos. α, and for the latter $= \frac{1}{2} n \lambda P$ cos. α. Hence the whole first part of the resistance arising from the friction of the axle-tree will be $= \frac{1}{2} (m + n) \lambda P$ cos. α.

Section 8.

The second part of the resistance arises from the power of gravity acting in the direction OQ. If the weight of the two fore-wheels be p, and that of the hind-wheels p', the power in the direction OQ is for the fore-wheels $\frac{1}{2} P + p$, and for the hind-wheels $\frac{1}{2} P + p'$; but, in the direction OP, directly opposite to the power OV, it is for the former $(\frac{1}{2} P + p)$ sin. α, and for the latter $\frac{1}{2} P + p')$ sin. α. Consequently, the second part of the resistance $= (P + p + p')$ sin. α.

Section 9.

The power OV $= M \left(1 - \frac{g}{G}\right)^2$, therefore, on roads of this class, and in regard to four-wheeled carriages, has to overcome a resistance which is compounded of both these parts, section 7 and section 8:

$$R = \frac{1}{2} (m + n) \lambda P \text{ cos. } \alpha + (P + p + p') \text{ sin. } \alpha.$$

II. *Two wheeled Carriages.*

Section 10.

In regard to these carriages OE (fig. 3.) $= \mu$.OF, and if the weight of the two wheels be $= \pi$, it will be found in the same manner as before, section 7. and section 8. that the resistance from the friction of the axle-tree is $= \mu \lambda P$ cos. α, and that from the power of gravity $= (P + \pi)$ sin. α.

Section 11.

But in this case, a third part is to be taken into consideration. When we assume the centre of gravity of the load P in the point S of the line FO continued, and draw through S the vertical line SH, as a weight P presses on the supporting lever IH in the point H, the horse at I must employ a power IK, which shall counteract that power SH = P. This power IK $= \frac{P.OH}{OI}$. Now if OH = OS tang. $\alpha = \varepsilon$.OI, the power, according to the direction IK, will be $= \varepsilon P$; and hence there arises in the direction IL a power εP sin. α.

Section 12.

Consequently, the power OV $= M \left(1 - \frac{g'}{G}\right)^2$ on roads

 of

of this class, and in regard to two-wheeled carriages, has to overcome a resistance compounded of these three parts:

$$R' = \mu \lambda P \cos. \alpha + (P + \varepsilon + \pi) \sin. \alpha.$$

III. *Comparison between these two Kinds of Carriages.*

If $\alpha = 0$, then is $R = \frac{1}{2}(m + n) \lambda P$, and $R' = \mu \lambda P$; consequently, $R < R'$ when $m + n < 2\mu$. That is: on solid, smooth, horizontal roads, four-wheeled carriages are better than two-wheeled when the axles and wheels are so constructed that the sum of the exponents of the ratio of their diameters in the former, is less than double the exponent of the ratio of the diameters of the axles and wheels in the latter.

Section 14.

If $p + p' = \varepsilon P + \pi$, then will $R < R'$, when $\mu + n < 2\mu$. That is: on solid, smooth, inclined roads, four-wheeled carriages are to be preferred to two-wheeled carriages under the above conditions, provided also that the weight of the fore and hind wheels in the former is equal to the sum of the weight of the wheels and of the overweight * in the latter.

Section 15.

If $m + n = 2\mu$, then is $R < R'$, when $p + p' < \varepsilon P + \pi$, That is: on solid, smooth, inclined roads, four-wheeled carriages are preferable to two-wheeled carriages when the ratio of the diameters of the axles and wheels is such that the sum of the exponents in the former is equal to double the exponents in the latter, and provided also that the weight of the wheels of the four-wheeled carriage is less than the weight of the wheels and the overweight in the two wheeled carriages.

Section 16.

From the comparison, in general it results, that for this kind of roads four-wheeled carriages ought to be preferred to two-wheeled carriages.

1st, When in regard to the proportion between the wheels and the axle-trees,

$$\frac{m + n - 2\mu}{2} < \frac{(\varepsilon P + \pi - p - p') \text{ tang. } \alpha}{\lambda P}.$$

2d, When in regard to the weight of the wheels,

$$p + p' - \pi < \varepsilon P - \frac{(m + n\ 2\mu) \frac{1}{2} \lambda P}{\text{tang. } \alpha}.$$

3d, When in regard to the weight of the load,

$$P > \frac{(p + p' - \pi) \text{ tang. } \alpha}{\varepsilon \text{ tang. } \alpha - \frac{1}{2} \lambda (m + n - 2\mu)}.$$

* That which arises from the centre of gravity being thrown behind the axle. See section 11, and also fig. 3.

4th,

4th, When in regard to the height of the load or of the centre of gravity,

$$\varepsilon > \frac{(p + p' - \pi) \text{ tang. } \alpha + \frac{1}{2} \lambda P (m + n - 2\mu)}{P \text{ tang } \alpha}.$$

5th, When in regard to the fteepnefs of the road,

$$\text{tang. } \alpha > \frac{\frac{1}{2} \lambda P (m + n - 2\mu)}{\varepsilon P + \pi - p - p'}.$$

IV. *Application to fome determinate Cafes.*

A few examples in numbers will illuftrate the ufe of the expreffions found both for R and R′, and alfo the comparifon of them with the moving power.

Example I.
Section 17.

Let us fuppofe that the road goes up a hill at an angle $\alpha = 10°$. Let the mean diameter of the axles of the four-wheeled carriages be 3′ inches, that of the fore-wheels 28 inches, that of the hind-wheels 42 inches; fo that $m = \frac{1}{8}$, and $n = \frac{1}{12}$. Let the weight of the fore-wheels be $p =$ 80 lib., that of the hind-wheels $p' = 110$ lib. Alfo, let the mean diameter of the axles of the two-wheeled carriages be $4\frac{1}{3}$ inches, the diameter of the wheels 39 inches; fo that $\mu = \frac{1}{9}$, and the weight of the wheels $\pi = 110$ lib. Let the load of both carriages $P = 2400$ lib., and the coefficient of the friction $\lambda = \frac{1}{5}$. In the laft place, we fhall fuppofe the height of the centre of gravity OS = 4 feet, and OI = 12 feet; fo that OH = 0·7053, confequently $\varepsilon = 0{\cdot}0588$. Hence we have,

$$\begin{aligned} \tfrac{1}{2} (m + n) \lambda P \cos. \alpha &= 49{\cdot}240 \\ (P + p + p') \text{ fin. } \alpha &= 449{\cdot}750 \\ \hline R &= 498{\cdot}990 \end{aligned}$$

$$\begin{aligned} \mu \lambda P \cdot \cos. \alpha &= 52{\cdot}523 \\ (P + \varepsilon P + \pi) \text{ fin. } \alpha &= 460{\cdot}352 \\ \hline R' &= 512{\cdot}875 \end{aligned}$$

In this cafe, then, R < R′, about 13·885 lib.

In regard to the moving power it may be admitted that a good draught horfe can draw, for three hours, in the manner above defcribed, fection 5, a burthen of 400 lib.; and that the fame horfe, unloaded, can travel three hours on the road fuppofed in this example with a velocity of 12 feet per fecond: for two fuch horfes, then, we fhall fuppofe M =

800 lib., and G = 12 feet. From these values, and R and R′ already found, we therefore have by section 6 the velocities g = 2·520, and g' = 2·392 feet in a second; so that these two horses on the given road could draw the load P = 2400 lib., at the rate of 9072 feet in an hour with a four-wheeled carriage, but with a two-wheeled carriage only 8611 feet per hour.

EXAMPLE II.

Section 18.

Let us assume, as before, $m = \frac{1}{8}$, $n = \frac{1}{17}$, $p = 80$, $p = 110$ and $\lambda = \frac{1}{7}$. Let the load in this case be only P = 1400 lib., and the inclination of the road $\alpha = 6°$. Let the weight of the wheels of the two-wheeled carriage be π = 130 lib., their diameter 48 inches, and the mean diameter of the axles 4 inches; so that $\mu = \frac{1}{12}$. In the last place, let the height of the centre of gravity OS = 2 feet; so that OH = OS tang. α = 0·2102, and consequently ε = 0·01752. Hence we shall have

$$\tfrac{1}{2}(m+n)\lambda P \cos.\alpha = 29{\cdot}007$$
$$(P + p + p')\ \text{fin.}\ \alpha = 166{\cdot}200$$
$$R = 195{\cdot}207\ .$$
$$\mu\lambda P \cos.\alpha = 23{\cdot}205$$
$$(P + \varepsilon P + \pi)\ \text{fin.}\ \alpha = 162{\cdot}492$$
$$R'\ 185{\cdot}697$$

In this case, therefore, R > R′, about 9·510 lib. For a horse, then, the strength of which is M = 400 lib., and the velocity on the above road G = 14 feet per second, we shall have g = 4·228 feet, and g' = 4·466 feet. Consequently, the load P = 1400 lib. would be drawn by such a horse on a four-wheeled carriage 15,220 feet per hour, and on a two-wheeled carriage only 857 feet further.

[To be continued.]

XXI. *On Painting.* *By Mr.* E. Dayes, *Painter.*

To Mr. Tilloch.

DEAR SIR,

THE following essays on Taste, Beauty, Grace, Invention, and Composition, being immediately connected with painting, I have done myself the pleasure of sending them for insertion in your valuable Magazine. I shall be obliged by by your numbering the essays, supposing that on the Composition of Landscape *, inserted in your eighth volume, to be No. 1. I do not mean to say in point of order it should be so, but the inclosed form a regular series as far as they go. I shall offer no apology for the frequent quotations introduced; my reason for so doing being not only to strengthen the argument, but also to relieve the reader.

I remain, dear Sir,
your humble servant,
EDWARD DAYES.

Francis-street, Bedford-square,
July 5, 1802.

ESSAY II.

On Taste.

'Tis taste, 'tis genius, 'tis heav'nly ray,
Prometheus ravish'd from the car of day,
MASON'S FRESNOY.

TASTE in the arts must be considered as that faculty or those faculties of the mind by which we are affected with, and form a right judgment in, works of the imagination. It is that which determines the painter in his choice, and from that choice we judge whether his taste be good or the contrary. Whether this faculty of the mind is to be acquired is doubtful; that it may be improved is unquestionable; hence it becomes our duty to avoid, particularly in our first outset, if possible, the seeing, much less the copying, things deformed and chimerical, as there is an acquired as well as a natural dulness. He whose taste is delicately just may be said to have received the highest polish from nature, and one of her choicest gifts; on the contrary, to want it, is to be dead to all the finer feelings. The man who possesses a justly cultivated taste is let into a thousand pleasures unknown to the vulgar,

——————His the city's pomp,
The rural honours his. Whate'er adorns
The princely dome, the column and the arch,
The breathing marbles and the sculptured gold,
Beyond the proud possessor's narrow claim,
His tuneful breast enjoys. AKENSIDE.

On the contrary, there are some men born with feelings so blunt

* From the favourable reception the essay here alluded to experienced, having been translated into several of the most respectable of the foreign journals, we have no hesitation in promising, that the lovers of the fine arts in general, and practical artists in particular, will derive much instruction and information from the essays with which Mr. Dayes has now favoured us. On the fine arts we have had too many publications from mere amateurs, and hardly any from professional men. From the latter, a single practical fact, delivered in a few lines, must always be of more intrinsic value than whole volumes from the former.—EDIT.

blunt and cold that they can hardly be ſaid to be awake during life. From a degree of exquiſite ſenſibility ariſe our notions of beauty and deformity in the natural as well as the moral world, and as our different minds happen to be more or leſs exquiſite, the more or leſs ſenſibly do we perceive the various degrees of good and bad, and of courſe are more or leſs capable of being charmed with the right and beautiful, and diſguſted with the wrong and deformed. Hence it is that this ſenſibility conſtitutes what is termed genius, which is only the power or capacity of clearly conceiving and properly combining images, and of adding to mere theory practice: to which a ſound head and a good heart is as neceſſary as a delicate imagination; for we cannot poſſeſs true genius without as exquiſite a feeling for moral beauty as for what is great and beautiful in nature or maſterly in poetry, painting, ſculpture, and muſic.

The reverſe of true taſte is ſhown in magnificence, parade, and luxury; and in whatever is horribly glaring, extravagant, and unnatural in the laſt degree. Gold, ſhowy colours, gaudy tapeſtry, the heavy, clumſy, and whatever is ſuperfluous, will ever paſs with the vulgar for elegance and greatneſs. So perſons of a bad taſte will prefer the forced, unnatural, and exaggerated, in expreſſion, attitude, or colour, to the truly ſimple, noble, or beautiful. We ſhould be guilty of an error were we to attempt to eſtabliſh one principle of taſte only, for were we to eſtabliſh one as right, all the others muſt be wrong; hence the miſtake of Sir Joſhua Reynolds, in ſpeaking of the Hercules, Gladiator, and Apollo; for, though each of thoſe figures are perfect of their kind, yet Sir Joſhua affirms that the higheſt perfection of the human figure is not to be found in any one of them, "but in that form which is taken from them all, and which partakes equally of the activity of the Gladiator, of the delicacy of the Apollo, and of the muſcular ſtrength of the Hercules." Such an opinion is contrary to nature, as it goes to deſtroy that variety ariſing from the active, the delicate, and the ſtrong: as well might we ſuppoſe a fine tree from conſolidating the various forms found in nature.

We muſt carefully diſtinguiſh between truth and taſte; for a thing may be true, and not poſſeſs one atom of taſte. The Dutch and Flemiſh pictures are true, as far as mere imitation goes; but will any one ſay, the wretches one ſees in ſome of Rembrant's works are taſty, or can the women of Rubens be conſidered as ſuch; yet thoſe men poſſeſſed great taſte in colour, *chiaro-ſcuro*, &c. We ſhould be careful of miſtaking tinſel for gold; many who repreſent kings, do it by a great

diſplay

difplay of ornaments, elfe make them ftrut and ftare, or have recourfe to a crown; where the greateft profufion of ornaments are admiffible, we fhould be fparing in their ufe, for fear of making that fine we cannot make good. Tafte and genius have been called infpiration, the gift of heaven, and our feelings have been irritated by mere words, that have alarmed and benumbed our faculties; but let us attend to the progrefs of our own minds, and we fhall find that our tafte has improved in proportion to our induftry to acquire knowledge. The old mafters have, in their turn, been held up as bugbears to frighten young artifts; the Italian writers on the arts have on all occafions ufed the words *heavenly* and *divine*, till they have operated as fcarecrows, to create a terror in modern painters, many of whom have ceafed to labour as competitors. We fhould never fuppofe the moft fublime degree of perfection has been attained; the fact is, the moft perfect works are not without their imperfections, and, while that is the cafe, there is room to improve it. M. Angelo is charged with heavinefs; Raphael as being dry, and poffeffing a poor *chiaro-fcuro*; Titian, as defective in drawing; and Parmegiano as making his figures too tall: but, while thofe confiderations act as a fpur to our induftry, we are bound to venerate them for the great catalogue of perfections they have made us heirs to. It is from thefe they have obtained their renown, the imperfections being only foils. We fhould never forget the obligations we are under to thofe who have, by directing our ftudies, introduced us to the arts; to our parents we owe our being, but to our teachers we owe the power of making a right ufe of it, a matter of no fmall confequence.

Tafte is not an imaginary fomething, depending on the accident of birth, but arifes from, and is immediately connected with, a found judgment. Were there not in art, as in every thing elfe, a ftandard of right and wrong, all opinion muft be capricious; but to acquire juft notions we muft habituate ourfelves to compare and digeft our thoughts, be well read in human nature as connected with the characters, manners, paffions, and affections of man; this, with fome knowledge of the human mind, will, in time, enable us to diftinguifh right from wrong, which conftitutes the true principles of tafte. We muft diftinguifh real from apparent truth in our purfuit. Real truth does not depend on opinion, it is immutable, fixed, and permanent, and in it muft be fought whatever is grand and beautiful. Apparent truth depends on fafhion, and, like it, is fluctuating and uncertain; it may be confidered as a fort of impoftor, for, though it carries with

it

it the appearance of ſcience, yet is far from having any true connection with it. Such is the conſtrained air and erect attitude taught in dancing, the violent actions uſed in theatres, and many others not countenanced by nature, but depending wholly on cuſtom for ſupport. The artiſt muſt tread in the ſimple path of nature, and leave thoſe adventitious and forced airs to the perſons to whom they belong, the dancing maſter, hair-dreſſer, &c. Unfortunately there is a faſhion in art, and which the vulgar would attempt to force upon us. Whatever is ſlight, crude, or undetermined, is all the rage, and the artiſts appear to be falling into a habit of painting without form: that deciſion obſervable in the old maſters, and which is inſeparable from the grand ſtyle, is almoſt neglected. To paint for what is termed effect may anſwer the purpoſe of the idle, the ignorant, and thoſe who make a trade of the art, but ſuch a practice will not ſatisfy the diſcerning. The only apology the artiſt can offer is, that he muſt fiſh with ſuch baits as will take: unfortunately, he does not live to paint, but paints to live. The Greeks had a great advantage over the moderns in having philoſophers to judge of their works, and ſtates to reward them.

We muſt not reject works of art becauſe they do not poſſeſs the firſt degree of taſte; for they may be taſty though not ranking in the firſt claſs; juſt as we ſay a thing is ſweet, though it is only in a certain degree ſo. It is the condition of man to labour much to obtain little; this ſhould make us cautious of pronouncing haſtily on works of art: none are unexceptionable, and perhaps there are but few from which we may not derive ſome benefit.

Of the various degrees of taſte, the grand conſiſts in the choice of objects ſuperior to the common (not only in man but in nature), and in the omiſſion of the ſubordinate and trivial parts. Beautiful taſte ſelects the beautiful for imitation. An union of the grand and beautiful will form the beſt and moſt perfect taſte. Meanneſs of taſte expreſſes diſtinctly all the trivial and little parts of objects, hence the whole becomes little. The debaſed or corrupt, delights in things monſtrous, deformed, and ugly: it may be called the *groteſque*, and the praiſe beſtowed on it ſhould be as limited as the views of the artiſt. Thoſe who have ſucceeded moſt in this way, have been praiſed by the ignorant in proportion to the *uglineſs* of the objects introduced in their works. Great and noble ſpirits will ever admire the ſublime parts of creation, while the rural and all the more humble beauties will beſt aſſociate with the domeſtic virtues.

Little

Little minds will ever be employed in the purſuit of trifles, while the elevated ſoul will ſeize mountains in its graſp:

> Who that from Alpine heights his lab'ring eye
> Shoots round the wide horizon to ſurvey
> Nilus or Ganges rolling his bright wave
> Through mountains, plains, through empires black with ſhade,
> And continents of ſand, will turn his gaze
> To mark the windings of a ſcanty rill
> That murmurs at his feet? AKENSIDE.

Wiſdom is the parent of taſte and virtue, the offspring of taſte is pleaſure—of virtue, happineſs. A man without taſte may be ſaid to be without piety, as by not feeling he is incapable of offering that praiſe which reſults from an admiration of the beauties of creation; he has a natural diſreliſh for what is good; he becomes the enemy of all the world; he feels not for a relative, a friend, or ſociety: the law of the land is his goſpel, and his attorney regulates his conſcience; he lives without love, and dies without pity.

We have two ways open to us to acquire a good taſte; the firſt and moſt difficult is by a reference to nature, the ſecond is through the medium of art. But, as the former would prove too difficult a taſk, we muſt therefore firſt diligently apply ourſelves to diſcover it in the works of the moſt celebrated artiſts, and thereby fit ourſelves to purſue the ſame inquiry in nature.

Beſides a perfection of judgment, we have alſo a truth of hand to attain. To this end, having ſelected an object worthy our attention, we are bound to imitate it with all the fidelity we are maſters of; and, as each maſter has in him excellencies not to be found in any other, we muſt avoid a partiality, or we ſhall loſe the benefit to be derived from them all. Thus we ſhall obtain a maſs of information not to be derived from any particular one. Hence the benefit reſulting from viewing galleries of pictures, as the various maſters become correctives to each other, and truth reſults from their general teſtimony. The company and converſation of men *well informed in the arts* will contribute to improve our taſte, becauſe artiſts form opinions on the works of different maſters according to their peculiar manner of thinking, which will naturally furniſh us with hints which we did not attend to, and enable us to enjoy other men's parts and reflections as well as our own. Information from this ſource muſt not, however, be generally expected; the artiſts are not all *wiſe* or *liberal*; many produce an effect without knowing the cauſe, ſome are moroſe and reſerved, others unwilling to teach

teach another what they have with difficulty learned, and *ſome few* will be found eaſy and communicative.

When we have made ourſelves acquainted with the beauties of art, we may conſider ourſelves at liberty to act on our own foundation; but we are bound to ſhow in our works that we act from an impreſſion made on our minds by nature, or we ſhall never excite ſimilar ſenſations in the ſpectator, but ultimately ſink into mere manneriſts or imitators. A general likeneſs prevailing through the whole of his works muſt ſtamp the artiſt a manneriſt; we mean not, however, ſuch a ſimilitude as may happen by chance. The adoption of a grace or an ornament, by no means implies plagiariſm. If they are introduced with fitneſs, there can be no charge of want of judgment. This is very different to uſing a viſible or ſtriking part of a compoſition, which no independent ſpirit would ſtoop to. Repreſentations of antient urns, armour, coſtumes, buildings, &c., will be of more value to the genuine artiſt than even the fineſt hiſtorical or other compoſition. A knowledge of the latter he ought to poſſeſs before he attempts to compoſe, and the utility of urns, armour, &c., will be obvious. Falling into imitation has produced what has been termed the *ſchools*, and ultimately proved their ruin; Nature ſufficiently revenges herſelf on thoſe who neglect her.

In the arts, as in every branch of ſtudy, the firſt thing we have to learn is what others have done, or, in other words, the preſent ſtate of human knowledge. Without this neceſſary information we ſhall ſtand as children only, and of courſe our improvement will be but ſlow; beſides, we ſhall have the mortification of finding our imaginary diſcoveries anticipated, and our labour fruitleſs. Another advantage will reſult from ſuch an inquiry, the learning how much experience is within the reach of diligence.

Imitation is the firſt part of painting, the ſecond is a judicious ſelection; but even in the imitative part we muſt cautiouſly ſhun objects deformed and baſe if we hope to poſſeſs the firſt taſte, and only copy ſuch as will teach us greatneſs, beauty, or accuracy. Such a conduct will enable us to reflect with wiſdom, and alſo to diſcover the cauſe, or from whence ariſe thoſe perfections by which we are moved. If in the courſe of our inquiry we find a perfection prevail through the whole of an artiſt's works ſo as to become a character, we may depend on it that was the kind of perfection ſought by the maſter; as in M. Angelo, greatneſs of ſtyle, knowledge of the figure, and foreſhortening; in Ra-

phael,

phael, expression, composition, and fine drapery; in Titian, colouring; in Parmegiano, grace; in Rubens, fine *chiaro-scuro*, &c. Among the British artists we may consult Reynolds for grace, colour, and a fine *chiaro-scuro*; and in landscape, the great Wilson, Gainsborough, and Barret, and the works of many justly celebrated living artists. Much will depend on industry; if we see a grace or beauty in a master we must endeavour to make it our own, not merely by copying it, but by investigating its cause, in which we shall be helped by imitation. If a composition strikes, a sketch of the whole may be made: so of the general disposition of the colouring; for, after a certain facility of hand is obtained, we must depend on our own exertions; therefore laboriously copying great compositions would be only loss of time. Studies from particular parts may be made, such as are remarkable for some peculiar excellence; for, unfortunately, the best works have much of common-place matter in them. From what has been observed it will be evident we must, in the first instance, either go to, or suffer ourselves to be guided to those works of art time has stamped a value on, as it is easier to learn from that in which the choice is already made, remembering till we can go alone we must depend on the opinions of others. But the ultimate end of our inquiry must be *that independence resulting from acting on an original principle*, or seeking those perfections in nature with which art abounds, or, in other words, giving those energies to the soul that leave it to act free of all restraint.

XXII. *On Basaltes* *.

THAT the Giants' Causeway, situate near the northern extremity of the county of Antrim, is one of the greatest natural curiosities, not only in Ireland, but on the surface of this globe, has long been acknowledged. It will therefore, I doubt not, gratify your readers to communicate to them some curious remarks on the different opinions of naturalists concerning the formation of the Giants' Causeway, with which the writer of this letter has been favoured by a gentleman of distinguished learning and abilities, who has long made this wonderful production of nature the object of his diligent investigation, and has discovered properties in it which had escaped former observers, not excepting the late ingenious Dr. William Hamilton, whose "Letters concern-

* From the Belfast News-letter.

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ing the Northern Coast of the County of Antrim," 1790, have so much merit, as must greatly aggravate our concern for his untimely fate *.

It will also, no doubt, afford great pleasure, both to philosophers and men of taste, to learn that a very exact delineation of this great natural curiosity, painted in a capital style, has been finished by Mr. Thomas Robinson, now in Belfast, whose fine picture of the battle of Ballynahinch, at present in possession of the marquis of Hertford, was so much admired. In this picture of the Giants' Causeway, Mr. Robinson has not only done justice to its picturesque and stupendous forms, but has paid particular attention to some striking peculiarities in its structure, deserving the notice of men of science.

To the following remarks I shall prefix extracts from the account or description given by Dr. Hamilton in his Letters, part ii. p. 26:

"The Giants' Causeway is generally described as a mole or quay, projecting from the base of a steep promontory some hundred feet into the sea, and is formed of perpendicular pillars of basaltes, which stand in contact with each other, exhibiting a sort of polygon pavement, somewhat resembling the appearance of a solid honeycomb. The pillars are irregular prisms of various denominations, from three to eight sides †; but the hexagonal columns are as numerous as all the others put together.

"On a minute inspection, every pillar is found to be separable into several joints, whose articulation is neat and compact beyond expression, the convex termination of one joint always meeting a concave socket in the next; besides which, the angles of one frequently shoot over those of the other, so that they are completely locked together, and can never be separated without a fracture of these parts.

"The sides of each column are unequal among themselves, but the contiguous sides of adjoining columns are always of equal dimensions, so as to touch in all their parts.

"But it is not here that our admiration should cease: whatever the process was by which Nature produced that beautiful and curious arrangement of pillars so conspicuous about the Giants' Causeway, the cause, far from being limited to that spot alone, appears to have extended itself through a large tract of country in every direction; insomuch that many

* He was murdered by a mob of assassins in 1797, with circumstances of uncommon cruelty.

† Since Dr. Hamilton wrote, a few columns have been found of even nine sides.

of

of the common quarries, for several miles around, seem to be only abortive attempts towards the production of a Giants' Causeway *."

I shall now subjoin the promised remarks, which are so original and satisfactory, that every judicious reader will join with the writer of this letter, in hoping that they will be resumed and given to the public in a more extended form; and let me add that the testimony, of so accurate a judge, of the correctness of Mr. Robinson's delineation, will raise it high in the opinion of persons of science †. A. B.

Remarks on the Accounts given by Naturalists of the Giants' Causeway.

The basaltic pillars which in the last thirty years have been discovered in various parts of France and Germany, and the Hebrides, have excited much attention, and occasioned many controversies among modern naturalists.

The Giants' Causeway was the first assemblage of such pillars that attracted notice, and is still admitted by all to be the neatest and most perfect group hitherto discovered; but in point of magnificence, the particular spot called the Giants' Causeway is inferior to many others on the same coast. Mr. Pennant probably knew of no other columns in the north of Ireland when he pronounced, that "basalt pillars in Staffa far exceed the Irish in grandeur." He was little aware that our basaltic country, and especially our coast, exhibits many miles of vast perpendicular precipices, lined with basalt columns, in parallel ranges, with a magnificence unrivalled in any other part of the world.

The colonade at Fairhead, on the coast of Antrim, is proved, in Nicholson's Philosophical Journal for December 1801, far to exceed Staffa in grandeur; its columns being each 250 feet long; that is, near five times as long as the tallest pillars at Staffa.

Nor is our superiority confined to the grandeur alone; our towering and extensive precipices disclose to the naturalist the materials and arrangement of the strata of which this country

* Appearances of the same kind have occurred forty miles distant, near Dromore, in a quarry in the bishop's demesne land, which is beyond the limits marked in Dr. Hamilton's map of the basalt country annexed to his letters. The country people here and in the north of England, and even naturalists in Scotland, use the term *whin-stone* as synonymous to basalt. Porphyry, I presume, is only another name for it.

† This picture is to be disposed of by raffle to one hundred subscribers at one guinea each, of which near ninety have given their names. Mr. Robinson is a native of Windermere in Westmoreland, and was a pupil of Romney's. Of the poetical talents of him and his infant son, see the Gentleman's Magazine for February last, p. 156.

is composed, displaying a variety of the basalt, of different forms and of a different principle of construction, internal and external; such as is not met with or not noticed in any other part of the world.

As we row along the base of these stupendous *façades*, we enjoy a scenery magnificent beyond description, and discover many curious circumstances which have hitherto escaped the notice of naturalists: I will mention one.

The Giants' Causeway, compared by Dr. Hamilton to a mole or quay, and supposed by Messrs. Desmarest and Raspe to be a jet or current of lava running into the sea from the base of a volcanic hill, now appears to be a part of one of the original strata of our globe, placed at its intersection with the plane of the sea. This stratum is forty-four feet thick, and entirely composed of basalt pillars of that length: it is inclined to the horizon in a small angle, and, when traced from the causeway eastward, ascends obliquely along the face of the precipice. It culminates at the distance of about a mile from the causeway: its upper surface is now elevated near 250 feet above the surface of the sea: proceeding eastward, it dips and finally emerges at Portmoon, two miles east from the causeway, forming at its immersion the vases of two beautiful conical islands.

Magnificent as the colonades may be supposed, which this stratum displays in so extensive a course across the face of these mighty precipices, they are by no means our finest; the stratum next but one above this is eleven feet thicker, and of course the pillars, of which it also is entirely composed, are fifty-five feet each, and its extent is somewhat greater than the former. The intermediate stratum is composed of another variety of basalt, prismatic, but not columnar: this is fifty-four feet thick.

The Giants' Causeway stratum, where it attains its greatest height, is the eighth, counting from the sea; all the lower ones emerge in succession as we approach Portmoon; and, where this stratum finally emerges, it has eight over it, four of them columnar, the pillars being of very different lengths, determined by the thickness of the stratum. But in each separate stratum the diameters of the pillars, and the perfection or imperfection of their construction, appear pretty much the same, while the whole mass of the strata are steadily parallel to each other.

When I last summer found at the Giants' Causeway an ingenious and rising artist, Mr. Robinson, whom I knew to be highly favoured by my friend the bishop of Dromore, employed to make a drawing of it, I at first thought I would

have

have directed him to parts of the coast, which would have afforded him subjects of greater beauty as well as novelty. But, upon reflection, I think he has made the best choice, as the name of the Giants' Causeway will probably excite an attention to the subject and the artist, which more stupendous scenery could not have procured with such as had not seen it. It remains, then, to relate a few particulars belonging to this wonderful production of nature, and to give a brief statement of the controversies to which it has given rise among modern naturalists.

The Giants' Causeway has been often compared to a honeycomb, which it certainly resembles much; but accurate observers find a very striking difference between their component prisms. The powers of the bee seem to be limited; he can construct his cell of no other figure than a regular hexagon, that is, with six sides.

Mathematicians well know that the hexagon is the only regular figure (with more sides than four), of which a number put together completely fill up space.

Yet it appears that in the Giants' Causeway, the space is completely filled without any such limitation, figures of every number of sides from three to eight (as Dr. Hamilton observes) being intermixed, yet the space is as accurately filled up as in the honeycomb, and so closely as to hold water when a hollow in the surface suffers it to collect.

The extreme regularity of the Giants' Causeway pillars has much embarrassed naturalists: some ascribe their regularity to crystallization; but the celebrated Mr. Kirwan has shown that in many particulars these prisms differ from all known crystals.

Some modern philosophers follow the opinion of a French naturalist, a M. Desmarest, who supposed the Giants' Causeway to be of volcanic origin, and that its regular prisms were formed in the currents of lava as they cooled. To this it has been strongly objected that similar figures have not been found in the currents of any known volcano.

Dr. Hamilton and M. Monnet allege that these prisms were formed in the heart of the volcano, at the bottom of its crater, and that we must wait until the mountain decays before we can discover them.

But they cannot have been formed there, as regular basalt prisms abound on the tops of mountains, and also several ranges of them are found placed alternately one over the other, forming accumulations many strata deep and most regularly disposed, which, had they been in the crater of a volcano, must have all melted into one mass; besides, these gentlemen make us wait too long for proof.

Mr. Raspe, observing that the Giants' Causeway ran into the sea, and conceiving it to be a current of lava, supposed that some unknown quality in the salt water, together with the sudden cooling, occasioned the material, of which it was composed, to assume regular forms.

But many currents of lava have been found in different parts of the world running into the sea, while prisms, like those at the Giants' Causeway, have not been observed at any of them.

An attentive examination of our coast shows the weakness of Mr. Raspe's theory, though warmly adopted by M. Dolomieu; for, although basalt pillars and colonades abound in the faces of our precipices hanging over the sea for twenty miles, yet columnar basalt comes into contact with the salt water but in three points; to wit, the two intersections of the Giants Causeway stratum mentioned above, and at Carrickarede, five miles eastward.

Dr. Hutton, adhering to the igneous system, but giving up the usual mode of producing lava by volcanic eruption, affirms that all basalt (the stone of which the Giants' Causeway is formed) is lava, first fused, and then consolidated in the bowels of the earth, whence it was elevated to its surface, and to the tops of our mountains, by the expansive force of subterranean fire.

Wild as this fashionable theory must appear, and contrary to all probability, it is also unsupported by any species of proof, and contradicted by facts in every part of this country; for, instead of the dislocation and contorsion of the strata, which, according to his theory, he says, we must expect, (Edinburgh Transactions, vol. i. p. 265,) and instead of finding them, as he says we do, "in every possible position, from horizontal becoming vertical, from continuous broken and separated in every possible direction, from a plane bent and doubled," nothing can exceed the regularity with which the strata are disposed over the whole face of this basalt country, nor does their steady parallelism seem ever to be disturbed.

Though basalt has for a long time been pretty generally considered as a volcanic production, yet more accurate modern observers have discovered many circumstances which show it never could have been in fusion; for instance,

All lavas abound with air-holes, while not a single cavity is to be found in any of our basalts, except what are mentioned below.

All lavas are accompanied by ſcoria, not a particle of which is to be found at the Giants' Cauſeway, or any where on our coaſt *.

Currents of lava are ſtated by Sir William Hamilton, Ferber, and Spalanzani, always to vary in their denſity, their materials being generally arranged according to their ſpecific gravities: thus, at the bottom compact lava, then cellular lava, then ſcoria, laſtly cinders and volcanic aſhes. Now, if baſalt be of volcanic origin, our ſtrata muſt be currents of lava, of courſe ſhould be governed by the ſame rule; inſtead of which, every baſalt ſtratum here is of uniform denſity and uniform material from top to bottom.

Marine ſhells and their impreſſions have lately been diſcovered in ſome of our baſalts †: this proves they never were in fuſion, as ſuch ſubſtances calcine and turn into lime with a very moderate heat.

Baſalt pillars have alſo been lately found with cavities filled with freſh water; a fact incompatible with igneous fuſion ‡.

Mr. Kirwan derives every thing from aqueous ſolution; and ſays, that the material of which our cauſeway is formed was ſplit into columns by deſiccation.

Eminent as this great man undoubtedly is in the chemical and mineralogical branches of natural hiſtory, yet on this ſubject his theory ſeems to be as inſufficient as thoſe of any of his predeceſſors; for his ſyſtem does not account for the delicate articulations of our pillars, by far the moſt curious circumſtance attending them, and moſt happily exhibited in different points of view in the preſent picture.

This theory, too, is incompatible with the different ranges or ſtrata of pillars placed on one another with ſolid rock between them.

But, above all, it is contradicted by fact, our pillars being

* Some travellers have thought they obſerved veſtiges of fire and ſcoria of iron; but, if they had broke the ſtones, they would have found they had been deceived by the exterior appearance, and that the internal ſtructure was incompatible with any ſuch principle. Some ſtones which have been picked up on our coaſt have been produced as exhibiting real marks of fire; but theſe had been uſed in forming hearths for the burning of kelp.

† Theſe had not been diſcovered when Dr. Hamilton's book was publiſhed.

‡ That ſuch water could not poſſibly have got through any chinks or clefts between the baſalt columns will be ſhown below; for nothing can be more compact and cloſely joined, ſo as not to admit the minuteſt interval. Indeed, this water is always found as a kind of nucleus, within the moſt compact part of the ſtone, and incloſed in a glazed covercle or gloſſy ſhell, which ſeems to have formed its nidus from the firſt formation of its ſtony bed.

in cloſe contact with each other, as appears by their ſurface holding water; whereas, had they been formed by their ſubſtance ſplitting on deſiccation, great intervals muſt have exiſted between them.

From all this it muſt appear that philoſophers have not yet diſcovered the proceſs adopted by nature in the conſtruction of this beautiful and ſtupendous work; but, though we cannot penetrate the ſecret of her operations, it is with pleaſure we admire her magnificence, eſpecially when joined to the moſt conſummate neatneſs; and where are both ſo abundantly diſplayed as at the Giants' Cauſeway and its vicinity? The toils of a journey are amply repaid by the contemplation of ſuch wonderful objects; and to thoſe who are too diſtant for ſuch an expedition, Mr. Robinſon's fine picture, finiſhed on the ſpot, and now at Belfaſt, will give a better idea of the Giants' Cauſeway, and its towering promontories, than any thing of the kind yet attempted. W. R.

XXIII. *Experiments and Obſervations on certain Stony and Metalline Subſtances which at different Times are ſaid to have fallen on the Earth; alſo on various Kinds of Native Iron.* *By* EDWARD HOWARD, *Eſq. F. R. S.*

[Continued from p. 31.]

IT remains for me to ſpeak of a ſubſtance mentioned in the *Lithophylacium Bornianum*, part i. p. 125, deſcribed thus:—"Ferrum retractorium, granulis nitentibus, matrice vireſcenti immixtis, (*Ferrum virens* Linn.,) cujus fragmenta, ab unius ad vigenti uſque librarum pondus, cortice nigro ſcoriaceo circumdata, ad Plann, prope Tabor, circuli Bechinenſis Bohemiæ, paſſim reperiuntur."

The iron thus deſcribed is moreover made remarkable by a note *, which obſerves, that credulous people aſſert it to have fallen from heaven, during a thunder ſtorm, on the 3d of July 1753.

The collection of baron Born, it is well known, has a place in the cabinet of the right hon. Charles Greville, who, from the effect produced by comparing the hiſtories and ſtructure of the Italian and Yorkſhire ſtones with the deſcription of this iron, was induced to ſearch the collection of Born, where he diſcovered the very ſubſtance aſſerted to have fallen

* Quæ (fragmenta) 3 Julii, anni 1753, inter tonitrua, e cœlo pluiſſe crẹduliores quidam aſſerunt.

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on the 3d of July 1753. How far these four substances have resemblance to each other, it will soon appear not to be my province to anticipate.

The president having done me the honour to submit his specimens of the Yorkshire and Italian stones to my examination, I became indebted to Mr. Greville and Mr. Williams for a similar distinction: and, being thus possessed of four substances, to all of which the same origin had been attributed, the necessity of describing them mineralogically did not fail to present itself. To execute this task, no one could be more eager, and certainly no one better qualified, than the count de Bournon. He has very obligingly favoured me with the following descriptions.

Mineralogical Description of the various Stones said to have fallen upon the Earth. By the Count de Bournon, F.R.S.

The stones I am about to describe are not of any regular shape; and those which were found in an entire state, that is, those which had not been broken, either by their fall or otherwise, were entirely covered with a black crust, the thickness of which was very inconsiderable.

The stones which fell at Benares are those of which the mineralogical characters are the most striking: I shall therefore begin the following description with them; and shall afterwards make use of them, as objects of comparison, in describing the others.

Stones from Benares.

These stones, as well as the others described in this paper, whatever may be their size, are covered over the whole extent of their surface with a thin crust of a deep black colour: they have not the smallest gloss; and their surface is sprinkled over with small asperities, which cause it to feel, in some measure, like shagreen, or fish-skin.

When these stones are broken, so as to show their internal appearance, they are found to be of a grayish ash colour; and of a granulated texture, very similar to that of a coarse grit-stone: they appear evidently to be composed of four different substances, which may be easily distinguished by making use of a lens.

One of these substances, which is in great abundance, appears in the form of small bodies, some of which are perfectly globular, others rather elongated or elliptical. They are of various sizes, from that of a small pin's head to that of a pea, or nearly so; some of them however, but very few, are of a larger size. The colour of these small globules is gray, ſometimes inclining very much to brown; and they are completely opaque. They may, with great eaſe, be broken in all directions: their fracture is conchoid, and ſhows a fine, ſmooth, compact grain, having a ſmall degree of luſtre, reſembling in ſome meaſure that of enamel. Their hardneſs is ſuch, that, being rubbed upon glaſs, they act upon it in a ſlight degree; this action is ſufficient to take off its poliſh, but not to cut it: they give faint ſparks when ſtruck with ſteel.

Another of theſe ſubſtances, is a martial pyrites, of an indeterminate form; its colour is a reddiſh yellow, ſlightly inclining to the colour of nickel, or to that of artificial pyrites. The texture of this ſubſtance is granulated, and not very ſtrongly connected: when powdered, it is of a black colour. This pyrites is not attractable by the magnet; and is irregularly diſtributed through the ſubſtance of the ſtone.

The third of theſe ſubſtances conſiſts in ſmall particles of iron in a perfectly metallic ſtate, ſo that they may eaſily be flattened or extended by means of a hammer. Theſe particles give to the whole maſs of the ſtone the property of being attractable by the magnet; they are, however, in leſs proportion than thoſe of pyrites juſt mentioned. When a piece of the ſtone was powdered, and the particles of iron ſeparated from it, as accurately as poſſible, by means of a magnet, they appeared to compoſe about $\frac{2}{100}$th of the whole weight of the ſtone.

The three ſubſtances juſt deſcribed are united together by means of a fourth, which is nearly of an earthy conſiſtence. For this reaſon, it is eaſy to ſeparate, with the point of a knife, or even with the nail, the little globular bodies above mentioned, or any other of the conſtituent parts of the ſtone we may wiſh to obtain. Indeed the ſtone itſelf may readily be broken merely by the action of the fingers. The colour of this fourth ſubſtance, which ſerves as a kind of cement to unite the others, is a whitiſh gray.

The black cruſt with which the ſurface of the ſtone is coated, although it is of no great thickneſs, emits bright ſparks, when ſtruck with ſteel: it may be broken by a ſtroke with a hammer, and ſeems to poſſeſs the ſame properties as the very attractable black oxide of iron. This cruſt is, however, like the ſubſtance of the ſtone, here and there mixed with ſmall particles of iron in the metallic ſtate: they may eaſily be made viſible by paſſing a file over the cruſt, as they then become evident on account of their metallic luſtre. This is more particularly the caſe with reſpect to the cruſt of thoſe ſtones which remain to be mentioned, they being much more

more rich in iron than that I have juſt deſcribed; a circumſtance I think it needleſs to repeat in the following deſcriptions of them. The ſtone now treated of, does not, when breathed upon, emit an argillaceous ſmell: the ſame remark may be applied to all the others.

The ſpecific gravity of this ſtone is 3352.

Stone from Yorkſhire.

This ſtone, the conſtituent parts of which are exactly the ſame as thoſe of the ſtones from Benares, differs from them, however,

Firſt, In having a finer grain.

Secondly, That the ſubſtance deſcribed as being in the form of ſmall globular or elliptical bodies, is not ſo conſtantly in thoſe forms, but is alſo found in particles of an irregular ſhape; a circumſtance that is not met with in the other ſtones: theſe bodies are likewiſe, in general, of a ſmaller ſize.

Thirdly, The proportion of martial pyrites, which has preciſely the ſame characters as that in the ſtones from Benares, is leſs; on the contrary, that of the iron in the metallic ſtate is much greater. The quantity I was able to ſeparate by means of the magnet, appeared to me to compoſe about eight or nine parts, in one hundred, of the weight of the whole maſs. I obſerved many pieces of this iron, of a pretty conſiderable ſize; one of them, taken from a portion of the ſtone I had powdered in order to ſeparate the iron, weighed ſeveral grains.

The part of the ſtone which is in an earthy ſtate, and which ſerves to connect the other parts together, has rather more conſiſtence than that of the preceding ſtones; and its appearance does not differ much from that of decompoſed felſpar or kaolin. The ſtone itſelf, therefore, although by no means hard, is rather more difficult to break with the fingers.

The ſpecific gravity of this ſtone is 3508.

Stone from Italy.

This ſtone was in a perfectly entire ſtate; conſequently, its whole ſurface was covered over with the black cruſt peculiar to all ſtones of this kind. As the ſtone was of a very ſmall ſize, it became neceſſary to ſacrifice the whole of it to the inveſtigation of its nature. Its grain was coarſe, ſimilar to that of the ſtones from Benares: in it might be perceived the ſame gray globular bodies, the ſame kind of martial pyrites, and the ſame particles of iron in the metallic ſtate. The proportion of theſe laſt was much leſs than in the ſtone from Yorkſhire, but rather greater than in the ſtones from Benares. The ſame kind of gray earthy ſubſtance ſerved to connect the different parts together; and nothing more could be perceived, except a few globules, which conſiſted wholly of black oxide of iron, attractable by the magnet, and one ſingle globule of another ſubſtance, which appeared to differ from all thoſe we have already deſcribed. This laſt ſubſtance had a perfectly vitreous luſtre, and was completely tranſparent: it was of a pale yellow colour, ſlightly inclining to green; and its hardneſs was rather inferior to that of calcareous ſpar. The quantity of it, however, was too ſmall to be ſubmitted to ſuch an inveſtigation as might have determined its nature. The black cruſt which covered the ſtone was rather thinner than that of the ſtones already deſcribed; and ſeemed to have undergone a kind of contraction, which had produced in it a number of fiſſures or furrows, thereby tracing upon the ſurface the appearance of compartments, ſimilar in ſome meaſure to what is obſerved in the ſtones called *ſeptaria*.

The ſpecific gravity of this ſtone was 3418.

Stone from Bohemia.

The internal ſtructure of this ſtone is very ſimilar to that of the ſtone from Yorkſhire. Its grain is finer than that of the ſtones from Benares: in it may be obſerved the ſame gray ſubſtance, both in ſmall globules and in particles of an irregular ſhape; alſo the ſame particles of metallic iron. The ſame kind of earthy ſubſtance likewiſe ſerved to connect the other parts together.

This ſtone, however, differs materially from the others.

Firſt, The particles of pyrites cannot be ſeen without a lens.

Secondly, It contains a much larger quantity of iron in the metallic ſtate; inſomuch, that the proportion of that metal, ſeparated from it by means of the magnet, amounted to about $\frac{25}{100}$ths of the weight of the whole.

This ſtone has alſo (owing, perhaps, to its having remained a much longer time in the earth than the preceding ones, all of which were taken up nearly at the very inſtant of their fall,) another difference, viz. many of the particles of iron in a metallic ſtate have undergone an oxidizement at their ſurface; a circumſtance that has produced a great number of ſpots of a yellowiſh brown colour, and very near to each other, over a part of its internal ſubſtance. This oxidizement, by adding to the bulk, and to the force of action, of the part we have deſcribed as ſerving by way of cement to the other constituent parts of the stone, has occasioned a greater degree of adhesion between these parts, and has rendered the substance of the stone more compact.

The great quantity of iron in a metallic state which this stone contains, added to its greater compactness, makes it capable of receiving a slight degree of polish; whereas it is impossible to give any polish to the others. When polished, the iron becomes very evident, in the polished part; appearing in the form of small specks, almost close to each other, which have the colour and lustre peculiar to that metal: these specks are, in general, nearly of an equal size.

The black crust of this stone is similar to that of the others.

The specific gravity of the stone is 4281.

It is easy to perceive, from the foregoing description, that these stones, although they have not the smallest analogy with any of the mineral substances already known, either of a volcanic or any other nature, have a very peculiar and striking analogy with each other. This circumstance renders them truly worthy to engage the attention of philosophers, and naturally excites a desire of knowing to what causes they owe their existence.

I proceed to consider the assistance to be derived from chemistry, in distinguishing these stones from all other known substances, and in establishing the assertion, that they have fallen on the earth.

The analysis made by the French academicians of the stone presented to them by the abbé Bachelay, was, in part, conducted by the ever to be deplored Lavoisier; but it was performed before that celebrated author had enriched chemistry with his last discoveries, and before he had given birth to the system under which it flourishes. The result of this analysis might well induce the conclusion, that the subject of it was common pyritical matter. It was unfortunately made of an aggregate portion of the stone, and not of each distinct substance, irregularly disseminated through it. The proportions obtained were, consequently, as accidental as the arrangement of every substance in the mass.

The analysis of M. Barthold, of the stone of Ensisheim, is subject to the same objections; but, after having the advantage of the foregoing descriptions, the researches which follow cannot be supposed altogether liable to a similar fatality.

[To be continued.]

XXIV. *On*

XXIV. *On the different Proportions of Carbon which conſtitute Crude Iron and Steel.* By DAVID MUSHET, *Eſq. of the Calder Iron Works**.

MY laſt communication contained ſeveral experiments to prove the quantity of carbon abſorbed by pure malleable iron in paſſing into the carbonated crude ſtate. The object of the preſent will be to exhibit the proportions of carbon which enter into the compoſition of the other varieties of crude iron and caſt ſteel. I continue the numeration of the experiments from my laſt:

	Grs.
Exp. VII. Swediſh bar iron - -	1174
Charcoal $\frac{1}{15}$th part, or 78 grs.	
A fuſion was obtained from this mixture, after which there remained only a ſmall portion of charcoal, too minute for weighing.	
The metallic button weighed -	1213
Gained in weight by the combination of charcoal equal to $\frac{1}{30}$th part the weight of the iron.	39
Weight of the iron 1174, and charcoal 78, =	1252
Weight of the button - -	1213
Total loſs of weight in the fuſion	39

equal to that gained by the iron. Upon minute inſpection, no part of the ſurface of this button was carbonated. The colour was blueiſh black, ſmooth in the centre but a little oxidated towards the edges. Its fracture preſented cloſe dark gray crude iron. The cryſtals much cloſer and more minute than in thoſe experiments where richly carbonated crude iron was obtained. Appreciating its real quality by compariſon with crude iron manufactured for ſale, it occupied that rank generally known by the names of No. II. gray melting pig iron.

	Grs.
Exp. VIII. Swediſh bar iron - -	922
Charcoal $\frac{1}{20}$th part, or 46 grs.	
From the expoſure of this mixture there reſulted a very perfect metallic button whoſe upper ſurface preſented a partial degree of radiated cryſtallization. It was found to weigh - - -	950
Gained in weight by the combination of carbon	28

equal to $\frac{1}{33}$d part the original weight of the iron. The fracture of this button was ſmooth, ſilvery white, occaſionally ſtudded with carbonaceous ſpecks in the form of ſmall

* Communicated by the Author.

grains,

grains, an exact resemblance to mottled pig iron. In this experiment there remained not the most distant trace of carbonaceous matter. A small portion of amber-coloured glass was formed round the edges of the metal.

	Grains.
Weight of the iron 922, charcoal 46, = -	968
Metal resulting - -	950
Total loss of weight	18

	Grains.
Exp. IX. Swedish bar iron - -	1330
Charcoal $\frac{1}{25}$th part, or 53 grs.	
From this mixture a perfect fusion and metallic button was obtained, which weighed - -	1351
Gained in weight by the combination of carbon	21

equal to $\frac{1}{63}$d part the weight of the iron. In this experiment also the charcoal had completely disappeared. The upper surface of the button was smooth, the under surface considerably pitted. The concaves chequered with a rude crystallization peculiar to cast iron. The fracture of this metallic mass was bright silvery white, destitute of grain, and exhibiting a very perfect streaky crystallization slightly radiated. Its resemblance was strikingly similar to that of highly blown cast iron prepared in the finery for the purposes of bar iron making; an operation commonly in use for the purpose of decarbonating the iron, that it may, in the subsequent process, sooner pass into the state of malleability. The weight of iron and charcoal in the experiment amounted to grs. 1383

Iron obtained - -	1351
Total loss in the fusion	32

Exp. X. Swedish iron - -	1348
Charcoal $\frac{1}{30}$th, or 45 grs.	
From this proportion of mixture in half an hour a perfectly fused button of metal was obtained, which was found to weigh - - -	1359
Gained in weight by the combination of carbon	11

equal to $\frac{1}{122}$d part the original weight of the iron. The upper surface of this button was smooth without configuration. Below the surface was uneven, and covered with minute but perfect crystallization. Its fracture was blueish silvery white, composed of flat dazzling crystals, proceeding in lines

lines from a centre to the edges of the button. Here it was most obvious, that from the smallness of the proportion of carbon presented to the iron, the resulting product was found assuming the earliest stage of granulation approaching to the steely state. The brilliant concretions observable in the surface of the button were too indistinct and flat for steel capable of withstanding the hammer.

	Grains.
The joint weight of the iron and charcoal amounted to	1393
Iron obtain - - -	1359
Total loss of weight in the fusion	34

Exp. XI. Swedish iron - - - 1502
Charcoal $\frac{1}{40}$th, or 37 grs.

The metallic button obtained by the fusion of this mixture weighed - - - 1505

Gained in weight by the union of carbon 3

equal to $\frac{1}{500}$th part the first weight of iron. The upper surface of this button was smooth, with a faint impression of a chequered crystallization. The under surface possessed some large pits, similarly, though more perfectly crystallized.

The fracture possessed one shade of blue beyond that of No. X. A regular granulated surface composed of flat oblong crystals was observable, still too indistinct and too much on edge for workable steel. The weight of charcoal and iron in this experiment amounted to grs. 1539

Metal obtained - -	1505
Total loss of weight in the fusion	34

Exp. XII. Swedish iron - - 1537
Charcoal $\frac{1}{50}$th, or 31 grs.

From the exposure of this mixture, a metallic button was obtained, which weighed - - 1533

Lost in fusion, equal $\frac{1}{384}$th part. 4

The surfaces of this button were uniformly smooth. The fracture was dense, and displayed a grain peculiar to highly saturated blistered steel. When put under the hammer, with a low red heat, it stood a few blows, but afterwards parted.

Weight of mixture employed in the experiment grs.	1568
Steel obtained - -	1533
Total loss of weight	35

Exp.

Exp. XIII. Swedish iron - - 1362

Charcoal $\frac{1}{90}$th, or 15 grs.

A very fine fusion was produced from the exposure of this mixture. The metallic button was found to weigh 1319

Lost in fusion, equal to $\frac{1}{31\frac{6}{10}}$th part, 43

This button presented a wavy crystallized surface. The under surface was rough, and contained one large pit accurately crystallized. The fracture was regularly granulated, small, but distinct, of a light blueish colour. The crystals, though distinct, were not so prominent as those of easy drawing cast steel. It, however, hammered with the usual degree of caution necessary to the working of cast steel. The bar of steel formed from the button possessed all those properties requisite for file making, and other purposes requiring a quality highly charged with carbonaceous matter.

	Grains.
Weight of the mixture - -	1377
Steel obtained - - -	1319
Loss of weight in this experiment	58

Exp. XIV. Swedish iron - - 1372

Charcoal $\frac{1}{100}$th, or 14 grs.

The button obtained weighed - - 1312

Lost in the fusion 60

equal to $\frac{1}{22\frac{8}{10}}$th part the original weight of the iron. The surface of this button was smooth, without crystallization. The under surface rough, and possessed of one large pit in the centre, faintly marked with the usual crystalline appearance. The fracture presented regular light blue grains, distinct, and more prominent than No. XIII. One-half of the button was drawn into a neat square bar, and proved steel of an excellent quality. One end of the bar being loose and shaled, welded tolerably well, and hardened afterwards with a low heat. In appreciating the quality of this result, it appeared to be that kind of steel suitable for penknives, razors, &c., possessed of neither the extremes of hardness nor of softness.

Beyond the proportion of $\frac{1}{100}$th part of charcoal to iron, I continued the experiment till the proportion was reduced to $\frac{1}{200}$th part. It would appear tedious to detail these experiments, the most interesting being already minutely described. In the same progressive manner, by diminishing the

the dose of carbon, the metallic result approached more and more to the softness of malleable iron, though by no means possessed of all its properties. In this series of experiments, iron presented with $\frac{1}{120}$th part its weight of charcoal was found to form very soft steel fit for making scissars, &c., which, in a good workman's hands, would have doubled, welded, and formed a very perfect point, afterwards hardening so as to display a beautiful close break of steel. By using the following precaution, it was even found capable of welding perfectly to iron. Two flat bars of a similar shape, one of this quality of steel, and one of good malleable iron, were put under the hammer with a good welding heat. After a few light blows, the junction was completely made. The united bars were allowed to cool without further hammering till the shade of heat was bright red. The whole piece was then drawn out in a solid compact form, whose fracture, when cold, presented a complete junction of the iron and steel, exhibiting at the same time their respective grains.

When iron is presented in fusion to $\frac{1}{140}$th or $\frac{1}{150}$th part of its weight of charcoal, the resulting product occupies a kind of middle state betwixt malleable iron and steel. It then welds with facility, and, provided the precaution formerly mentioned is attended to, may be joined either to iron or steel, at a very high welding heat. Thus combined with carbon, it is still susceptible of hardening a little, but without any great alteration in the fracture. It possesses an uncommon degree of strength and tenacity, capable of an exquisite dere e of polish, arising from its complete solidity and the purity of fracture conveyed to it by fusion.

When the dose of carbon is further diminished, and in the ratio of this diminution, the same steel or iron becomes more and more red short, and less capable of cohesion under a welding heat, so that, when the proportion is reduced to $\frac{1}{200}$th part the weight of the iron, the quality resulting is nearly analogous to the fusion of iron *per se*, or that obtained by the fusion of iron and earths.

It will appear evident from the result of these and former experiments, that crude iron and steel only differ from each other in the proportions of the carbon they contain. In the details now before us, charcoal alone is used in addition to the malleable iron as pure as is ever made, to effect every principal stage or modification of the metal. Hence we conclude, that

Iron semi-steelified is made with, charcoal, $\frac{1}{150}$th part.
Soft cast steel, capable of welding, with, - $\frac{1}{120}$th
Cast steel, for common purposes, with, - $\frac{1}{100}$th

Cast

Cast steel requiring more hardness, with, of charcoal, - - -	$\frac{1}{90}$th part.
Steel capable of standing a few blows, but quite unfit for drawing, - -	$\frac{1}{50}$th
First approach to a steely granulated fracture, is from - - -	$\frac{1}{30}$th to $\frac{1}{40}$th
White cast iron - -	$\frac{1}{25}$th
Mottled cast iron - -	$\frac{1}{20}$th
Carbonated cast iron - -	$\frac{1}{15}$th
And supercarbonated crude iron -	$\frac{1}{12}$th, or when any greater quantity is used.

Although this is the quantity of charcoal necessary to form these various qualities of metal by this mode of synthesis, yet we are by no means authorized to conclude that this is the proportion of real carbonaceous matter taken up by the iron, seeing that in experiments No. I. to No. VI. inclusive, the weight gained by the iron was upon the average equal only to $\frac{1}{21\frac{8}{10}}$th part; whereas the charcoal which disappeared in the different fusions amounted to 61.1 per cent. of the original quantity introduced along with the iron.

In the succeeding experiments the following differences are remarkable:

No. VII.	Charcoal used	$\frac{1}{15}$th	-	Iron gained	$\frac{1}{30}$th part.
No. VIII.	-	$\frac{1}{20}$th	-	-	$\frac{1}{33}$d
No. IX.	-	$\frac{1}{25}$th	-	-	$\frac{1}{63}$d
No. X.	-	$\frac{1}{30}$th	-	-	$\frac{1}{122\frac{1}{2}}$
No. XI.	-	$\frac{1}{40}$th	-	-	$\frac{1}{500}$th
No. XII.	-	$\frac{1}{50}$th	-	Iron lost	$\frac{1}{384}$th
No. XIII.	-	$\frac{1}{90}$th	-	-	$\frac{1}{36\frac{5}{10}}$th
No. XIV.	-	$\frac{1}{100}$th	-	-	$\frac{1}{22\frac{8}{10}}$th

From this we see that when a proportion of charcoal equal to $\frac{1}{40}$th part, and above, the weight of the iron is used, the latter always gains in weight; but when a more sparing proportion is introduced, room is left for the exertion of another affinity upon the metal, and it consequently and invariably loses in weight proportioned to the diminution of the carbon. I have here further to remark upon the foregoing experiment, and upon the nature of experiments by synthesis performed in this way in general, that the results as to quality will differ materially when different portions of matter are used. So that an operator repeating the above experiments either in

 crucibles

crucibles smaller or larger, or with a greater or less weight of mixture, would not obtain the same results.

The formation of cast steel in the large way, founded upon the results of the foregoing experiments, affords an incontestable proof of this. In fusions of 18, 22, and 25 lbs. of iron each, we are obliged to increase the dose of carbon considerably beyond that requisite in small experiments. To form steel equal to that obtained in experiment XIII. wherein $\frac{1}{70}$th of charcoal was used, $\frac{1}{55}$th part is requisite to be introduced. For steel similar to that in experiment XIV. $\frac{1}{65}$th and $\frac{1}{70}$th part are used. For softer steel $\frac{1}{90}$th, whereas in the small experiment $\frac{1}{120}$th part was sufficient. If in the manufacturing a small extra quantity of carbon is requisite, this is saved by the comparatively small loss sustained in the transmutation of the iron into steel.

Many instances have occurred in the first fusion from a cast steel pot in the large way, where 25 lbs. of iron, and its requisite proportion of carbon, not exceeding $\frac{1}{70}$th, have afforded an ingot of cast steel weighing 24 lbs. 12, 13, 14, and 15 ounces, being a loss equal to no more than $\frac{1}{110}$th, $\frac{1}{200}$th, $\frac{1}{350}$th, $\frac{1}{400}$th part the weight of the iron, whereas in experiments No. XIII. and XIV. the loss of metal amounted to $\frac{1}{31\frac{6}{10}}$th, and $\frac{1}{22\frac{8}{10}}$th part the weight of the iron.

I shall conclude this paper with a few remarks upon the state in which carbon exists in steel and in crude iron.

When malleable iron is fused with $\frac{1}{130}$th or $\frac{1}{140}$th part of its weight of carbon, the resulting product is considerably steelified. The fracture is lighter in the colour than it formerly was in the state of iron. When fused with an 80th to $\frac{1}{100}$th, steel of an ordinary quality is produced, the fracture of the metal still becoming whiter. When the dose of carbon is increased beyond this, the steel becomes so hard and dense as to be unfit for hammering. The fracture now will be found approaching to the colour of silver, and losing its granulated appearance, assuming, however, a crystallized form. In this state the metal will be found to resist the hammer and file, and to be unfit for any purpose. Increase, however, the quantity of carbon to $\frac{1}{12}$th or $\frac{1}{15}$th, the resulting product is no longer destitute of grain, nor possessed of the same degree of hardness. The fracture will be found gray, and the surface easily reduced by the pile. A further increase of the carbon is accompanied by an increase of these properties. At 1-8th or 1-6th, the filings of the metal, when thrown into water, leave a carbonaceous pellicle covering the whole surface, and of a considerable thickness.

Thus

Thus we find that carbon hardens iron till it arrives at the highest pitch of density, which is indicated by the metal losing grain, and assuming a crystallized silvery fracture. At this point or maximum we may conceive that the respective proportions of mixtures are so nearly balanced that the affinity exerted by the iron is just sufficient to deoxidate the charcoal, and that hitherto nothing but pure carbon similar to the diamond has combined with the iron. If, however, the equilibrium is destroyed by a larger portion of charcoal, then we find the affinity too weak to deoxidate the whole, and part of it unites in the state of an oxide of carbon; at first constituting a mottled fracture, and afterwards, as the dose is increased, all those deepening blueish gray shades peculiar to soft cast iron. Hence carbon or its oxide again softens iron. It never, however, restores the properties of forging or of hammering. One invariable law, however, is maintained, that the fusibility of iron under every circumstance and modification is in the ratio of the quantity of carbon united.

XXV. *Researches relative to the Moon's Influence on the Atmosphere and on the Variations of the Barometer.* By C. COTTE, *Member of different Learned Societies* *.

DURING forty years study of meteorology I have constantly viewed, with a peculiar degree of interest, the influence of the moon upon our atmosphere.

The opinion of this influence is founded upon a prejudice so antient, that I thought it worth while to endeavour, by means of researches and combinations of facts, established on the basis of observations contained in our registers, to discover, not a complete system, but the proper data to conduct us, by degrees, to the solution of the problem.

The results of my endeavours in this way may be perused, 1st, in my Treatise on Meteorology, published in 1774, p. 186, 302, 317, note; 280, 606: 2dly, in my Memoirs on Meteorology, published in 1788, vol. i. p. 100, &c. vol. ii. p. 80: 3dly, in the *Journal de Physique* 1782, part ii. p. 249; 1786, part i. p. 276; 1792, part ii. p. 272; 1793, part i. p. 279; 1800, part i. p. 358, part ii. p. 337; 1801, part i. p. 338, part ii. p. 221, 409.

The new researches which I now offer to the public have

* From *Journal de Physique*, &c. tom. liv. Prairial, an. 10.

been occasioned by reading in the *Bibliotheque Britannique* (*Sciences et Arts*, tom. xix. p. 227, Mars 1802), an extract of a memoir of Mr. Luke Howard on a periodical variation of the barometer, apparently due to the influence of the sun and moon on the atmosphere, extracted from the Philosophical Magazine.

The author establishes his conclusions upon a year's observations made in 1798 at Plaistow in Essex, about five miles east of London, and on ten years of similar observations made at London, and recorded in the Transactions of the Royal Society from 1787 to 1796.

In order to be more readily understood by speaking to the eye, Mr. Howard has given a plate divided into lunar weeks according to the four principal phases of the moon, on which are engraved two curves which represent the course of the mercury in the barometer. One of these, which is dotted, represents the course of the barometer as observed at Plaistow in 1798; the other is a line indicating the variations of the barometer at London, corresponding to each of the principal plans on a mean of ten years *.

M. Begnelin at Berlin, and M. Maret at Dijon, have long since adopted charts of this kind to represent the course of the barometer and thermometer. M. M. A. Pictet mentions having drawn out one in 1774, in order to compare the contemporary movements of the barometer at Geneva and Bordeaux.

I likewise prepared a large one to obtain a parallel view of the course of the barometer in two corresponding years of the lunar period of nineteen years, from 1768 to 1797. It were to be wished that the use of such charts could be universally introduced, and that they might be always to be had ready engraved, so that there should be nothing to do but to trace the curve upon them, as is now the case at London.

Mr. Howard remarks, and the inspection of his plate demonstrates it, that at the approach of the new and full moon the barometrical line experiences a depression, and, on the contrary, it is elevated on that of the quarters. The greatest depression of the year 1798 corresponds to about twelve hours after the new moon on the 8th of the eleventh (lunar) month, and the greatest and truly extraordinary elevation

* The first part of this statement is correct, except the mention of two curves and an error of the press in the original (92 for 98). The latter part contains a mistake, which the author must have committed by writing from memory. The line here mentioned serves merely to connect the several points at which the barometer stood at the time of each phasis, and thus to show the change of level more distinctly.—EDIT.

occurred

occurred the 7th of the second (lunar) month at the time of the last quarter *.

The greatest depression of the mercury that had been observed at Paris for forty years happened January 20, 1791, on the day following the full moon.

This coincidence appears to be most regular in fair and moderate weather; and, in general, when the barometer fell during the interval between the new or full moon and the quarter, an evident perturbation in the atmosphere accompanied. I have remarked the same anomalies in the diurnal variations of the barometer; they are regular in settled weather, and are disturbed in changeable.

Mr. Howard draws this general conclusion, that the gravity of the atmosphere as indicated by the barometer may be subject to certain periodical changes, effected by a cause more steady and regular than either change of temperature, currents, or solution and precipitation of water, to which the whole variation has been heretofore attributed.

On comparing the mean height of the barometer at each phase of the moon with the general mean of the year, he found that the mean at the new and full moon was constantly lower, and that at the quarters higher than the general mean. The same result attended the same examination of the ten years observations made at London. The barometer, according to the latter, is depressed at least † four-tenths of an inch (English) while the moon passes from the two quarters to the conjunction and opposition, and rises in the same proportion in her return to the quarters; an effect which the author attributes to the attraction of the sun and moon for the matter of the atmosphere, which ought to have its tides as well as the ocean, but less considerable in proportion to

* It appears that the author has here mistaken the numerical distinction of the months, as if it were applied to the lunar and not to the calendar months, as the chart shows it is. As the elevation here mentioned is, perhaps, almost without a parallel in the records of science, it may not be uninteresting to add a few particulars respecting it, of which we were informed by Mr. Howard. The latter part of the preceding month had been stormy, and solar halos had appeared on two successive days, followed by rain, snow, and hail, amidst which the barometer began rising rapidly on the day before the full moon. This elevation went on for forty-eight hours, with the wind mostly south-west, and blowing very hard. It afterwards apparently went round by north to east, with frosty nights. The highest temperature observed on the day of the maximum was 39°, with a still atmosphere and a fog. The depression which followed began with the wind at south-east, and thence it veered to the westward, most probably by south, as the frost went off with rain.—Edit.

† In the original it is one-tenth, which appears by reference to the author's statement to be correct.—Edit.

its leſſer denſity. This had been already proved by M. l'abbé Chiminelle, (*Nouv. Mém. de l'Acad. de Berlin* 1778, p. 45, *de l'Hiſtoire*; *Journal de Phyſique* 1782, *2nde partie*, p. 88; *Mém. ſur la Météor.* tom. i. p. 617.) The barometograph of M. Changeux indicated *daily* tides, and they have alſo been obſerved at Calcutta in Bengal. (*Vide* Philoſophical Magazine, vol. vii. p. 363.)

The new form in which I have arranged my regiſters in order to facilitate my examination of C. Lamarck's Theory of Lunar Conſtitutions, (*Journal de Phyſique* 1801, 2d part, p. 222.) has likewiſe ſerved very conveniently to verify the reſults announced by Mr. Howard. I have noted, during the ſpace of 34 years and 5 months, (from the 1ſt of January 1768 to the 22d of May 1802,) the aſcending and deſcending direction of the barometer in each of the ſizygies and quarters of the moon which have occurred through that period of time. I here ſtate the total ſum of the elevations and depreſſions of the mercury at each of the phaſes:

For $34\frac{1}{2}$ Years.	New Moon.	1ſt Quar.	Full Moon.	2d Quar.
Sum of elevations	218	296	199	290 times.
—— of depreſſions	281	229	279	106
Differences	63	67	80	84

Theſe reſults of near 35 years obſervations confirm, as will be ſeen, the concluſions drawn by Mr. Howard, both from his obſervations for one year at Plaiſtow, and thoſe made for ten years in the Royal Society's apartments.

It is to be remarked, 1ſt, That the four numbers which expreſs the differences between the elevations and depreſſions are nearly in an exact proportion, ſince 63 : 67 : : 80 : 85 $\frac{1}{3}$.

2dly, That the two latter phaſes, viz. the full moon and laſt quarter, have more effect than the two firſt.

3dly, I have examined what phaſes of the moon have correſponded to the greateſt and leaſt height of the mercury for each month during ten years, and have obtained the following reſults:

For ten Years.	New Moon.	1ſt Quar.	Full Moon.	2d Quar.
Greateſt elevation occurred at	26	40	26	28 times.
Greateſt depreſſion occurred at	30	34	29	27
Differences	4	6	3	1

The ſcience may be therefore ſaid to have advanced one ſtep further towards perfection on this occaſion; and it is to be hoped that, by redoubling our diligence in multiplying obſervations,

observations, and combining them in various ways to obtain their results, its progress may be still accelerated. The useful purposes which may be thereby answered in philosophy, agriculture, and medicine, may be properly urged to observers as the means of supporting their ardour, and indemnifying them for those sarcasms and reflections which even some learned men have been pleased to bestow upon observations of this sort, together with their authors. (See my Considerations on Meteorology, *Journal de Physique* 1801, t. lii. p. 388.)

XXVI. *Description of a new Gas-holder.* By W. H. Pepys *jun.**

THE combustion and deflagration of inflammable substances, metals, and various compounds in oxygen gas, form some of the most beautiful and interesting experiments in modern chemistry. The intense splendour of the liberated light and the variety of its colours astonish the spectator, and become a pleasing addition to our rational amusements, while the experiments serve at the same time to elucidate some of the great laws of nature.

Many people, however, have complained that, notwithstanding the simplicity to which the apparatus for such experiments has been reduced, something was still desirable to enable those who have not had many opportunities of acquiring habits of experimenting to enjoy this interesting science without the inconvenience of being obliged to use a pneumatic cistern for the purpose of transferring the gas. To accommodate some friends of this description, I contrived a gas-holder, which not only obviates the above inconvenience, but is capable of being employed to transport the gas from place to place, and to preserve it from being contaminated, and of being used for experiments with the blowpipe.

This apparatus is in some respects similar to that recommended by Mr. Watt. A small circular cistern is added at top, which is connected with the gas-holder by means of two pipes furnished with cocks. It has also a brass cock on the side, and a glass gage or register tube showing the quantity of included gas by the level of the water. The following is a description of the different parts:

The gas-holder G (Plate IV.) may contain from two to ten gallons.

R, the register tube; the ends of which are cemented into

* Communicated by the Author.

two tin sockets by corks at the top and the bottom of the gas-holder, into which it opens at both ends: of course the level of the water in the apparatus will always be seen in the tube, and consequently that of the gas.

C, the circular cistern, with its two cocks and pipes, marked 1 and 2.

Ck, a brass cock on the side, with a screw, to which bladders or a blowpipe may be attached.

O, an opening into the gas-holder, in which a pipe is soldered at such an angle, that when all the uppermost cocks are shut no water can possibly escape. But when a conducting-pipe, from a retort or other apparatus generating gas, is introduced into this opening, then, as the gas passes up into the gas-holder, an equal quantity of water will be discharged at O into any vessel fit to receive it.

S*p*, a spout on the side of the cistern to enable the operator to add water even when the receiver fills its whole area.

H H, handles to lift the gas-holder by.

R*c*, a glass deflagrating receiver standing in the cistern.

A, its adopting cork and cock.

S, a watch spring in a slit wire prepared for combustion. The wire passes through a cork.

D, a deflagrating dish of iron for sulphur, phosphorus, bark of charcoal, sugar, camphor, &c.

B, a blowpipe, with a gum elastic tube E, capable of joining the cock *Ck*.

To make use of this apparatus, first fill the gas-holder with water, by closing the opening O with a cork, and also the cock *Ck*, and keeping the circular cistern full of water, while the cocks 1 and 2 are both open. The air is driven out of the gas-holder through the cock 1, by the water descending into it by the cock 2. When full, the water in the register will be on a level with the top of the gas-holder. Then shut the cocks 1 and 2. You may now remove the cork from the opening O, which is then prepared to receive the conducting-pipe from any apparatus from which the gas is generating. As the gas is delivered the water escapes, and should be caught in any convenient vessel. The register will then show the quantity received: when full, close the opening O with a cork wrapped in leather, which prevents the communication with the atmosphere. It may now be easily removed or conveyed where it is wanted.

When it is required to fill a glass receiver, as R*c*, with the gas, having previously filled the circular cistern with water, place it in the cistern, put in the adopting cork A, and, with the mouth applied to the cock, exhaust the receiver, in which the water will rise till full. Then close the cock

cock A, and open the two cocks 1 and 2, and the gas will aſcend into the receiver, while the water will take its place in the gas-holder. The ſubſtances to be experimented upon ſhould be mounted with wires paſſing through corks covered with wetted leather, like the watch-ſpring S, or the defla-grating pan D, in which the ſubſtances intended to be ex-poſed to the action of the gas muſt be ignited.

It is not here neceſſary to enter into a particular account of each proceſs, as they are in general well known even to the young experimentaliſt. It may be neceſſary, however, to add as a caution—that, after the deflagration, the gas-holder and receiver ſhould be removed into an open place or under the chimney, that the acid gas, or any other injurious air, may be ſufficiently changed before the receiver is again ex-hauſted by the mouth.

When the blowpipe is uſed it ſhould with its elaſtic pipe be ſcrewed on to the cock *Ck*; the ciſtern ſhould be kept full by reverſing a large receiver of water over it, or any other ſimple method, and the cock 2, only opened for the admiſſion of water.

Bladders mounted with cocks may be filled with gas by firſt emptying them of atmoſpheric air, then ſcrewing them to the cock *Ck*, filling the ciſtern with water, and opening the cock 2. In all theſe inſtances the quantity uſed may be aſcertained from the regiſter, which has a ſcale of pints or cubic inches attached to it.

The numerous experiments in which the gaſes, particularly oxygen, are uſed, will, I conceive, be a ſufficient apology for troubling the readers of your valuable and intereſting Maga-zine with this trifle, which I have really found uſeful in the laboratory.

XXVII. *Experiments on Charcoal.* *By* CLEMENT *and* DESORMES.

[Concluded from p. 73.]

SECOND METHOD.

Action of the Sulphur.

HAD we begun our labour as we have related, we ſhould probably have been ſatisfied with the proofs before eſtabliſhed, that there exiſts no hydrogen in charcoal; and we ſhould not have had recourſe to the action of ſulphur. But an ex-periment having made known to us a particular combination of charcoal and ſulphur, we reſolved to continue our labours.

We

We ſhall here obſerve, that as this combination appeared to us to be the liquid hydrogenated ſulphur of Scheele, mentioned in the memoir of C. Berthollet on ſulphurated hydrogen, we were ſtrongly inclined to acknowledge the preſence of hydrogen in charcoal; and we did not change our opinion till after an examination on a large ſcale, and the moſt deciſive experiments.

Sulphur and charcoal combine at a high temperature, and probably in different proportions. One of theſe combinations is liquid at the uſual temperature and preſſure of the atmoſphere. It is this combination in particular which we ſhall examine.

It is tranſparent and colourleſs when pure, but in general of a greeniſh yellow colour; has a diſagreeable odour ſomewhat pungent, but not inſipid like that of ſulphurated hydrogen: it produces on the ſkin a conſiderable degree of cold, and evaporates as ſpeedily as ether, without any reſiduum if colourleſs, and leaving ſulphur behind it if yellow. Its ſavour is at firſt cool, but afterwards exceedingly pungent like that of ether.

It is heavier than water, and keeps at the bottom of that fluid without mixing with it, in the ſame manner as a heavy oil.

As this combination reſults from the union of ſulphur and charcoal, it may with propriety be called *carburated ſulphur*.

Preparation of carburated Sulphur.

This ſubſtance is obtained by making ſulphur paſs through an ignited porcelain tube in which charcoal in fragments and in powder has been previouſly heated. It muſt be heaped up a little in order that the ſulphur in vapours may be obliged to come into full contact with it.

To operate exactly, we adjuſted to one extremity of the porcelain tube which contained the charcoal a long glaſs tube, pretty large, containing a file of ſmall ſticks of ſulphur which could be ſucceſſively puſhed into the porcelain tube by an iron ſpike paſſing through a cork with which the tube was cloſed. At the other extremity was an adaptor of glaſs terminated by a bent tube immerſed in a glaſs flaſk which communicated with the pneumatic tub.

With a little care, an apparatus of this kind may be eaſily conſtructed ſo as to loſe nothing.

Before the ſulphur is introduced, all the gas the charcoal is capable of giving by heat muſt be ſuffered to eſcape: the ſulphur muſt be introduced ſlowly. When it acts on the charcoal, a yellowiſh liquid, having the appearance of an oil, is ſeen to condenſe itſelf in the adaptor. By continuing the heat

heat it evaporates, and is condenſed in the water of the flaſk; it traverſes it in globules which in appearance do not diſſolve, and which are collected at the bottom.

The complete ſucceſs of this experiment is very uncertain. The regular manner in which ſulphur acts when heated in cloſe veſſels, is one of the principal obſtacles. It is well known that if ſuddenly expoſed to a great heat inſtead of being volatilized, it becomes fixed in ſome meaſure, and forms a kind of paſte. It often happens that ſulphur expoſed to a ſtrong heat in a porcelain tube is not volatilized, and that no carburated ſulphur is formed. In that caſe more ſulphur is introduced, to bring the other to ſuch a low temperature that the whole may be volatilized; but it then paſſes too rapidly over the charcoal to be united with it, and the ſublimated ſulphur, by condenſing in the adaptor, often makes it burſt. It is much better to urge the ſulphur very ſlowly, and, in particular, to incline the tube towards the adaptor to make the ſulphur run upon the charcoal.

During the production of the carburated ſulphur, no gas is diſengaged. The air in the veſſels only receives an expanſion by its mixture with the carburated ſulphur, which is exceedingly volatile, and a little which has become inflammable eſcapes.

Notwithſtanding the difficulty of ſucceeding in this experiment, we made one in which ten grammes of charcoal entirely vaniſhed. It appeared to us that it formed nearly one-third of the combination. When any bits of charcoal remain they are viſibly corroded and of a paler black colour than before, being ſubjected to the action of the ſulphur.

When more ſulphur than is neceſſary for the production of liquid carburated ſulphur paſſes on the ignited charcoal, the reſult is a ſolid, which cryſtallizes in the adaptor. Theſe cryſtals ſeem to reſemble thoſe of ſulphur, but they contain charcoal, for they evidently leave ſome of it after their combuſtion in the open air. This ſolid carburated ſulphur may contain a little of the liquid, and in that caſe it forms a paſte, which in the air ſoon loſes its odour and its conſiſtence.

It appears that to produce a combination of ſulphur and charcoal they muſt be both exceedingly warm; for, by heating in a retort a mixture of ſulphur and charcoal well united, a little gas only is obtained of a bad odour, inſoluble in water, and which Scheele called *inſoluble hepatic gas*.

We burnt a gas nearly ſimilar, which may be procured in large quantity, by means we ſhall deſcribe hereafter; and we had for product a great deal of carbonic acid and ſulphurous acid, but apparently no water.

 Whether

Whether this was a gaseous combination of charcoal and sulphur, or gaseous oxide of carbon, holding in combination sulphur, we will not venture to determine. Oxygenated muriatic acid gas, however, when brought into contact with this substance, the nature of which is not perfectly known to us, destroys it almost entirely, and sulphur is deposited, which is the case also when carburated sulphur is evaporated in the air.

Beautiful carburated sulphur may be obtained, but in small quantity and after long exposure to the action of the fire, by heating sulphuret of antimony with charcoal. Sulphuret of mercury treated in the same manner gives a very small quantity, but those of copper and iron do not produce a single atom.

When sulphuret of strontian is prepared by sulphate and charcoal, if there be a great deal of the latter, carbonic acid is obtained; carbonous gas, mixed probably with hydrogen; and, in the last place, a fetid gas, partly soluble and partly insoluble in water. This second portion seems to us to be the gas above mentioned. In this experiment a very large quantity of strontian was disengaged: the union of the sulphur with the charcoal is the cause, perhaps, which makes it abandon its base.

By exposing a mixture of charcoal and sulphuret of potash, carefully made to a strong heat, there is obtained a prodigious quantity of this gas, which, we have already said, may be only gaseous carburet of sulphur, and which by combustion gives a great deal of sulphurous acid and carbonic acid.

The distillation of calcined sulphate of alumine and charcoal gave also a little of this gas. Sulphuret of lime, treated in the same manner, gave none of it.

By distilling wax with sulphur a great deal of sulphurated hydrogen is obtained, and at last liquid carburet of sulphur, but stained by the undecomposed oil and an empyreumatic oil.

Examination of the Liquid Carburet of Sulphur.

We have already observed that on the first view we suspected this substance to be the hydrogenated sulphur of Scheele, but the following experiments showed this opinion to be false.

C. Berthollet assigns to this substance the property of suffering sulphurated hydrogen to be disengaged, and of depositing sulphur. But the combination which we call *carburated sulphur* does not contain sulphurated hydrogen.

1st, If a quantity of this substance very limpid be put under

under a bell filled with water under a receiver, and if the air be exhausted till the remainder forms an equilibrium with a column of mercury of about 20 or 25 centimetres at the mean temperature, the carburated sulphur is then seen to assume the state of gas; it rises in large bubbles through the water without being dissolved in it: and, if the pressure be restored, the gas is immediately condensed, and reappears under a liquid form.

Sulphurated hydrogen which traverses water at the same pressure, dissolves in it; water saturated with sulphurated hydrogen, at the pressure of the atmosphere parts with but a very small quantity of it, when the pressure is reduced to a fourth. The gas then produced by carburated sulphur is not sulphurated hydrogen.

2d, If carburated sulphur be introduced into a barometric tube, in which the mercury maintains itself at 76 centimetres, it immediately falls to 50 centimetres. The temperature being 12·5* degrees, if the tube be immersed in a mercurial tub, the whole gas which made the mercury in the barometer fall, becomes condensed, and the tube is filled with mercury. This gas, then, is not sulphurated hydrogen, for without the contact of an absorbent the latter would have remained gaseous.

This experiment ascertains nearly the elastic force of carburated sulphur at the mean temperature. That, indeed, introduced into the barometer by making the mercury descend to 50 centimetres, supplies, by its elasticity, the place of a column of 26 centimetres, which is the measure of it. That of ether at the same temperature is somewhat greater.

If the pressure of the atmosphere were only 26 centimetres, no carburated sulphur would exist but in the gaseous state.

3d, If liquid carburated sulphur be put into a vessel with acetite of lead over it, and if this vessel be exposed in a complete vacuum, the carburated sulphur will be seen to assume the elastic state, and to traverse the acetite of lead without blackening it, which sulphurated hydrogen would not fail to do. If the carburated sulphur be stirred with a solution of lead, it at length becomes turbid, and assumes a brown and not a black colour.

We tried, but in vain, to combine sulphur with sulphurated hydrogen to obtain hydrogenated sulphur; we, however, made this gas pass with sulphur in vapours into a warm receiver. There was no very sensible action; the sulphur only retained the odour of the gas, but was no less solid.

* We suppose of Reaumur's thermometer, = 60° Fahr.—EDIT.

By

By pouring, according to the advice of C. Berthollet, a little of hydrogenated fulphur into an acid, we obtained a precipitate of fulphur of an oily appearance, but fimilar to a pafte, and which foon loft all the fulphurated hydrogen gas it contained: it then became folid like common fulphur, which is very different from carburated fulphur, as the latter has no fmell of fulphurated hydrogen, and when pure fcarcely leaves any refiduum.

These experiments feem to us fufficiently decifive to conclude that carburated fulphur contains no fulphurated hydrogen.

The fpecific gravity of this liquid muft vary; we found it once to be 13, that of water being ten.

Carburated fulphur inflames with great facility. It emits a ftrong odour of fulphurous acid; depofits a little fulphur, which then burns; and there remains black combuftible charcoal as ufual.

This body, on paffing into an ignited glafs tube, experiences no fenfible alteration.

It evaporates at the ufual temperature, and greatly increafes the volume of the air—nearly as much as ether. It exercifes the fame action on oxygen, azotic, hydrogen, and nitrous gas. It renders them all inflammable, but does not feem to produce on them any particular alteration *.

The oxygen which holds carburated fulphur in gas, detonates with a prodigious force—incomparably greater than that produced with hydrogen. We hoped to be able to employ this method to dofe the conftituent principles of this body, but we did not think it prudent to operate this detonation in clofe veffels. Thefe veffels ought to be exceedingly ftrong, and even then, if of glafs, the experiment would be attended with danger.

The air which has diffolved carburated fulphur fuffers it to burn quietly.

As we have mentioned the differences between carburated fulphur and hydrogenated fulphur, we muft not conceal a refemblance which we have found between them.

Nitrous gas which holds in folution carburated fulphur gafified by it, is inflammable like the other gafes; but the colour and beauty of its flame are peculiar, they can be compared only to that of zinc, which burns with rapidity.

* This evaporation of carburated fulphur takes place exactly in the fame manner as that of ether; it is proportional to the volume of the gas, and does not depend on the nature of it: this affords a new reafon for believing it probable that the cafe is the fame with the evaporation of water.

Sulphurated

Sulphurated hydrogen mixed with nitrous gas produces a similar effect.

This is the only experiment in which carburated sulphur did not exhibit the same phænomena as if it contained sulphurated hydrogen; and this fact cannot certainly destroy the opinion which we formed, in consequence of all those we have compared and repeated, in order to prove the difference of these two bodies: besides, it is possible that the colour and vivacity of the flame may have arisen from the sulphur, which is a principle of both.

If a piece of rag be dipped in liquid carburated sulphur and wrapped round the bulb of a thermometer, and if the evaporation be assisted by the wind of a bellows, it will make the thermometer descend to the freezing at least, that is to say, lower than ether under the same circumstances.

This substance unites with phosphorus, and dissolves with great facility; but this solution is not more inflammable than phosphorus alone.

It unites also to a small quantity of sulphur without changing its state, only it becomes more coloured.

It seems to have no action on charcoal.

The water in which carburated sulphur condenses during its preparation acquires a greenish-yellow colour, which in the course of time becomes white and milky. At first, this solution precipitates lead of a reddish-brown colour, and then black, as sulphurated hydrogen does; and at length, after a considerable time, white, like the sulphuric acid. It is to be presumed that the water in this case is decomposed. If this action of carburated sulphur on water is not very visible, it is the more so when the water contains a fixed alkali; the union takes place with difficulty even by heat; the carburated sulphur traverses the alkaline solution in vapours without uniting speedily with it: however, if heated in a vessel almost close, in order to prevent the escape of the carburated sulphur, it dissolves almost entirely, and nothing remains but a little charcoal in the form of a black powder. This solution, when recently made is of a dark amber colour, and disengages only a very little sulphurated hydrogen by the addition of an acid; but at the end of some time, and particularly when evaporated, there is formed a great deal of sulphurated hydrogen and carbonic acid. The latter is so abundant that the alkali crystallizes very easily. This phænomenon takes place in particular with soda. The rest of the solution is hydrogenated sulphuret, which precipitates solutions of lead of a beautiful red colour. This precipitate, which becomes browner in the

air,

air, is a hydrofulphurated oxide of lead. Carburated fulphur unites alfo with ammonia, but the alkali does not become cryftallizable: the whole is volatilized by heat.

The nitric, muriatic, and fulphuric acids do not attack carburated fulphur cold. When warm, the nitric acid burns a part of it.

Liquid fulphurous acid does not attack it fenfibly. The cafe is the fame with the gafeous. Carburated fulphur is volatilized in it as in the other gafes, and there is no precipitation of fulphur; which would not fail to be the cafe if there were fulphurated hydrogen.

Liquid oxygenated muriatic acid burns it flowly, and it appears that it attacks the charcoal rather than the fulphur, for the latter becomes folid. This will probably afford the means of analyfing that fubftance when it becomes neceffary to afcertain exactly its conftituent principles.

Carburated fulphur diffolves very well in olive oil, but better when hot than when cold: it depofits a little charcoal, and cryftallizes regularly and very foon by cooling.

Alcohol makes it pafs almoft inftantaneoufly to the foft ftate.

A portion of that which is diffolved is precipitated by the water, and ftill retains charcoal.

Ether mixed with carburated fulphur makes it cryftallize regularly and immediately another part is diffolved. A cryftallization better determined is obtained almoft as fpeedily by the action of a warm folution of potafh placed in an open veffel, where the too elaftic carburated fulphur has an opportunity of efcaping. The cryftals, the moleculæ of which we might almoft fay we faw arranged, are elongated octaedra, pretty large, very regular and complete, becaufe they are formed in the middle of the liquor.

It might have been believed that the charcoal united itfelf to the phofphorus and gave birth to a new compound; but here, as in many other circumftances, analogy is in fault, and we were not able to obtain, by fimilar means, this combination.

This account of our experiments is already too long, if its direct utility be confidered. It is very probable that when we found this carburated fulphur, had we not fuppofed it to poffefs fome ufeful principles, we fhould have paid lefs attention to it. But, fince, we were not fo fortunate as to find any other effects produced by it than that of occafioning a confiderable degree of headach, and difpofing us to fleep, by infecting the air which we infpired. The labour, however, is done,

done, and we know that the combination of charcoal and ſulphur preſents nothing very intereſting *. It is, however, poſſible that in abler hands this ſubſtance may be the mean of leading to new diſcoveries.

CONCLUSIONS.

1ſt, The nature of the gas has no influence on the evaporation of the liquids; that is to ſay, the reſpective quantities of ether, alcohol, carburated ſulphur, and very probably water, evaporate equally in equal volumes of oxygen gas, hydrogen, azote, carbonic acid, and atmoſpheric air, when the temperature, preſſure, and other circumſtances are ſimilar.

2d, Charcoal of whatever kind it may be gives no water in burning, and requires the ſame quantity of oxygen; it therefore contains no hydrogen, and if there be oxygen it always contains of it the ſame, ſince the carbonic acid produced is always the ſame.

3d, Sulphur and charcoal can combine at a high temperature. The reſult is, 1ſt, a tranſparent and highly volatile liquid; 2d, a cryſtallizable ſolid, and, perhaps, a gas permanent at the uſual ſtate of the atmoſphere: in theſe combinations no trace of hydrogen can be obſerved.

4th, The gaſeous oxide of carbon, obtained by dried charcoal and carbonic acid, or other analogous means, does not contain hydrogen. It is a ſimple combination inflammable *per ſe*.

The *Journal de Phyſique et de Chimie*, publiſhed by C. Van Mons for the month of Pluvioſe laſt, contains a memoir, by the Dutch chemiſts, on the ſuppoſed gaſeous oxide of carbon.

It contains experiments which to us do not ſeem concluſive. Theſe chemiſts did not even obſerve the preſence of oxygen in that gas. Had they doſed the quantities on which they operated, they would have ſeen that the carbonic acid in paſſing on the charcoal almoſt entirely diſappears, and ſhows itſelf again under an inflammable form. It formed part then of this new gas, which then became mere carbonated hydrogen: it is very probable that what they obtained was united with hydrogen only, becauſe the charcoal had not been ſufficiently heated and well protected from the action of humidity.

Of this we have a proof in the experiment in which theſe chemiſts, by making azote paſs upon the charcoal inſtead of carbonic acid, rendered it inflammable. We long ago made this experiment with charcoal well burnt, and the azote acquired no inflammability.

* For our part, we think the ſubject extremely intereſting.—Edit.

The same chemists, to prove their assertion, state, that copper does not decompose the carbonic acid, as iron does in the experiment of Cruickshank. But it may be said in answer, that as the former metal does not decompose the water, it may not have the property of decomposing carbonic acid.

In a word, the combination of inflammable gas with sulphur, obtained by the Dutch chemists, and which they took to be sulphurated hydrogen, was only a mixture of that gas with the gaseous oxide of carbon a little sulphurated, of which we have already spoken.

Carburated sulphur is not a discovery entirely new: since our labour we have learned that it had been announced in some work or other before.

XXVIII. *An Essay on Longevity.* By Sir JOHN SINCLAIR, *Bart.*

Introduction.

THE means of preserving health, and of attaining great age, are subjects which seem to be well entitled to the peculiar attention of every thinking man. In regard to the former, there is no question: the pleasure that arises from the possession of health, and the distress which sickness occasions, are perpetual mementos that health cannot be neglected. But as to the latter, the propriety of aspiring to long life has been doubted; and it is said, after a person has lived for 50 or 60 years, and has fulfilled his duties as a man, that he had better retire to make way for others, and that the sooner he quits these sublunary scenes the better. Such sentiments, however, ought not to be indulged. If persons lived only for themselves, and for the gratification of their own passions, and to promote their own interests alone, this might be the case. But if we live, as we ought to do, to promote the happiness of others as well as our own, and if by living long we can be of more service, from the knowledge which greater experience and longer observation must necessarily furnish, the result is, that we ought to live as long as we have health and strength to perform good actions to others, and that the power of doing good ought to be the proper limit by which our wishes for existence ought to be bounded: nor ought it to be omitted, that there is an evident and necessary connection between good health and longevity, as it is impossible to possess the one without its contributing to the enjoyment of the other.

In sketching out some observations on this important subject,

ject, it is my intention to state, 1. The circumstances which tend to promote longevity. 2. The rules which have been adopted by those who have attained great age. 3. The peculiar description of countries most remarkable for long life. And, 4. To add some tables of longevity and the duration of human life.

I. *Circumstances tending to promote Longevity.*

The circumstances tending to promote longevity may be considered under the following general heads:—1. Climate. 2. Form of the individual. 3. Parentage. 4. Natural disposition. 5. Situation in life. 6. Professions. 7. Exercise or labour. 8. Connubial connections. 9. Sex. And, 10. Renewal of age.

1. *Climate.*—In the first place, climate seems to be of considerable importance; and it may be laid down as a general rule, that the moderate, or even the coldest climates, are the most favourable to long life. Heat seems to relax and enfeeble, cold to strengthen and brace, the human frame. The diet also of hot countries is not so nourishing as that of cold *; and there is in general a greater disposition and greater opportunities to indulge in various excesses in the former than in the latter. But if the climate be cool, a rainy atmosphere seems to be less unfavourable to longevity than could well be imagined; for Ireland, which is a wet country, boasts of a great number of old people. And a very large proportion of the aged who have lived in England and Scotland, have resided in the western, and, consequently, the rainiest counties in the island †.

2. *Form.*—The next circumstance to be considered is, the form and size of the individual. It is generally admitted that persons of a compact shape, and of a moderate stature, are the most likely to live long. Height often originates from the disproportioned growth of some particular part of the body, which necessarily has a tendency to engender weakness and disease. Tall persons also are apt to acquire a habit of stooping, which contracts the chest, and is a great enemy to free respiration; whereas the short-sized find little difficulty in keeping themselves erect, and are naturally much more

* In cold countries they live more upon animal, in hot countries upon vegetable, food, and fruits. A judicious mixture of both is the best plan to pursue; but, of the two, animal food is the most nourishing.

† Moisture, it would appear, is not prejudicial to health, if it does not affect the purity of the air. Even stagnated water, if in peat bogs or morasses, is not unwholesome, as the water, by the astringency of the peat, is prevented from becoming putrid. Lincolnshire also, and several of the marshy counties of England, can produce a number of instances of great age, but probably they were from the more elevated parts of these districts.

 active,

active, by which the animal functions are retained in a state of much greater perfection. The only disadvantage attending a short stature is, that it is frequently accompanied with corpulence, which is rather unfavourable to long life.

3. *Parentage.*—Being born of healthy parents, and exempted from hereditary disease, are circumstances evidently favourable to longevity. A puny frame, like Cornaro's, may, by the greatest care and anxiety, be preserved in existence; but those who inherit health and strength, and are born with robust constitutions, can alone expect not only to live long, but to enjoy the pleasures and comforts of life, whilst they continue to possess it.

4. *Natural disposition.*—Longevity also seems to depend much upon good temper, mixed at the same time with a cheerfulness of disposition or good spirits *. Neither the irascible, nor those who, from despondency, sink under the crosses of life, can expect to live long. Even those who suffer their strength and spirits to be exhausted by severe study, or other mental exertions, seldom reach great age. In the long list of 1712 persons who lived about a century, Fontenelle (who did not quite reach 100 years,) is the only author of any note; and his great age is ascribed to the tranquil ease of his temper, and that liveliness of spirits for which he was much distinguished; for he retained to the last *the youth of old age*, as the French happily express it.

5. *Situation in life.*—It is commonly observed, "that it is not the rich and great, not those who depend on medicines, who become old, but such as use much exercise, are exposed to the fresh air, and whose food is plain and moderate †." And it is certain that persons of that description, in general, stand the best chance of living long. At the same time, though instances of old age in great and noble personages are not often to be met with, yet they may be as many, *in proportion to the smaller number of such persons*, as those in the lower but more numerous classes of society. Nor is there any thing inconsistent in power, rank, or wealth, being accompanied with a long period of existence, provided other circumstances are favourable to longevity.

6. *Professions.*—In the next place, it is evident that long life must depend much on the manner in which the individual is employed. Unhealthy occupations generally become fatal. Yet Peter Prin, a glass-blower, is said to have attained the great age of 101; and John Tyler, a miner at Leadhills,

* Hence the great age to which many of the French nobility lived, particularly before the regency of Orleans.

† See Easton on Human Longevity, Introduction, p. xi.

in

in Scotland, is supposed to have reached even 132 years*. His age, indeed, could not be proved by direct, but it rests on very strong circumstantial, evidence; and a person of the most undoubted authority (Dr. Walker, professor of natural history in the university of Edinburgh,) informs me, "that in his muscles, joints, and in his whole conformation and aspect, he wore the appearance of more remote antiquity than he had ever seen in any human creature." But on the whole, farmers, gardeners, and labourers in the country, are in general the longest lived. Foot soldiers also, who have survived the dangers of war, are remarkable for long life. They are generally stout and vigorous men, and the regularity to which surviving soldiers must have accustomed themselves, whilst the careless and disorderly drop off, the erect posture to which they have been trained, and being of course men well formed by nature, and habituated to march and walk well, (which familiarizes them to a natural and healthy exercise,) all combine in their favour.

7. *Exercise or labour.*—It is also proper to remark, that not only moderate exercise, but even labour, if not too severe, contributes to good health and old age. In many instances, persons have worked at threshing, and other laborious occupations, exposed to a current of fresh air, after they had passed beyond the age of 100; and, if accustomed to them, they do not appear to have suffered any inconvenience from such exertions.

8. *Connubial connections.*—Nor ought it to be omitted, that a large proportion of the long-lived have preferred a married to a single state, and in general have left behind them a numerous family. Whether a life of celibacy occasions disease, or leads to irregularity, or sours the temper, or to whatever other cause it ought to be attributed, may be a subject of dispute, but it is certain that the number of single persons who live long bear no proportion to the married †.

9. *Sex.*—Further, though a greater number of males are born than of females, at least in European countries, yet there is reason to believe that of the two sexes, women reach old age in the greatest proportion. For this various causes may be assigned, as the greater regularity and temperance of their mode of living, their being less exposed to dangers and hardships,

* It is said that neither of these instances ought much to be wondered at, as a glass-blower is constantly exposed to fresh and dry air, and the labour of miners under ground is not for many hours, and they generally reside in hilly districts.

† This applies to both sexes, in particular to the male. Dr. Rush, of Philadelphia, asserts, that he never saw but one unmarried man exceed fourscore years.

hardships, less subject to violent agitations, and generally endowed with more cheerfulness and gentleness of disposition.

10. *Renewal of youth.*—In the last place, among the symptoms of longevity, none is more striking than when nature seems to renew itself, by producing, even in old age, new teeth, new hair, &c.; but the instances of this are extremely rare.

II. *Rules tending to promote long Life.*

We shall now proceed to state such rules as have been followed by those who have attained great age, as they may furnish some hints that may be serviceable to others.

The plan laid down by the celebrated Cornaro is well known, and the abstemious manner in which he lived has often been recommended to the imitation of others; but I question much whether many would wish to lead the same life for the sake of mere existence. Life is no longer desirable than whilst it can be enjoyed with some degree of satisfaction, and it is of little consequence, if a person merely vegetates, whether he lives or not.

Without entering therefore into various particulars, fitter for the discussions of experimental philosophy than for real life, (as weighing the food taken, &c. &c.) we shall proceed to mention the rules which have been found the most effectual, and which are the most likely to be carried into practice. They may be classed under the following heads:—1. Food. 2. Clothing. 3. Habitation. 4. Labour or exercise. 5. Habits or customs. 6. Medicine. And, 7. Disposition of mind.

1. *Diet.*—The importance of wholesome food for the preservation of health and long life, and the avoiding of excess, whether in eating or drinking, need not be dwelt upon. Some instances, indeed, are mentioned of persons who have continued to commit excesses and have lived long; but these are to be considered in no other light than as exceptions from a general rule; and it may reasonably be contended, that if such persons lived to a great age notwithstanding their intemperance, they would have lived much longer had they followed a different course.

2. *Clothing.*—It is equally unnecessary to detail at any length the necessity of warm clothing, more especially in advanced life, and during the cold seasons, as the best mode of preventing a number of diseases to which old men are particularly exposed, and which by no other means can be avoided.

3. *Habitation.*—The health of every individual must greatly depend on the place where he resides, and the nature of the house which he inhabits; and as it has frequently been remarked that the greatest number of old people die in winter, and

and that many individuals, in a weak and consumptive state, are obliged to fly to warmer climates as the only means of safety, it has thence occurred to Dr. Pearson that it would be of service both to the aged and to the consumptive to have houses erected of such a peculiar construction that the air could always be preserved, not only pure, but nearly of the same, and of rather an elevated temperature, so that the invalids who resided in them should never be affected by the vicissitudes of the seasons. Such an idea, it must be admitted, cannot be a general remedy or resource; but it is well entitled to the attention of those who are in affluent circumstances, by some of whom, it is to be hoped, an hospital for the aged and the consumptive will be erected, and the experiment fairly tried, both for their own sakes and for that of human nature in general.

4. *Exercise and labour.*—That either exercise or moderate labour is necessary even to aged persons, for the purpose of preserving the human frame in order, can hardly be questioned, provided any great exertion is avoided, than which nothing is more likely to destroy the springs of life, particularly when these become feeble. Travelling in moderation also, from the change of air and scene, has been found of great use.

5. *Habits and customs.*—In the next place, good health, and consequently longevity, depends much on personal cleanliness, and a variety of habits and customs, or minute attentions, which it is impossible here to discuss. It were much to be wished that some author would undertake the trouble of collecting the result of general experience upon that subject, and would point out those habits which, taken singly, appear very trifling, yet when combined there is every reason to believe that much additional health and comfort would arise from their observance.

6. *Medicine.*—It is a common saying, that every man, after the age of forty, should be his own physician. This seems, however, to be a dangerous maxim. The greatest physicians, when they are sick, seldom venture to prescribe for themselves, but generally rely on the advice of their medical friends. Persons who pretend to be their own physicians are generally much addicted to quackery, than which nothing can be more injurious to the constitution. It is essential to health that medicines should never be taken but when necessary, and never without the best advice, in regard to the commencement, which ought not to be too long delayed, otherwise much benefit cannot be expected from them, and also with respect to nature or sort, quantity, and continuance.

At present, the powers of physic, it is generally acknowledged, are extremely bounded. The medical art, however, is probably still in its infancy, and it is impossible yet to say to what perfection it may reach, not only in consequence of the new improvements which chemistry daily furnishes, but also of those which may be made by the discovery of new and valuable plants in countries either already known or hitherto unexplored, and indeed the new uses to which old medicinal plants may be applied. Perhaps such discoveries will be much accelerated, when, instead of being left to the zeal and industry of individuals, they shall meet with that public encouragement and protection to which they are so peculiarly well entitled.

7. *Disposition of mind.*—In the last place, nothing is more conducive to longevity than to preserve equanimity and good spirits, and not to sink under the disappointments of life, to which all, but particularly the old, are necessarily subjected. Indeed this is a point which cannot be too much inculcated; for experience sufficiently demonstrates that many perish from despondency, who, if they had preserved their spirit and vigour of mind, might have survived many years longer.

III. *Countries remarkable for Longevity.*

The countries the most remarkable for long life are those of a hilly nature. We are informed by Pallas that the inhabitants of the mountainous districts of the province of Isesk, in the northern parts of Siberia, live to a great age; that people of 100 years are very common, and that he saw an invalid soldier aged 120. The inhabitants of the plains in their neighbourhood are, at the same time, by no means so healthy or so long lived. Buffon places the mountainous districts of Scotland at the head of a list containing those parts of Europe the most distinguished for longevity; and, indeed, there is no country in Europe where, in proportion to its population, a greater number of individuals reach to 60, and thence to 80, and even 90 years of age, in full possession of all their faculties, both personal and mental, than is the case in that part of Great Britain *. There is also every

* In a work containing a collection of instances of longevity for no less a period than 733 years, namely, from A. D. 1066 to 1799, (by J. Easton) in which there is given the name, age, place of residence, &c. of 1712 persons, from all parts of the world, who had attained to a century and upwards, 170 are stated to have been natives of Scotland, and the two most remarkable in the whole list are Kentigern, a native of Scotland, and Peter Torton, of Temeswar, in Hungary, both of whom attained the great age of 185 years. This Kentigern, also known under the name of Saint Mungo,

every reason to believe that many of the departments of France, and the mountainous districts of Germany, Hungary, Sweden, Norway, and even those of Spain, Portugal, Italy, and America, will produce extraordinary instances of longevity whenever any particular inquiry is made regarding that interesting circumstance.

IV. *Tables of Longevity.*

Having thus discussed the subject of longevity in general, it may not be improper to lay before the reader the following table, explaining the shortness of human life, and pointing out how few there are, in proportion to the number born, who reach even the period of 60 years *.

Of a hundred men who are born, there die, according to Hufeland,

Under 10 - - -	50
Between 10 and 20 - - -	20
20 and 30 - - -	10
30 and 40 - - -	6
40 and 50 - - -	5
50 and 60 - - -	3
	94

Hence it would appear that there are only six out of a hundred who stand a chance of living beyond 60 years.

Of persons who have lived above a hundred years, the industrious Haller has collected 1113 instances, and gives the following statement of the duration of their lives †.

Of those who lived from 100 to 110 years, the instances have been above - - - -	1000
From 110 to 120 about - -	62
120 to 130 - - -	29
130 to 140 - - -	15
140 to 150 - - -	5
152 (Parr) - -	1
169 (Jenkins) -	1
	1113

Mungo, was the founder of the bishopric of Glasgow. The following verses were made on his extraordinary age and place of interment:

" Cum octogenos centum quoque quinque vir annos
" Compleret, Sanctus est Glasgow funere functus."

Spottiswood's Hist. of the Church of Scotland, p. 11 and 112.

* On the Art of prolonging Human Life; a work written by professor Hufeland, of Jena, in Germany.

† Haller's Elementa Physiologiæ Corporis Humani, vol. viii. lib. 30. sect. 3. p. 103.

But in a recent publication, the following table is given as the refult of a more extenfive collection of inftances of longevity.

Of males and females who lived from 100 to 110 years, both inclufive, the inftances have been - 1310

Above 110 to 120 - - -	277
120 to 130 - - -	84
130 to 140 - - -	26
140 to 150 - - -	7
150 to 160 - - -	3
160 to 170 - - -	2
170 to 185 - - -	3
	1712 *

Conclufion.

Such is the fubftance of the obfervations which have occurred to me on this interefting fubject. I fhall conclude with remarking, that on the whole it is more than probable, by proper attention and good management, perfons in general might not only live longer, but might enjoy life with more relifh, than is commonly the cafe at prefent; and it is to be hoped, in refpect of this, as well as of many other particulars, that human nature is ftill in the threfhold of acquirement, that it will yet obtain greater and more important acquifitions of knowledge, and may reach further improvement both with regard to the extent of perfonal and mental gratifications, which our fpecies may be found capable of enjoying, and alfo the means of poffeffing them, with more fatisfaction and comfort, and for a much longer period of time.

[To be continued.]

XXIX. *Memoir on the Anatomy of Vegetables. Read before the Phyfical Clafs of the Inftitute by* C. MIRBEL.

[Continued from p. 40.]

CHAP. IV.

Of the tubular Tiffue.

THERE are two kinds of tubes, the great and the fmall.

Art. I. *Of the large tubes.*—The large tubes during the firft period of their formation are not, as might be fuppofed, membranaceous canals feparate and diftinct from the tiffue;

* See Eafton on Longevity, printed an. 1799.

and

and they exiſt only becauſe there is a lacuna in the membranes. Such is the extreme ſimplicity of the organization of vegetables, that all the difference obſerved in them is merely confined to ſome modifications in the cellular tiſſue. But the ſides of theſe large tubes, being continually moiſtened by the fluids imbibed by the plant, gradually aſſume more conſiſtence, and ſeparate from the reſt of the tiſſue when their ſolidity ſurpaſſes that of the ſurrounding membranes. I could never obſerve large tubes in muſhrooms, lichens, and fuci, even when I employed a microſcope; but it is ſufficient to have good ſight to be able to diſtinguiſh the aperture of theſe canals on the tranſverſal ſection of the ſtems, the branches, and roots, of ſeveral monocotyledons and dicotyledons. In the former, they are always found in the centre of the ligneous filaments, and ſometimes they compoſe the major part; in the ſecond they are diſtributed often, as it were, at random in the wood; ſometimes alſo they form groups placed very regularly at certain diſtances, or they are ranged in concentric zones. They are exceedingly numerous, in particular around the medullary canal. They are found alſo in the bark. If their progreſs be followed they will be ſeen to have their origin in the root, to enter the trunk, and to riſe parallel to each other: then to unite, to ſeparate and deviate from their vertical direction, to penetrate the bud which is formed at the ſurface of the bark; to lengthen with it, and to diſtribute themſelves throughout all its ramifications, to paſs from the branch into the ligneous filaments the bundle of which compoſes the petiole, and to divide themſelves among the large fibres of the leaves as the arteries and veins diſtribute themſelves in the human body. They may be obſerved alſo in the fibres of the perianthes, the filaments of ſome ſtamina, the piſtils, and the ligneous filaments which traverſe the pulp of fruits. Scarcely is the embryo formed when theſe tubes are obſerved. In this infancy of the vegetable they are not concealed by the wood, which does not yet exiſt: the ſubſtance deſtined to produce it is then in a ſtate of fluidity, which permits the obſerver to examine the parts which it covers. It is not yet the proper place for ſpeaking of the vegetable chyle produced by the fluids aſſimilated in the veſſels of the plant, I ſhall recur to that ſubject hereafter. The large tubes form ſometimes medullary radii, as I have obſerved in the equiſetum or horſe-tail; but, in my opinion, this caſe is rare.

The large tubes are of four kinds: ſimple tubes, porous tubes, falſe tracheæ, and tracheæ. Theſe are modifications of the ſame organ.

1ſt, *Simple*

1ft, *Simple tubes.*—The fides of thefe tubes are perfectly whole, neither pores nor fiffures are obferved in them: they generally contain refinous or oily juices, known under the denomination of *proper juices.* Thefe tubes are very remarkable in green trees, in euphorbia, periploca, and, in general, in all plants the juices of which are thick. They are more numerous and more vifible in the bark than in any other part.

2d, *Porous tubes.*—The fides of thefe tubes are perforated with fmall pores fimilar to thofe mentioned in the article on the cellular tiffue, with this difference, that they are much more numerous, and that, inftead of being diffeminated by chance, and without order, as is often the cafe, in the cells, they are diftributed in regular and parallel feries around the tubes. Thefe tubes do not appear to be fo peculiarly deftined as the preceding to contain refinous or oily juices. They are very numerous in hard wood, fuch as the oak.

3d, *The falfe tracheæ.*—Thefe tubes are interfected in a tranfverfal direction with parallel flits, which from their appearance might induce us to believe that they are formed of rings placed one above the other, or of filaments twifted in a fpiral form; but they cannot be unrolled, or feparated into diftinct rings; and befides, with a little attention, one may difcover the continuity of the membrane, and confequently the place where the flits end. Thefe, then, are porous tubes, but their pores are much larger than thofe of the preceding. I muft even obferve, that the edge of the flits is furnifhed with a roll fimilar to that which furrounds the fmall pores. Thefe tubes are deftined for the fame purpofes as the porous tubes; but in general they are found in thofe kinds of wood which are lefs hard and compact, and even in herbaceous plants: I have obferved them in a great number of the monocotyledons. The centre of the lycopodia prefents a thick cylinder compofed, in a great meafure, of veffels of this nature. Ferns contain alfo a great many in their ligneous filaments. Dicotyledons are likewife provided with them. They are exceedingly numerous in the vine, the wood of which is foft and porous.

4th, *The tracheæ.*—Want of experience has affigned to thefe tubes, which have not been fufficiently obferved, a denomination confecrated by cuftom. The tracheæ of plants have a refemblance in their form to the tracheæ of infects, and it has thence been concluded, on too flight grounds, that thefe tracheæ in the former as well as in the latter muft be the organs of refpiration. The vegetable trachea is a tube formed of a filament twifted into a fpiral form from right to left,

left. This filament is opake, brilliant, argenteous, and thick. Its tranſverſal ſection preſented to me ſometimes a flat plate or an ellipſis, and ſometimes even two filaments united by an intermediate membrane; but I never could obſerve the aperture of a tube, as ſeveral authors have aſſerted. The ſurface is ſometimes ſmooth, ſometimes unequal, and ſometimes porous. The ſpirals of the tracheæ are often ſo cloſe, that when their arrangement is not diſturbed, on breaking or cutting, without precaution, the parts which conceal them, they appear to be continued tubes ſlightly ſtriated. Malphigi and Reichel ſay that choked parts have been remarked in the length of the tracheæ; and at firſt I believed that I obſerved the ſame, but I have ſince found that this was merely an optical illuſion. Theſe tubes exiſt in great numbers in the herbaceous monocotyledons and dicotyledons, but eſpecially in the aquatic kinds, the tiſſue of which is weaker: they occupy the centre of the ligneous filaments in the monocotyledons; in trees with two cotyledons they are ſeen around the pith: in theſe they are often mixed, and confounded with the falſe tracheæ. I never ſaw them in the hard parts of vegetables, unleſs theſe parts had long been in a ſtate of ſoftneſs, which permitted the tracheæ to expand: this is what takes place in branches and twigs from which the pith has diſappeared. Theſe tubes have formed themſelves when the medullary ſubſtance exiſted. The tracheæ are not found in the length of the bark; they penetrate into the petioles and leaves in the ſame manner as the falſe tracheæ; they every where act the ſame part as the latter, and do not contain thick juices but in plants where they are very abundant, ſome as of the lily kind. It is well known that, to ſee theſe organs with the naked eye, it is neceſſary to take a young, green, and ſoft branch, to twiſt and break it without violence, that the tracheæ may be unrolled without rupture: if the two parts of the branch which have been divided be then oppoſed to the light, one can diſtinguiſh the half-unrolled filaments which proceed from the one part to the other, and the ſpirals are cloſe or at a diſtance, according as the parts are brought near to, or removed from, each other. They unroll themſelves or contract in the ſame manner in leaves which have been torn. The leaves, however, of the *butomus umbellatus* exhibit a contrary phænomenon; the tracheæ, which in this plant are exceedingly numerous, when once unrolled no longer contract themſelves.

Let us now return to the large tubes in general. The diviſion into ſimple tubes, porous tubes, falſe tracheæ, and tracheæ,

tracheæ, is not rigorous. In eſtabliſhing it, I do not pretend to aſſign immutable laws of nature; I have had occaſion to obſerve that it often deviates from them. Thus the *butomus umbellatus* exhibits in the ſame tube the pores of the porous tubes, the ſlits of the falſe tracheæ, and the ſpirals of the true tracheæ; ſo that one tube comprehends three of the modifications I have deſcribed. Theſe tubes I call the mixt. Other vegetables exhibit ſomething analogous or in ſimilar ſituations, there are found in them one of the four varieties of the large tubes. It is not uncommon to ſee all theſe tubes cloſely united the one to the other, and forming only one tiſſue. In a word, it may be conjectured, with ſome appearance of reaſon, that in many caſes the tracheæ unroll themſelves only becauſe the membranes which unite their ſpirals are torn. Let us conclude then that theſe differences, which on the firſt view appear of ſo much importance, are only ſlight ſhades in the vegetable economy. But the large tubes, conſidered in a more general manner, preſent themſelves to the mind as the creative organs; their numerous ramifications diſtributed throughout all the parts of the vegetable carry thither the vivifying juices; by theſe the ſtem acquires more vigour, the bud is produced, pierces the bark, and lengthens under the form of a branch; the leaf expands, the flower blows, and the fruit ſwells up and ripens, while the embryo concealed in its boſom receives its firſt nutritive juices.

Article II.

Of the ſmall Tubes.

Theſe are compoſed of cells united to each other like thoſe which compoſe the cellular tiſſue; but in the cellular tiſſue the diameter of the cells is nearly equal in every direction; while in the former the cells are much elongated, and form real tubes, the extremities of which are ſhut: the ſides alſo are leſs tranſparent, and the membranes of which they are formed have more conſiſtence: they are often perforated with a great number of pores. This tiſſue is thick, ſolid, and tenacious. It is generally difficult to cut it through; but it preſents much leſs reſiſtance lengthwiſe, and often ſeparates eaſily into threads of greater or leſs delicacy, and which very improperly have been called fibres. The ſolidity of the vegetable depends in particular on the quantity and denſity of this tiſſue: it contains, according to the ſpecies in which it is found, ſometimes thick and coloured juices, but ſometimes, and more commonly, limpid and colourleſs juices. In the

fir

fir it is impregnated with a resinous liquor; in the vine, especially at the time of the sap, it abounds with an aqueous fluid.

The embryo, still inclosed in its teguments, has few or no small tubes: all its parts are soft or almost mucilaginous. This tissue is never found but in the expanded plant. It is observed in the centre or at the circumference of the ramifications of certain ramified lichens, and in the stems of moss: in monocotyledons, this tissue distributed around the large tubes forms the ligneous filaments; in dicotyledons, placed around the pith, and the large surrounding tubes, it forms the ligneous strata. The small and large tubes are generally united: the existence of the former depends on the presence of the latter. The bond which connects them is nothing else than that which unites the effect to the cause. Large tubes, however, are sometimes found without the small, and the small without the large; but it is to be recollected that the latter are the creative organ, and consequently their existence is independent of that of the others. So much for the first case. And it must be considered that there is an epoch for many vegetables at which the large tubes are filled up with the tissue to which they gave birth. So much for the second case.

The prominent parts of the grooves and striæ which cover the surface of the vegetables are bundles of small tubes. This tissue is observed also in the most delicate ribs of the leaves and petals: it penetrates the stamina and pistils, and reaches to the extremity of the stigmata; but in these delicate organs it loses its rigidity, and is nothing but cellular tissue very much elongated.

Chap. V.

Of Lacunæ.

Nature, which effects expansion without violence, and which conducts organized beings, by insensible gradations, from non-existence to life, and from life to death, seems here to deviate from her usual progress: she destroys to create, and from the annihilation of organs gives birth to a new organic system. Lacunæ are regular and symmetric vacuities formed in the interior of vegetables by the laceration of their membranes.

Lacunæ, in general, exist only in plants, the tissue of which is soft. They are very numerous in most of the aquatic herbs. They are, however, found sometimes in vigorous trees the wood of which is very hard; but in all cases they are formed only by the destruction of the cellular tissue, which is the weakest

weakeſt part of the membranous tiſſue. If lacunæ occur more frequently in the monocotyledons, it is becauſe theſe vegetables in general have leſs vigour, and an organization leſs perfect; or, if I may venture to ſay, leſs vegetative power. A phænomenon which deſerves the attention of phyſiologiſts is, that theſe lacerations inſtead of hurting the vegetable ſerve only to increaſe its ſtrength by concentrating it more. Plants the texture of which is flaccid, and thoſe in particular immerſed in water, receive juices in abundance; but they cannot aſſimilate them, becauſe the organs are not ſufficiently vigorous in proportion to the volume of theſe plants, which have more ſize than real ſtrength. But if by internal rupture the organs which have become uſeleſs are deſtroyed and the uſeful organs are retained; in a word, if one part of the organization is ſacrificed to the other, the part which maintains itſelf receiving the whole nutritive ſubſtance will acquire more ſtrength, and the vegetable may ſtill grow with new vigour; for its ſtrength will not be diminiſhed, and its impediments will be leſs.

No lacunæ are obſerved in the embryo, becauſe its lacerations are a real diſorganization, which cannot take place in beings that begin to live. They are formed therefore only in the courſe of time. They ſhow themſelves in the petioles of fern, in the ſtems of the potamogetons, and in a multitude of other vegetables like longitudinal tubes interſperſed throughout the cellular tiſſue. In the equiſeta they affect a diſpoſition exceedingly regular; one greater than the reſt forms a tube in the centre of the ſtem; around this tube there are other very ſmall lacunæ arranged circularly, and ſome larger and cloſer to the circumference are diſpoſed in alternate order with them. The lacunæ of the leaves of the monocotyledons are interſected by frequent partitions, which are only the cellular tiſſue collected at certain diſtances, and which cloſes the tubes by membranous diaphragms. This organization, or rather diſorganization, appears through the tranſparent tiſſue of the *typha*, and a multitude of other monocotyledons with ſword-formed leaves. The ſame phænomenon may be obſerved in the tiſſue of the ſheaths of which the ſtem of the banana-tree is compoſed.

The *reſtio* has longitudinal lacunæ, and alſo tranſverſal apertures in the thickneſs of the bark: it does not appear that the latter kind of lacuna occurs often in vegetables.

One might ſuſpect that the large tubes of plants always begin by being lacunæ, and that the internal vacuities, where a new tiſſue, which increaſes both the volume and denſity of the vegetable, is developed, are only lacunæ alſo.

CHAP.

Chap. VI.

Of the Glands.

Whether plants have glands analogous to thofe of animals; that is to fay, organs proper for giving to the fluids the qualities neceffary for the development and prefervation of the being by making them undergo new combinations, and by feparating from them the ufelefs or prejudicial qualities, is a queftion not eafy to be determined. In fo delicate a fubject, facts and reafoning are equally obfcure: however, it appears to me beyond a doubt that we do not catch with our beft microfcopes but the coarfe part of the vegetable organization. I cannot conceive that the transfufion of the fluids of one cell into another is fufficient to modify thefe fluids fo far as to change them into organized matter, and to render them fufceptible of giving a new increafe and new vigour to the plant. I cannot conceive either that the common laws of chemiftry could alone effect this phænomenon, becaufe, in either hypothefis, nothing could prevent labour or chance from unveiling to man the fecret of nature: but this confequence is repugnant to reafon. It appears, then, to me more judicious to admit fecretory organs in which the fluids are affimilated. It muft, indeed, be fuppofed that the membranes are not impenetrable to the fluids, fince they dilate, unfold themfelves, and change their nature; but they muft neceffarily modify the fluids, fince the latter, by penetrating them, become capable of increafing the membranous tiffue in all its dimenfions: it is in the membranes, then, that we muft fearch for the vegetable glands. It might be fuppofed, with fome appearance of truth, that the opake and irregular rolls with which the pores and apertures of the large tubes are bordered are glandulous bodies. The filaments of the tracheæ, the thicknefs of which greatly furpaffes that of the membranes, feem alfo to difcharge the fame functions; and what gives to thefe probabilities more weight is, the confideration that the mucilage, which is transformed into organized tiffue, is always accumulated around the fmall and large tubes, which are all covered with thefe opake bodies.

[To be continued.]

XXX. *Short Account of the Ornithorynchus Paradoxus, or Duck-billed Platypus.*

This animal, of all the quadrupeds yet difcovered, feems to be the moft extraordinary in its conformation, as it exhibits

bits the perfect resemblance of the bill of a duck engrafted on the head of a quadruped. So ſtrong, indeed, is the ſimilitude, that, when the ſtuffed animal was firſt brought to Europe, ſome naturaliſts were inclined to ſuſpect that the bill was a deceptive preparation produced by artificial means; and it was not without the moſt rigid obſervation that they could perſuade themſelves that the beak or ſnout of the quadruped was real.

The length of the whole animal from the tip of the beak to that of the tail is 18 inches; that of the beak is 1$\frac{3}{4}$ inch. The body is depreſſed, and has ſome reſemblance to that of an otter. It is covered with very thick ſoft fur, of a moderately dark brown colour above, and of a ſomewhat ferruginous white beneath: the head is flattiſh, and rather ſmall than large: the mouth or ſnout, as already mentioned, has ſo ſtriking a reſemblance to that of ſome broad-billed ſpecies of duck, that it might be miſtaken for ſuch: round the baſe of it there is a flat circular membrane rather wider below than above, that below being nearly the fifth of an inch, and that above an eighth. The tail is flat, and covered with fur like the body; it is rather ſhort and obtuſe, and has an almoſt bifid termination: it is broader at the baſe, and gradually decreaſes to the tip: it is about 4$\frac{1}{2}$ inches in length, and its colour is ſimilar to that of the body. The legs, which are ſhort, terminate in a broad web, which in the fore-feet extends to a conſiderable diſtance beyond the claws, but in the hind-feet it reaches no further than the roots of the claws. The forefeet have five ſtraight, ſtrong, and ſharp-pointed claws; the two exterior ones ſomewhat ſhorter than the middle ones. The hind-feet have ſix claws, which are longer and more inclining to a curved form than thoſe of the fore-feet: the exterior toe and claw are conſiderably ſhorter than the four middle ones: the interior or ſixth is placed much higher up than the reſt, and reſembles a ſtrong ſharp ſpur. The legs are all hairy above; the fore-feet are naked both above and below. The internal edges of the under mandible, which is narrower than the upper, are ſerrated with numerous ſtriæ, as in a duck's bill. The noſtrils are ſmall and round: they are ſituated about a quarter of an inch from the tip of the bill, and are about the eighth of an inch diſtant from each other. The ears are placed about 1$\frac{1}{2}$ inch beyond the eyes; they appear like a pair of oval holes the eighth of an inch in diameter, without any external ear. On the upper part of the head a little beyond the beak there is on each ſide a ſmalliſh oval ſpot in which the eyes are placed, or at leaſt thoſe parts which ſeem allotted to the animal for ſome kind of of vision: from the thickness of the fur and the smallness of these organs, they seem to be but ill calculated for distinct vision, and, in all probability, are like those of moles and some animals of that tribe. The whole apparent diameter of the cavity of each does not exceed the eighth of an inch.

The general form and structure of this animal, and, in particular, its bill and webbed feet, evidently show that it must be resident in watery situations; that it has the habits of digging or burrowing in the banks of rivers or under ground; and that its food consists of aquatic plants and animals. It is a native of New Holland. The average size is not yet ascertained.

The annexed figure of this animal, given in Plate III., was delineated and engraved from a very complete preserved specimen in the possession of W. H. Pepys jun. esq.

For an anatomical description of the head of this animal, and a figure, see Philosophical Magazine, vol. xi. p. 366.

XXXI. *Curious Particulars respecting Bees.* By Mrs. Cooper, *of Wormley in Hertfordshire.*

To Mr. Tilloch.

HAVING read many curious accounts of the management of bees by different authors, with plans proposed for taking their honey without destroying them, I was resolved to become an apiator, and on the 25th of August 1800 I purchased a hive of bees, which was supposed, by computation of judges, to weigh above twenty pounds. I fed them in the winter following with brown sugar wetted with ale, which I put into a vehicle I call a boat, from its similitude to a Caffree canoe, and which I make out of the young shoots of elder dried for the purpose, and just big enough to push into the door of the hive: sometimes I give two a day, but never more, the whole not being above a good table spoonful. When the flowers began to show themselves in the spring of 1801, and I perceived them coming home loaded, I only fed them on such days as they could not go out, and desisted from it entirely in the month of April.

The bees appeared healthy and very numerous, frequently covering the whole hive outside, which I thought indicated their going to swarm: but in this I was totally disappointed; and as the season declined I began, the better to preserve my bees, to feed them as the preceding year; which I continued until the flowers and honey dews convinced me they had enough. On the 4th of June 1802 my stock sent forth a

 very

very fine swarm; which I hived; and kept a good look-out for a cast, but was in this disappointed. On going to look at the hive about five o'clock one afternoon I found in front of it, on the grass, a *queen bee,* answering the description of all authors; but with this difference, though alive there was not any bee near her. I brought her into the house to examine her thoroughly, and to see if she had met with any accident, but could not perceive any defect. I then put her on a twig, and, placing her at the door of the hive, the bees within soon led her into it. The time being elapsed when I had reason to expect a cast, and anxious to increase my stock, I purchased from a neighbour, on Thursday the 8th of July, a cast, for which I paid five shillings and sixpence; and on his bringing it home, I desired him to remove my old hive to a new place, the better to see if any dirt or moth was under it, in order to clean it, and then to place the new cast on the spot the old had occupied. This he performed.

The next day all was quiet; but the day after I perceived an uncommonly busy communication betwixt the two hives; and on the Sunday I found the old hive totally deserted, and that the bees had all joined the new cast without any fighting whatever, leaving me a hive completely full, out of which I immediately took twenty pounds of fine liquid honey, and of which, Mr. Editor, you may partake any time you travel this way while it lasts. Thus I have saved my bees; which, I doubt not, were allured for want of room, their hive being quite full, and the new one being put in its place.

As chance has produced many great events, it may be worth the while of any apiator to try, by the purchase of a cast at the time of the year I have done, whether it will not equally succeed *. I mention the time, because I have doubts whether a later season will permit the bees to stock themselves with food sufficient for the following winter; and it must be observed that this year, 1802, has proved a most uncommonly fine year for bees, from the numerous honey dews we have had. I remain, Sir,

Your obliged reader,

CHARLOTTE COOPER.

Wormley, Herts,
July 20, 1802.

* Does not the issue of the experiment related in this paper suggest also another? New empty hives have sometimes been placed beside full old hives, in the hope that the new swarm might take up its abode there; but we believe it has seldom answered the wish of the bee-master. If, however, as in the case before us, the old hive was put in a new place, and then an empty hive put on its old site, is there no probability that the bees would take possession of the new hive; perhaps merely from want of room, but possibly from an idea that the contents of the old hive would still remain in store for them?—EDIT.

XXXII. Ex-

XXXII. *Extract from the Report made to the French Board of Longitude by* C. LAGRANGE, LAPLACE, MECHAIN, *and* DELAMBRE, *on the Lunar Tables sent to the Board to compete for the Prize proposed on that Subject.*

THE public will recollect with what interest the National Institute received, two years ago, the memoirs of the astronomers Bürg and Bouvart respecting some of the elements of the lunar tables. Struck with the importance and immensity of their labour, the class of the mathematical and physical sciences, the president of which at that time was of all its members the one who could best ensure the eclat and success of its deliberations, decreed that the prize to be offered should be doubled. By doing much more than was required of them, the competitors gave birth to a question far more difficult than that which they had solved. The same mean motion was not capable of satisfying the epochs which they had established for the commencement, the end, and the middle of the 18th century.

This irregularity, so alarming for the future precision of the tables, could not be explained but by supposing, either that the inequalities already comprehended in the tables were not sufficiently well known, or that there were still wanting some equations which had hitherto escaped the researches of all geometricians.

The terrible labour which these new considerations required did not permit us to hope for so speedy a solution as was necessary to the wants of astronomy and navigation. It was requisite that an appeal should be made to all astronomers, in the hope that some of them might have collected a series of the necessary materials. The board of longitude applied with confidence to a government composed in such a manner as to be sensible, much better than any other that ever existed, of the value of the sciences and of the utility of their application. With its consent, the ministers of the interior and marine contributed in equal portions towards an extraordinary prize of 6000 francs (240l. sterling), which they hastened to propose to the emulation of the astronomers of all countries. Twenty months after this prize was announced, the board of longitude received the new tables of which we are going to give an account.

To verify the tables constructed from the whole mass of the good observations published till that period, it was necessary to have other observations, equally good, but more recent. Choice was made of 150, both from the registers of the

the national observatory of Paris, from the last publications of the astronomer royal in England, and from the correspondence of the director of the observatory of Gotha. It is sufficient to say, that it was impossible to find any deserving of more confidence, either on account of the excellence of the instruments with which they were made, or the known merit of the observers.

We shall describe in a few words the difficulties which the author of the tables had to surmount, and the precision to which he has attained.

By thousands of comparisons he has proved, in the first place, that the periodical inequalities before determined were susceptible only of very small amelioration. He introduced some equations imperfectly indicated, and afterwards neglected, by Mayer and Mason; and some others much more important, indicated in the last volumes of the *Connoissance des Tems* by C. Laplace: they rendered the tables much better, but did not correct the inequality of the mean motion.

It remained to try equations of a long period. As theory had not furnished any, the author endeavoured to determine empirically the law of the anomalies observed: he lost himself in an inextricable labyrinth; but, at the time when, fatigued with so many vain efforts, he had renounced all hope, he learned that Laplace had discovered the form and arguments of two new equations, the determination of which he deferred till he could obtain a more precise observation. With this aid, almost unhoped for, our author undertook a new labour, and was able to fix the value of the two equations, which explained the whole in the happiest manner. The result was, a more exact knowledge of the mean motion; a more perfect agreement between calculation and observation; and a well-founded hope that this agreement will be maintained, and that we shall no more see, as of late years, errors increase in a rapid and alarming manner.

This is not the place for entering into numerical details; they will be found in a paper and tables submitted to the board. To give an idea of the precision of the new tables, it will be sufficient to say that the errors which can be ascribed to them very seldom amount to 12″: whence it follows, that the astronomer who observes the moon will rarely find between the real and the calculated place a greater difference than the thickness of the very delicate thread which is in the focus of the telescope; and, to show of what importance this exactness is to navigation, we shall say, that as these 12″ of motion do not require above a minute of time, the navigator will never err eight minutes in his longitude, at least

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for the want of tables; so that, if he is able to introduce the same exactness into his observations, he may consider the problem of the longitude as sufficiently solved for practice.

The commissioners conclude that the new tables, by the immensity of the labour which they suppose, the intelligence which directed the labour, the great superiority they have over other tables, and the utility they will daily be of to astronomers and navigators, are altogether worthy of the prize.

(Signed) LAGRANGE, LAPLACE, MECHAIN; and DELAMBRE reporter.

This report having been adopted by the board, the secretary produced a proof that the new tables are the work of M. Bürg, adjunct astronomer of the imperial observatory of Vienna, already so advantageously known by the prize which he participated, in the year 8, with C. Bouvart. The president, therefore, in name of the board of longitude, adjudged the prize to M. Bürg, and it was agreed that a deputation should be named to present the above report to the consuls of the French republic. This deputation, consisting of C. Lalande, Bougainville, Fleurieu, and Chabert, were admitted on Friday, Messidor 6, to an audience of the first consul; who, after having heard the above report, and asked several questions, in regard to the labour and the author of it, was pleased to express his approbation by doubling the promised sum.

Dr. Maskelyne, the astronomer royal of England, being informed of the correctness of the new tables, has requested a copy of them, that he may employ them in his calculations for the Nautical Almanac. The board of longitude congratulates itself on thus having an opportunity of giving to this distinguished man of letters, one of the foreign associates of the National Institute, a mark of its high consideration, and of the gratitude which it owes to him for the collection of excellent observations with which he has enriched astronomy during the course of 36 years.

XXXIII. *Proceedings of Learned Societies.*

FRENCH NATIONAL INSTITUTE.

IN the public sitting of Messidor 17, year 10, the following papers were read:—1st, The new prize questions proposed. 2d, Notice respecting the new planet of Dr. Olbers, by C. Lalande. 3d, Report made in name of a commission appointed to consider means proper for accomplishing the

 intention

intention of the first consul, who proposes to establish a prize for an important discovery in electricity or galvanism; by C. Biot. 4th, Historical notice respecting the life and works of C. Legrand d'Aussi, by C. Levesque. 5th, Report on the prize proposed in regard to a question in architecture, by C. Ameilhon. 6th, Report on the prize proposed for the eulogy of Boileau-Despreaux, by C. Andrieux. 7th, Historical notice on the life and works of C. Dolomieu, by C. Andrieux. 8th, Short memoir on the origin of printing, by C. Daunou. 9th, Fragment of a free and abridged translation of the third book of the Pharsalia, containing a description of the siege of Marseilles; by C. Legouvé.

The following are the new prize questions which have been proposed:

Class of the Moral and Political Sciences.

Morals.—How far does the barbarous treatment to which animals are subjected interest public morality, and would it be proper to make laws on that subject?

The prize will be a gold medal of the weight of five hectogrammes (about 70l. sterling), and will be adjudged in the public sitting of Vendemiaire, year 12. No papers will be received after the 15th of Messidor, year 11.

Political Economy.—What influence has the progressive abolition of slavery in Europe had on the increase of knowledge and the riches of nations?

The prize will be a medal of the same value, and will be adjudged in the public sitting of Nivose, year 12. Papers will be received till the 15th Vendemiaire, year 11.

Class of Literature and the Fine Arts.

Eloquence.—In the public sitting of Germinal 15, year 9, the class proposed as the prize question for eloquence the eloge of Nicholas Boileau-Despreaux; but, as none of the papers presented were thought worthy of the prize, the class proposes the same subject again for the year 12.

The prize will be a gold medal of the value of five hectogrammes, and will be adjudged in the public sitting of Vendemiaire, year 12. The papers must be transmitted to the secretary of the Institute before the 15th of Messidor, year 11.

Class of the Mathematical and Physical Sciences.

Mathematics.—To make a new series of experiments on the pressure which water in a state of motion exercises against a body at rest, and that which the same fluid when at rest exercises against a body in motion; making it a principal object of research to measure the particular pressure experienced by

points

points properly distributed on the anterior, lateral, and posterior parts of the surface of the body subjected to experiment and placed at different depths in the fluid; to determine its velocity in different points of the streams which are nearest the body; and, in the last place, to determine the curves which these streams affect, the point where they begin to deviate from the general direction of the progressive motion of the body, and that where they unite behind it.

The prize will be a medal of the weight of five hectogrammes, about 70l. sterling, and will be adjudged in the public sitting of the month of Nivose, year 13. No papers will be received after the 30th of Fructidor, year 12.

Physics.—The class proposed on the 15th of Germinal, year 8, as the subject of a prize the following question:—"To determine, by accurate experiments, the influence which atmospheric air, light, water, and earth, have upon vegetation." As two memoirs only were transmitted on this subject, neither of which was thought worthy of the prize, and as the class apprehend that the extent of the question may have discouraged those capable of examining it with the best success, they now confine it to one of its elements, and propose as follows:—"To determine, by experiment, the different sources of the carbon in vegetables."

The prize will be doubled, and consist of the value of two kilogrammes of gold, about 280l. sterling. The determination of the class will be published in the public sitting of the month of Nivose, year 13. The papers must be transmitted to the secretary of the Institute before the 1st of Vendemiaire the same year.

The class has thought proper also to remind chemists of the subject proposed for the first time on the 15th of Germinal, year 8, the renewed period of which will expire on the 1st of Nivose, year 12. It is as follows:—"What are the characters which in vegetable and animal matters distinguish those which serve as ferment from those in which they produce fermentation?"

Report made to the Class of the Mathematical and Physical Sciences of the Institute on the Prizes founded by the First Consul for Discoveries in regard to Electricity and Galvanism.

The first consul, who even amidst the cares of war has caused the sciences to flourish, being desirous that the peace should carry them to the highest degree to which they can attain, has given to the National Institute the means of accelerating their progress.

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His intentions in this respect are expressed in the following letter, which was transmitted to the class by the minister of the interior:

Paris, Prairial 26, an. 10.

"I intend, citizen minister, to found a prize consisting of a medal of 3000 francs (about 120l. sterling) for the best experiment which shall be made in the course of each year on the galvanic fluid. For this purpose, the memoirs containing the details of the said experiments shall be sent before the 1st of Fructidor to the first class of the National Institute, which in the complementary days shall adjudge the prize to the author of that experiment which has been most useful to the progress of science.

"I desire to give, by way of encouragement, the sum of 60,000 francs (2400l.) to the person who by his experiments and discoveries shall, according to the opinion of the class, advance the knowledge of electricity and galvanism as much as Franklin and Volta did.

"Foreigners of all nations are admitted to the competition.

"I beg you will make known these dispositions to the president of the first class of the National Institute, that it may give to these ideas such development as may appear proper; my particular object being to encourage philosophers, and direct their attention to this part of philosophy, which, in my opinion, may lead to great discoveries.

(Signed) "BONAPARTE."

The National Institute, which has taken an active part in the grand discoveries with which the theory of electricity has been enriched, will be fully sensible of the importance of the subject indicated by the first consul. Of all the physical forces to which natural bodies are subjected, electricity appears to be that the influence of which is oftenest manifested. It not only acts on inorganic substances, which it modifies or decomposes, but organized bodies themselves experience from it the most astonishing effects. What to the antients was only the simple result of some attractive properties, has become for modern philosophers the source of the most brilliant discoveries.

The history of electricity may be divided into two periods, which are distinguished as much by the nature of the results as by that of the apparatus employed to obtain them. In one, the electric influence is produced by the friction of glass or of resinous matters; in the other, electricity is put in motion merely by the mutual contact of bodies. We must refer to the first of these epochs the distinction between the two kinds of electricity, resinous and vitreous, the analysis of the Leyden flask, the explanation of thunder, the invention

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of conductors, and the exact determination of the laws according to which the repulsive force of the electric matter varies according to the distance. The second comprehends the discovery of the muscular contractions excited by the contact of metals, the explanation of these phænomena by the motion of metallic electricity; and, in the last place, the formation of the electric pile, its analysis, and its various properties. Volta has done in this second period what Franklin did in the first.

The sciences are now so connected with each other, that every thing which tends to improve the one advances the rest at the same time. Under this point of view, galvanism, in the history of them, will form a memorable epoch; for there are few discoveries which have given to philosophy and chemistry so many new facts, and facts so remote from those before known. The aggregate of these facts has been referred to a general cause, which is the motion of electricity: it remains to determine accurately the circumstances by which they are accompanied, to follow the numerous applications they suggest, and to discover the general laws which, perhaps, are contained in them. The greater part of the chemical effects presented by the new kinds of apparatus are not yet completely explained; and it is of the more importance that they should be well known, as they furnish to chemistry means very powerful for decomposing the most intimate combinations. It is also interesting to examine whether the electric properties which certain minerals acquire in their variations of temperature do not depend on a disposition of their elements analogous to that which constitutes the Voltaic pile. In a word, it is to be desired that the theory of electricity augmented by these new phænomena should be completely subjected to calculation in a general, direct, and rigorous manner; and the progress already made in this path has proved that this difficult subject requires the sagacity of the most ingenious philosophy and the aid of the most profound analysis.

But it is in its application in particular to the animal economy that it is of importance to consider the galvanic apparatus. It is already known that metals are not the only substances the contact of which determines the movement of electricity. This property is common to them and some liquids, and it is probable that it extends, with divers modifications, to all the bodies of nature. Do not the phænomena exhibited by the torpedo and other electric fishes depend on an analogous action exercised between the various parts of their organization? and does not this action exist with a degree

degree of intensity less sensible, but no less real, in a number of animals much greater than has hitherto been believed? An exact analysis of these effects, a complete explanation of the mechanism which determines them, and a comparison of them with those exhibited by the Voltaic pile, would, perhaps, afford a key to the most important secrets in the animal economy. By thus considering the aggregate of these phænomena, one foresees the possibility of a grand discovery, which, by unveiling a new law of nature, may conduct them to the same cause, and connect them with those which the motion of electricity has presented us in minerals.

Of these considerations the class was, no doubt, sensible; and if it did not propose a prize for the improvement of this part of philosophy, it was for this reason that, as the extent of the subject seemed to require more than one competition, it could not devote to it exclusively encouragements which it owes to useful knowledge in general. However, each of its members, and all the learned of Europe, ardently desired that the researches of philosophers might be directed towards this important object, and they ought to congratulate themselves on seeing their wish accomplished in the most complete manner.

To fulfil the intentions of the first consul, and give to the competition all the solemnity which the importance of the object, the nature of the prize, and the character of the founder require, the commission unanimously propose as follows:

The Class of the Mathematical and Physical Sciences of the National Institute opens the general competition required by the first consul.

All the learned of Europe, even the members and associates of the Institute, are admitted to the competition.

The class does not require that the memoirs should be immediately addressed to it. Every year it will crown the author of the best experiments which shall come to its knowledge, and which shall have advanced the progress of the science.

The grand prize will be given to the person whose discoveries shall form a memorable epoch in the history of electricity and galvanism.

The present report, containing the letter of the first consul, shall be printed, and serve as a programme.

Done at the National Institute, Messidor 11, year 10.

(Signed) LAPLACE, HALLE, COULOMB, HAUY; and BIOT, reporter.

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The report and its conclusions are adopted. It shall be read at the next public sitting.

Certified agreeably to the original.

(Signed) LACROIX, secretary.

BATAVIAN SOCIETY OF THE SCIENCES AT HAARLEM.

This society has proposed the following questions till the 1st of November 1803:

1st, What have we been taught by the latest observations in regard to the influence of the oxygen of atmospheric air in changing colours, whether aided with the action of light or not; and what advantages can be thence derived?

2d, What have we learned from the discoveries respecting the decomposition of water and atmospheric air in regard to the manner in which plants obtain their nourishment; and what conclusions can thence be deduced for improving the culture of useful vegetables?

3d, What has experience taught us in regard to the purifying corrupted water and other impure substances by means of charcoal? How far can the manner in which this is done be explained from the principles of chemistry; and what further advantages can be derived from it?

The society have extended also to the 1st of November 1802 the three prizes, proposed in 1799, respecting the chemical discoveries in regard to the physiology of the human body; also the question proposed in 1796, and repeated in 1799, respecting the whale fishery; the question, proposed in 1800, respecting Chladni's vibration figures; and the two questions, proposed in 1801, on the nature of fire, and the application of it to produce heat, and on preventing the corruption of stagnant water.

They have repeated also, for an indefinite time, the three following questions, proposed 1793—1795, on the utility of animals apparently pernicious; on the use, in the *materia medica*, of unknown indigenous plants; and on the plants, not yet in use, which may be employed as sound and wholesome nourishment.

MEDICAL SOCIETY AT MONTPELLIER.

This society has proposed the two following questions, the prizes of which will be adjudged, the first in May 1803, and the second in May 1804. The prize for each is 500 francs.

1st, To determine in what kind of chronic diseases, and under what circumstances, inflammation may be useful or dangerous; and in what cases in the treatment of these diseases it ought to be excited or moderated?

 2d, To

2d, To establish, from experience and observation, what degree of confidence ought to be given to the method of using by friction certain substances which are generally administered internally? To determine the effects of these medicines when taken internally and applied by friction, and how strong the doses ought to be? To point out the circumstances and diseases in which either of these methods deserves the preference? And, in the last place, to determine what parts of the body can be employed in different diseases for the more effectual application of these remedies?

XXXIV. *Intelligence and Miscellaneous Articles.*

AEROSTATION.

THE attention of the public has been lately directed to this art, almost forgotten in England, by the arrival of M. Garnerin from Paris with two aërostatic machines of considerable size, and a parachute, which have been exhibited for some time past in the Pantheon. As this art, however little it may promise in other respects, has been found beneficial in military tactics, and might be employed with great advantage in making meteorological and statical experiments, it is well worth the notice of scientific men: we therefore hope that the following particulars respecting M. Garnerin's two aërial excursions in England, on the 28th of June and 4th of July, will be gratifying to our readers, and particularly to those who had not an opportunity of seeing him ascend. In a future number we intend to give a concise historical view of the progress of aërostation, with an engraving of M. Garnerin's balloons and his parachute.

The first Voyage.

In this excursion M. Garnerin was accompanied by captain Sowden, who paid him a sum of money to enjoy the gratification. They ascended from Ranelagh gardens; and the particulars, as detailed by M. Garnerin, were as follow:

The morning of the 28th (the day of his ascent) appeared to promise weather sufficiently favourable for the purpose, though it was rainy. At eleven o'clock, therefore, he began the chemical operations necessary for the production of the inflammable gas. The balloon filled rapidly, though considerably agitated by the wind.

From one o'clock to half past four, the wind continued to increase, and at length blew so violently, that, had he made any

any previous experiment in this country, he should have yielded to the earnest solicitations of the brilliant and numerous company with which he was honoured, and should have deferred his ascent to a period less tempestuous.

M. Garnerin, however, though he determined not to disappoint the public expectation himself, felt it to be his duty to press captain Sowden not, for the sake of curiosity, to expose himself to the perils attendant upon such a journey in such weather. The captain, however, resisted all these solicitations, and resolved to accompany him. From a quarter past four to five some showers of rain fell, which only allayed the fury of the wind for a short time, for after they had ceased it blew with more violence than ever.

At five o'clock Messrs. Garnerin and Sowden took their seats, the cords were cut, and the balloon ascended. Each held a flag of the nation to which he belonged, which he waved to the company present. The balloon first made the tour of the place where the spectators stood, and, after being greeted with the loud plaudits and good wishes of every person, ascended majestically and rapidly into the regions of the air. The wind blew from the south-west. The balloon, therefore, proceeded over St. James's park, the Thames, and Westminster and Blackfriars bridges.

M. Garnerin then found that the balloon began to descend: he threw out some ballast, and it rose immediately with great rapidity, and carried the travellers over the cathedral of St. Paul's.

During all this time, the whole metropolis was distinctly seen by the aëronauts, whose balloon was equally visible to the inhabitants of the metropolis. When it was over St. Paul's, M. Garnerin asked captain Sowden how he felt himself? The captain replied, that he was perfectly enchanted with his situation, and with the superb expanse of sky, and with the earth, now fast lessening to the view, and soon to be seen no more. The temperature of the atmosphere now began to change very sensibly, and to be fifteen degrees colder than when they began to ascend. It was extremely cold. The balloon continued rapidly to ascend, was soon above the clouds, and the earth was visible no more. When the travellers were above the clouds, the climate became sensibly milder: the inflammable air began to dilate, and M. Garnerin gave it all possible means of vent proper for their safety.

They now dined with good appetites, and very comfortably, above the clouds, at an elevation of upwards of 10,000 feet above the earth. During the dessert, M. Garnerin told captain Sowden that the pleasantest part of their journey was

passed,

passed, and that they must now prepare for a very disagreeable descent, on account of the continued violence of the wind.

About half an hour had elapsed since their ascent. M. Garnerin now opened the valve, and the balloon descended through black and cold clouds; they then descried land again, and also the sea, towards which their course was fast carrying them: indeed they were nearly over that arm of it into which the Chelmer empties itself.

As soon as they had approached sufficiently near the earth, they threw out their anchor and cable. When the balloon first touched the ground, it rebounded with considerable violence; this rebound was followed by about twenty more, more violent than the first. The gusts of wind dragged them over fields and hedges, which tore their hands and clothes; their anchor touched the ground several times, but dragged; and it was not till some minutes had elapsed that it took a steady hold in a thicket near a house. Here they conceived themselves to be released from all peril: but the inhabitants of the house, alarmed at the balloon, would not assist them; nay, actually offered to fire on the adventurous travellers. In the mean time the cable of the anchor broke, and they were dragged through trees and branches, the balloon being agitated to an extreme degree, and rebounding very violently. At length they were driven against a tree, and captain Sowden received a severe blow on the back part of his head. The balloon was now torn in the lower part, the cords broke, the boat broke; the travellers had hold of a tree, from which they were torn by the violence of the wind. At last, a bound which the balloon made, enabled them to jump out. The balloon, abandoned to itself, and much torn, fell about 200 paces further.

The place where M. Garnerin and captain Sowden landed was on a common, four miles beyond Colchester, and sixty miles from Ranelagh. The time that elapsed from their departure to their landing on the common was three quarters of an hour.

M. Garnerin's hands were much torn, and his legs and thighs considerably bruised. Captain Sowden received a severe blow on the back part of his head, and was much bruised and torn in other parts of his body by the bushes and trees against which they were driven.

M. Garnerin pays the highest tribute to the courage and coolness of his companion, who, after the balloon had first rebounded, could several times have jumped out of it with great ease and safety: but he persisted in sharing the fate of his companion, till they were both enabled to land in safety.

Captain

Captain Sowden's Account.

Mr. Editor,

As numberless questions have been put to me respecting the sensations I experienced while in the upper regions, I think it a duty incumbent on me to inform the public, and to set them right as to the erroneous ideas they have of an aërostatic voyage. On our first ascending, we felt a few drops of rain. After we had gained the height of about 3000 feet, I desired M. Garnerin not to ascend any higher till he had passed the metropolis, that the inhabitants might be gratified with a fair view of us. When we had got at a small distance from London, we ascended through some very thick clouds, of which I could perceive three distinct rows, at the lower one of which we found the quicksilver of the thermometer at 15°, and I was obliged to put on my great coat; but on ascending still higher we found the air more temperate, and the quicksilver rise gradually to 5° above summer heat. We then seemed to be stationary, and felt no more motion than one would feel in sitting in a chair in a room. I then proposed to M. Garnerin to overhaul our lockers, where we found a ham, a cold fowl, a cake, and two bottles of orgeat, wines or spirits being dangerous to take, owing to the rarefaction of the air. The chill of the clouds having given us an appetite, we made a table on our knees with the seats of the car, and ate a very hearty meal. The clouds then dispersed from under us, and we had a delightful view of the country.

Whether it is owing to the rarefaction of the air, or to the strong light thrown on the earth, I cannot determine, but I found that my sight, which at all times is rather weak, became so strong, that I could easily distinguish the minutest objects on the earth: it appeared like a vast panorama, or map, of about fifty miles in circumference, where we could not only follow with our eyes the different cross roads and intersections on it, but even distinguish the ruts on them, and the very furrows in the field. The sense of hearing was stronger here than on earth; for, at the height of 15,000 feet, we could distinctly hear the rattling of the carriages on the roads, the lowing of cattle, and the acclamations of the people who saw us; though, at the same time, we could hardly hear ourselves speak: and I am persuaded that a person on the earth, with a strong voice and a speaking trumpet, might make himself perfectly understood by any person at that height in the air. I have observed that almost every sensation I experienced while in the upper regions was exactly the contrary to what is the general opinion of the public. I was assured by a number of the most celebrated literati, who pretended to be very learned on that ſubject, that I ſhould find the cold increaſe, the higher I aſcended; inſtead of which I found the heat increaſe to that degree, that I was obliged to take both my great coat and jacket off. It is alſo the general opinion that looking down from ſo ſtupendous a height renders a perſon ſo giddy as not to be able to keep his ſeat: on the contrary, I found that I could look down with a vaſt deal of pleaſure, and without experiencing that inconvenience; whereas looking round on the vaſt expanſe that ſurrounded us, rendered my eyes ſo dim, that I was ſometimes a few minutes before I could perfectly recover my ſight. I experienced no difficulty of breathing, or inconvenience from the motion of the balloon; for, though we moved with immenſe velocity, we felt not the leaſt wind or preſſure of air, it being ſo perfectly calm, that the flags in our hands, and thoſe with which the balloon was decorated, hung ſupine, nor did they ſtir.

I obſerved, that between every row of clouds, not only the atmoſphere, but the wind, varied ſeveral degrees; for, on our paſſing through the firſt cloud after leaving London, the wind, which had before been nearly ſouth-weſt, changed to ſouth-ſouth-eaſt, by which means we found ourſelves over St. Alban's, in Hertfordſhire. On aſcending ſtill higher, the wind became nearly weſt, which drove us over Epping foreſt, which I diſtinguiſhed very plainly; it appeared like a gooſeberry-buſh. I then pointed out our courſe to M. Garnerin on the map, and obſerved to him that we ſhould ſoon perceive the ſea, which in a ſhort time we ſaw very plainly. M. Garnerin then told me we had not a moment to loſe, and muſt deſcend with all poſſible ſpeed; at the ſame time pointing out a very heavy cloud to me, nearly under us; and ſaid—"Il faut que nous paſſions à travers de ce drole la; accrochez-vous ferme, car nous allons nous caſſer le col." I anſwered—"De tout mon cœur." We then opened the valve, and we deſcended with rapidity. On ruſhing into the cloud, I found, as he had conjectured, it contained as violent a ſquall of wind and rain as ever I experienced. The attraction of the water, the force of the wind, and the conſtant emiſſion of gas from the valve, hurled us with ſuch velocity towards the earth, that I expected to ſee his prediction verified; though, I can aſſure you, my ideas at that time did not coincide with the anſwer I made him.

M. Garnerin ſtill retained all his coolneſs and preſence of mind; and, while we were deſcending with that extreme ſwiftneſs, deſired me, the moment I ſhould find the car about to touch the earth, to catch hold of the hoop which was faſtened to the bottom of the net, to which the car was fuspended, and lift myfelf up into the net; by which means we faved ourfelves from being dafhed to pieces. The balloon did not reafcend immediately, but dragged us along the ground, with aftonifhing fwiftnefs, for the length of nearly three fields, before the grappling-iron took good hold: and then we thought ourfelves fafe, being clofe to a farm-houfe, from which feveral perfons came out to fee us: but though we threw out ropes to them, and called for help, they were fo confternated that neither threats nor entreaties could prevail on them to come to our affiftance; for, as I afterwards heard, they took us to be two forcerers, it being rather an unufual thing to fee two men coming down poft hafte from the clouds. We were for about three minutes in that fituation, till another guft of wind broke our cable, and we afcended again nearly 600 feet.

In the buftle of preparing the ropes for the farmers, M. Garnerin had let the rope belonging to the valve flip out of his hand, by which means the bottom of the balloon was preffed upwards by the wind. M. Garnerin defired me to try to regain it; which I at laft effected by climbing up into the net, though the force of the wind ftruck the tin tubes faftened at the bottom of the balloon, and through which the rope led, with fuch violence againft my face, that it had nearly ftunned me. Having recovered it, we redefcended, but were borne with fuch violence acrofs the country, fometimes along the ground, fometimes in the air, that I feveral times propofed to M. Garnerin to abandon the balloon, and to fave ourfelves: but he continually objected to it, and reminded me of my promife not to quit him. In the mean time we were dafhed againft feveral trees, one of which had nearly deftroyed us: being with my back towards it, I received a blow on the head, which threw me at full length at the bottom of the car. M. Garnerin, in attempting to affift me, was nearly thrown overboard; two of the cords that held the car broke, and at the fame time fome of the branches tore the balloon: upon which M. Garnerin cried out, "The balloon is torn, and we are faved." Another guft of wind difengaged us from the tree, and we touched the ground once more, with a lefs violent fhock than before. We then both got out, but fo exhaufted with our numerous exertions that we had hardly ftrength to follow the balloon, which fell again about 200 paces further; when we completely maftered it, by throwing ourfelves upon it, and by that means preffing out the remainder of the gas.

It rained fo very hard, that I propofed to M. Garnerin to leave the balloon in the field, and go in fearch of fome houfe for shelter and refreshment. We accordingly made the best of our way to a house, which we espied about half a mile off, belonging to a Mr. Kingsbery: and here a very curious mistake took place. When we inquired for the master of the house, Mr. Kingsbery appeared: but, seeing two persons of so strange an appearance, (M. Garnerin having a French hat on with the national cockade, bearing the tri-coloured flag, and myself being in a sailor's dress, with the union jack in my hand,) he imagined we came on account of the election; and, before we could address him, said, "Gentlemen, though I am a freeholder, I have made a determination not to vote for one side or the other." So much was he impressed with this idea, that it was some time before we could make him sensible that we had nothing to do with the election, but that we came in a balloon, in three quarters of an hour, from London; that we were very much bruised and tired, and that we required his assistance and shelter. He then received us in the most hospitable manner, not only providing us with refreshments and dry clothes, but even offered us beds, the use of his house and horses, and sent immediately some farmers with a cart to carry the balloon from the field and convey it to a place of safety; and, as we expressed a wish to get to Colchester that night, he sent for a post-chaise to convey us thither, where we were received with loud acclamations by the inhabitants. The next day we returned to Langenhoe, where we had left the balloon, and, after drying it on the grass, packed it up, and made the best of our way to town, where we arrived about four o'clock the next morning.

I cannot help admiring the coolness and presence of mind M. Garnerin preserved even in the most imminent danger; and I am so confident of his great talents and skill in conducting a balloon, that I would venture to go to the end of the world with him.

This is as near a statement as I can recollect; and I should take it as a favour if you would insert it in your Publication, as you will thereby save me a great deal of trouble, having hardly breath enough to answer the numerous inquiries concerning our aërial excursion. I am, Sir, yours, &c.

R. C. Sowden.

The second Voyage.

M. Garnerin was accompanied in this voyage by Mr. Locker, who gives the following account of it:

Although the world has been already presented with an account of a late aërial excursion, I flatter myself so much interest

tereſt is ſtill entertained by the public for the ſafety of M. Garnerin, that the following particulars of his ſecond aſcent will prove acceptable. The very unfavourable weather, attended with a heavy gale at ſouth and ſouth-weſt, induced M. Garnerin to give up his intention of aſcending to diſplay the promiſed experiment of the parachute. In this event, it had been arranged that Mr. Sowden ſhould once more accompany him; but ſome miſunderſtanding having taken place between thoſe gentlemen, and having had ſome previous converſation on the preceding day with M. Garnerin on the ſubject, I aſcended with him yeſterday afternoon at ten minutes before five o'clock from Lord's Cricket-ground. The ſtrong aſſurances of my companion, added to what I had read on the ſcience of aëroſtation, and the experience of former aëronauts, had ſo fully perſuaded me of my perfect ſecurity, that I enjoyed the wonderful and enchanting proſpect which now preſented itſelf with unmixed pleaſure. Although the denſe ſtate of the atmoſphere obſtructed the ſight of diſtant objects in ſo great a degree that our horizon was ſomewhat limited, the unuſual concourſe of ſpectators, which gradually diminiſhed to an undiſtinguiſhed maſs, and the view of a great part of the metropolis, together with the ſurrounding country, afforded me an entertainment well worth the purchaſe of any ſuppoſed danger. After throwing out ſome part of our ballaſt we aſcended very rapidly, and by the intervention of ſome thick clouds (which had much the appearance of a ſea of cotton beneath us, as deſcribed by Mr. Baldwyn, of Cheſter), we entirely loſt ſight of the earth. We moved with much rapidity, although our motion was to me perfectly imperceptible; and at length the clouds diſperſing, we again ſaw the country below us. I attempted, in vain, to aſcertain our ſituation, by calling to my recollection the appearance of the country, which appeared to me more like a proſpect ſeen in a camera, when placed in a very elevated ſituation, than any thing to which I could compare it; I think a map is an incorrect compariſon, as the various objects are not, as in nature, delineated with ſufficient minuteneſs to bear ſuch a reſemblance.—About this time M. Garnerin looked at his watch, and, obſerving we had been five minutes on our voyage, propoſed to deſcend in about the ſame time.

The peruſal of Mr. Sowden's narrative led me to obſerve, with much attention, the power of hearing noiſes below. Neither M. Garnerin nor myſelf could diſtinguiſh ſounds above the elevation of 3 or 4000 feet; though M. Garnerin imagines a very confused sound, but totally undistinguishable, may be heard considerably higher. We never attained a greater height this day, by M. Garnerin's computation, than about 1200 French toises, or 7800 feet, as M. Garnerin, being desirous to return the same evening to town, did not choose to lose a favourable opportunity of descending. At length we saw at a distance what afterwards proved to be Epping forest, with a range of distant hills beyond; and observing an open champaign country, M. Garnerin opened the valve, and we began to descend. He directed me to call to some persons employed in a field, as we approached the ground, to take hold of the ropes which we had thrown out for the purpose, and recommended me to hold fast by the cords, to avoid the shock on the balloon's first touching the earth. This precaution proved very necessary, as the force with which we descended was very considerable, from the force of the wind rather than by our specific gravity, and the rebound bore us up again with velocity to the height of 150 or 200 feet. In redescending we struck against a tree, the shock of which gave M. Garnerin a severe blow on the back; and he observed that this was the only occasion, during a period of twelve years in which he had been in the habit of aëronavigation, and the 27th time he has ascended, that he ever suffered such an inconvenience. Several of the peasantry being now at hand, we were prevented from any further ascent, and alighted from the car with perfect safety. We immediately inquired our situation, and found we had fallen in a field of Mr. Owen's, at Chingford, in Essex; and, referring to our watches, observed we had made our voyage exactly in one quarter of an hour. We dispatched a messenger to Woodford for a post-chaise, and, having expressed the inflammable air, packed the balloon in the car, and had it conveyed to a small inn at Chingford-green, adjoining which we had descended; from whence, after a slight repast on some provisions we had brought with us, we set off for London, and arrived at M. Garnerin's, in Poland-street, a quarter after nine in the evening.

Although the mob, which surrounded us on our descent, were, as usual, both troublesome and officiously impertinent, we received great attention from Mr. Hughes, of the Stamp-office, London, and several other gentlemen, who beheld our arrival. Attention would have been, however, insured to us, if necessary, by the paper put into the hands of M. Garnerin, signed by his royal highness the prince of Wales, the duchess of Devonshire, lords Besborough, Cathcart, and other persons

of

of distinction, who witnessed our ascension at Lord's Cricket Ground. I am, &c.

Greenwich, July 6. ED. HAWKE LOCKER.

(COPY.) July 5, 1802.

"We, the undersigned, having been present at the ascension of M. Garnerin with his balloon this afternoon, and witnessed the entire satisfaction of the public, beg leave to recommend him to the attention of any gentleman in whose neighbourhood he may happen to descend.

George, P.W. Besborough. R. Ford."
G. Devonshire. Cathcart.

M. Garnerin's balloon ascended at Lord's Cricket Ground, London, at ten minutes before five, and descended at Chingford-green, in Essex, in a field of Mr. Owen's, at five minutes past five, passing a distance of nine miles in one quarter of an hour: this circumstance attested at the King's Head, Chingford-green, in the presence of

George Clinton Davies, Thomas Williams,
John Hughes, Stamp-office, London; George Soames,
John Odtrins, Richard Pamphilion.
Garnerin, E. H. Locker, } The aërial travellers upon this occasion.

We believe Mr. Locker means to publish a fuller account of his voyage.

VOYAGES AND DISCOVERIES.

C. Riedlé, gardener to the expedition under Capt. Baudin, has addressed the following letter to C. Thouin, professor in the National Museum of Natural History:

"Island of Timor, September 28, 1801.

"We left the Isle of France on the 25th of April last. Our passage to Lewin's Land, New Holland, was thirty-two days. Scarcely had we arrived on the coast, when the currents drove us to the distance of more than ten leagues. We, however, succeeded in approaching it, and coasted along it for several days at the distance of about two leagues without observing a single place where we could land in safety with the boat. The whole coast is bordered with reefs; it presents a barren aspect, and nothing is seen but small bushes amidst white sand. But, when we reached the latitude of Point North, we discovered a vast bay, the entrance of which appeared to be at least fifteen leagues in breadth, and which penetrates more than ten leagues inland. It was called the *Baye du Geographe* *.

"We anchored in this bay on the 28th of May. The first care of our commandant was, to dispatch an officer to sound it, and construct a chart of it. I obtained leave to go in the boat. We landed at a place bare of wood, but ornamented with a great variety of plants. I much regret that I was able to remain here only a few moments.

"Next day we hove up our anchor in order to take a sta-

* This is the name of the commodore's vessel.

tion at the bottom of the bay. A great part of the crew went on fhore; and here, for the firft time, we had an opportunity of feeing the natives of the country.

" The fhores of this bay, thofe at leaft which we were able to explore, prefent in general only downs, or fmall hills of fand accumulated by the wind. Some fhrubs grow here, but thinly fcattered, and the largeft are not fix feet in height. Beyond thefe are low grounds covered with thick woods. Among thefe, in particular, is diftinguifhed a kind of juniper. Thefe beautiful trees retain their foliage throughout the whole year, grow very clofe to each other, and, as their tops all rife to the fame height, they appear to the eye which views them from the top of the downs like large fheets of verdure extended horizontally and attached to different trees which furround them. Their bark, which is exceedingly thick, and five or fix lines in thicknefs, is employed by the inhabitants for covering their huts, to make dreffes to fecure them from the cold, and as beds to fleep on.

" The upper part of the foil confifts of a ftratum of vegetable earth, of the colour of turf, at leaft fix inches in thicknefs. Below is found very black mofs earth. I collected fome of it as a fpecimen.

" This day I obtained feveral beautiful plants, among which were a *gnaphalium*, with large flowers as white as fnow; and an *atriplex*, with larger and longer leaves than thofe of the bay laurel. I met with others which were not new to me, and I even faw fome which grow in the neighbourhood of Paris. Our excurfion ended with the day, and it was night-fall when we returned on board.

" It was intended that we fhould fail from the bay next morning; but the officers of the *Naturalifte* *, who had landed on a different part of the coaft, having reported to the commodore that they had difcovered a kind of river, it was determined that the long-boat and a canoe fhould be fent to explore it. Every body wifhed to be of the party: the botanift, the mineralogift, the doctor, the commodore's fecretary, and myfelf, were admitted.

" This day was a day of misfortune. I had made a rich collection of plants, and was returning loaded with them to the landing-place, when I learned that the boat had run aground, and that it was impoffible to get it afloat again. The canoe fet out alone at ten in the evening, and the officer who had charge of it promifed to ufe the utmoft difpatch to inform the commodore of our difagreeable fituation.

" The number of perfons on fhore being fixteen, we made

* The other veffel belonging to the expedition.

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an intrenchment around us, lighted a large fire, and appointed a guard of three men to keep watch during the night. Next day paſſed away without hearing any news from the ſhip. The day following ſtill nothing was ſeen. The ſea, however, appeared to be viſibly rougher, and to become more and more threatening. We began to be in want of proviſions and water. At laſt, on the third day, we ſaw a boat coming from the *Geographe*, which brought us all the aſſiſtance we ſtood in need of. We learned, that the one which carried to the commodore the news of our diſtreſs had been thirty-ſix hours in reaching the veſſel, having had to ſtruggle againſt a very hollow ſea; that the barometer had fallen more than ſix lines in the courſe of a very ſhort time; and that every thing announced a violent ſtorm. The commodore requeſted us to haſten our embarkation; and to leave on ſhore our arms and ammunition, together with all our baggage, and even all the plants which I had carefully collected, and for which there was no room in the canoe. It was juſt time: two hours later we ſhould not have been able to reach the ſhip: it would even have been impoſſible to embark.

" A canoe having been diſpatched from the *Naturaliſte* to recover the effects we had left on ſhore, one of the ſailors, an excellent ſwimmer, threw himſelf into the ſea to tow it on ſhore; but, being thrown down by the waves, he ſunk and diſappeared. The canoe returned without landing, and brought back nothing but the melancholy intelligence of the loſs it had ſuſtained.

" We were three days in getting from this bay. The day after, the *Naturaliſte* ſeparated from us; and we did not ſee her again till ſhe reached Timor, a month after our arrival at that iſland.

" After we left the bay, and when the bad weather was over, we approached the land, and ſtretched along the coaſt as near to it as poſſible. Never in my life did I ſee a country more arid or barren: not a drop of good water to be got; little or no vegetation; and the land inacceſſible, and ſurrounded by reefs and deep water. Sometimes, when at the diſtance of ſix leagues from the coaſt, we had thirty-ſix fathoms water, and in a few minutes we found only five.

" In this manner we reached the *Baye des Chiens Marins*, where the veſſel anchored. During the time we ſtaid here I had an opportunity of viſiting two iſlands, which may be each twelve or fourteen leagues in extent. I traverſed them nearly in every direction, obſerving with great care their natural productions, particularly the plants, ſeveral of which

were

were unknown to me. I collected seventy species. It was then I regretted that I had not been able to land on different points of the immense coast along which we had sailed. Notwithstanding its appearance of sterility, what a store of hidden curious and unknown productions it would have presented to me!

"On our departure from the *Baye des Chiens Marins* we discovered a new island, which we marked on our chart. We called it *l'Isle des Amiraux*, because we saw a great many birds of that name upon it. This island is about three leagues from the land. Notwithstanding the good intentions of the commodore, it was not possible for any of the naturalists to go on shore; but the officer ordered to reconnoitre it brought back several beautiful shells and plants. He observed also a quadruped of the size of a shepherd's dog; and discovered a spring of excellent water.

"We continued our voyage along the coasts of New Holland, but no where went on shore. At length, after a most dismal navigation, we anchored, on the 23d of August, in the harbour of Coupant, in the island of Timor. On the 25th we took up our lodging on shore in two houses provided by the governor for the commodore: the latter resides in one of them, and the naturalists in the other.

"How great a contrast this fertile and woody country, especially in the part which we inhabit, forms with the coasts we have just sailed along! The plants, indeed, are not so uncommon as those of New Holland. A great many of them are cultivated in the Isle de France. I have seen the wild bread-fruit tree, mango trees, and tamarind trees of a prodigious height, areca trees, cocoa-nut trees of different kinds, the maringa, sophara, &c. The whole country around the harbour of Coupant is covered with these beautiful trees. I have seen fig trees thirty feet in circumference, shading the ground to a great distance with their branches, and capable of sheltering from the rain a whole battalion of soldiers. I found the *rizophora mangas*, which I had before observed in America; but the tree which appeared to me most remarkable was the *casuarina*, the trunk of which grows to the size of ten feet in circumference, and rises to the height of fifty.

"This island is watered by a multitude of streams: it contains beautiful plains, which are easily laboured with the plough. The principal objects of cultivation are rice, maize, yams, and tobacco.

"I have already made a great many herborizing excursions in the island. In drying the plants for the *hortus siccus*, I do not forget to preserve living ones, to be conveyed to the Isle

Isle of France, and perhaps to Europe. I shall leave them at Timor, to which we intend to return when we have explored the south part of New Holland. I have little hope of bringing back many from that strange country. The commodore has already informed me that it is almost impossible to carry on board living plants on a coast so dangerous, and to stow them in a vessel where so much room is required for performing the multiplied manœuvres rendered necessary by the increased danger.

"I think we shall leave this place about the end of the month in order to explore the south coast of New Holland."

The court of Madrid has determined to send out two *sçavans* to make discoveries in the interior of Africa. They are now at Paris, but are to visit this country for the purpose of purchasing mathematical and astronomical instruments. They wish also, previous to their departure, to have an opportunity of conferring with the African Society, and of seeing Mungo Parke, who is so eminently qualified to give them that previous information which may enable them to prosecute their researches with success.

ANTIQUITIES.

The prefect of the department of the Côtes-du-Nord having ordered some researches to be made by digging in the village of Coursenlt, two leagues from Dinan, the workmen employed came to the ruins of a buried city, respecting the existence or destruction of which no traditionary accounts are preserved. Several antiquaries are of opinion that it was the antient capital of the Curiosolites, the name of which is still preserved in the corrupted appellation of Coursenlt. Several highways, the pavement of which is in good preservation, end at this village, and proceed in the following directions: one towards Rennes, another towards Vannes, a third towards Coutances, and a fourth towards the sea. A quantity of walls, of greater or less thickness, have been found, which, no doubt, formed the houses and streets of the town; cisterns; the half of an octagon temple; a great many medals of Nero, Tiberius, Faustina, Constantine, and others, with small bronze figures. There is reason to hope that more important discoveries will be made to decide the uncertainty which prevails among the learned in regard to the existence of this antient town.

In our eleventh volume we informed our readers that M. Von Hammer among other interesting objects had discovered and got possession in Egypt of an Arabian MS. of great antiquity,

antiquity, which would probably furnish a complete key to the hieroglyphics. We are now able to state some further particulars respecting this invaluable acquisition. The title of the work is, "The wished-for Object in regard to the Secret of the Alphabets," collected in the time of the caliph Merwan by a man of learning, who at that period was much employed in translating Syriac and Chaldaic books into the Arabic. The name of the author is Achmed Ben Abubeker Ben Wahschize It contains eighty alphabets; some of them known, some unknown; some of them now in use, and some of them employed in the east for writing in cyphers; and, at the end, three tables of hieroglyphics with an explanation added to them in Arabic, and which is founded on principles more agreeable to truth than could be expected from an Arabic work on the subject. The gentleman who found this manuscript had it translated into English on his arrival from Egypt; and Mr. Nicol, the bookseller, known by his zeal for the progress of every thing that tends to promote the cause of literature, has, we understand, undertaken to publish the original and translation at his own expense. The unknown alphabets are to be cut in wood, and the text will be printed with a new letter which exceeds in elegance any thing of the kind ever before produced in oriental types. This work will be ready, it is supposed, in the course of the present year; and, with Zoega's new work on obelisks, and the works to be published by the Society of Antiquaries on the stone with three inscriptions, in the hieroglyphic, vulgar, and Greek language, will, in all probability, throw great light on this subject, not yet sufficiently explained.

MAMMOUTH.

The following is an extract of a letter on this subject from C. Roume, private agent of the French government at Saint Domingo, dated Philadelphia, January 4, 1802:

"Mr. Peale, that indefatigable naturalist, whom the Americans have the happiness to possess without knowing his merit, has discovered several skeletons of the mammouth, one of which is entirely complete except a few of the double parts; but drawings of the parts which are wanting have been made from those that remain. He has taken the greatest care to mount this skeleton, and yesterday it was publicly exhibited.

"The first day, however, was destined only for the members of the Academy of Arts and Sciences at Philadelphia; and I should not have been able to pay a visit to this antient inhabitant of America had it not been for the politeness of Mr. Peale, who admitted me into the exhibition-room, with several

ſeveral Frenchmen who accompanied me, and particularly C. Fouſſenguy.

" The latter, then, can tell you, that the ſkeleton of the mammouth does not ſenſibly differ from that of the Aſiatic elephant but by ſome particularities in the teeth and tuſks. The maxillary teeth of the elephant touch each other in ſurfaces not very unequal; while the upper ſurfaces of the teeth of the lower jaw, and the inferior ſurfaces of the teeth of the upper jaw, in the mammouth, are furniſhed with very prominent and pretty ſharp tubercles.

" The tuſks of the elephant have only one curve, while thoſe of the mammouth have a double curve. They firſt iſſue from the upper jaw more divergent than thoſe of the elephant; they then turn ſo as to form part of a ſpiral, deviating more and more to the left. In a word, ſetting aſide the double curve, and conſidering each tuſk in profile as if it were traced out on the ſame plane, the whole of the curve of the tuſks of the mammouth is rounded much more; that is to ſay, preſents an arc of a great many more degrees than that of the elephant.

" Had a ſkeleton of the elephant been placed by the ſide of the preſent one, I ſhould, perhaps, have been able to remark other differences; but theſe were the only ones it was poſſible for me to obſerve.

" Mr. Peale is going to mount a ſecond ſkeleton of the mammouth, but much leſs complete: he intends to commit it to the care of his ſon, who will exhibit it in the principal cities of Europe, in order to obtain money to maintain his family, and to enable him to continue his reſearches, which may lead to other diſcoveries no leſs intereſting, ſince it is now fully proved that there exiſted formerly in America another animal ſtill greater, perhaps, than the mammouth. This proof reſults from ſome maxillary teeth and boney fragments, which have nothing in common with the ſame parts in the mammouth, and which are formed on a much larger model.

" I beg you will communicate theſe details to the National Inſtitute. Get Mr. Peale choſen a correſponding member. You will not repent it. I have already prevailed on him to ſend his ſon firſt to France; and I have promiſed that you will give him a good reception, and preſent him to the Inſtitute, who certainly will not fail to induce the firſt conſul to purchaſe the ſkeleton which Mr. Peale jun. will bring with him, either that it may be depoſited in the National Muſeum immediately, or after he has been allowed to exhibit it in different parts of Europe. The ſkeleton which has been mounted is 11 feet 9 inches Engliſh in height from the extremity of the vertebral epiphyſes of the ſhoulder to thoſe of the fore-feet."

STATISTICS.

C. Chaptal has ſent the following letter to M. Otto, miniſter plenipotentiary of the French republic at London, in conſequence of receiving, through his hands, a copy of Sir John Sinclair's paper on longevity, a part of which has been given in the preſent number of the Philoſophical Magazine:

"I beg you will thank Sir John Sinclair for the work he has ſent me: it is worthy of a man who is conſtantly employed with what is uſeful, and who has directed his attention to one of the moſt curious and moſt intereſting points in the ſtudy of man. Anſwers to the queſtions propoſed by Sir John Sinclair would, no doubt, throw great light on the cauſes, hitherto obſcure, in regard to the difference in the duration of the life of man. We ſee ſome placed in circumſtances which might be conſidered favourable, carried off at a very early age; while others, ſurrounded by all the apparent cauſes of death, reach the utmoſt term of human life. I ſhall circulate the queſtions propoſed by Sir John Sinclair, and I have given orders that the tables of mortality drawn up by the government ſhall be tranſmitted to him every year, with the particular obſervations which accompany them. I ſhall be very glad to know his opinion on this labour as it reaches him. I beg you will aſſure him of my eſteem, and that I wiſh a correſpondence may be eſtabliſhed between us."

MEDICINE.

In a letter which came to hand a few days ago from our friend Dr. Mitchell, of New York, whoſe political engagements (having been again elected member of Congreſs) have not leſſened his ardour for ſcience, we have received ſeveral important communications, which ſhall appear in our next. We ſhould, however, feel ourſelves culpable if we delayed the publication of the following caſes of pulmonary conſumption cured by a ſalivation; communicated in a letter from Dr. Ruſh to Dr. Miller, dated Philadelphia, May 6, 1802:

"I have great pleaſure in informing you that Dr. Parke has lately diſcharged a patient from the Pennſylvania hoſpital perfectly cured of a pulmonary conſumption by means of a ſalivation. I have likewiſe been again made happy in ſeeing the triumph of that remedy in the caſe of Mr. James Hunter, a young gentleman of reſpectable character in this city. He had been afflicted for ſeveral years with weak lungs; and, in conſequence

conſequence of an attack of the bilious fever laſt fall, became diſeaſed with all the uſual ſymptoms of a confirmed conſumption. The ſalivation was adviſed by Dr. Phyſick and myſelf, and was continued to a ſevere degree for ſeveral weeks. His cough and fever left him with the ceſſation of the diſcharge from his ſalivary glands. I ſaw him on the ſecond of this month in good health, and with a conſiderable increaſe of fleſh ſince his recovery.

DEAFNESS RELIEVED BY GALVANISM.

Profeſſor Pfaff, of Kiel, in a letter to Dr. Friedlander, at Paris, ſays: " There is an inſtitution for the deaf and dumb at Kiel. For three weeks paſt I have employed the electric pile of Volta as a cure for deafneſs. It produces its effect very ſlowly. The letters which the deaf and dumb can hear, as we may ſay, ſerve as a meaſure to determine the degree of their deafneſs. They hear the letter *a* the ſooneſt, then *e*, and in the laſt place *i*. They often change *o* into *u*. One of them heard *ou* for ſome days as *u*. Of all the conſonants, *r* is that which they hear firſt. They are ſoon able alſo to hear *ſs* and *ch*; but they do not hear *l* and *s* till very late. The ſame phænomena are obſerved in ſeveral individuals at the ſame time. It appears, however, that the Voltaic pile produces only a momentaneous irritation of the auditory nerves during the time it is employed, and that this irritation is followed by a weakneſs and relaxation of the parts. The patients became deaf as before when I ceaſed to electrify them, for the effect is nothing elſe than that produced by electricity. I propoſe to continue my experiments for two months at leaſt.

DEATH.

On the 28th ult. at his houſe in Marlborough-ſtreet, in his 35th year, Thomas Garnett, M.D. of a fever of the typhous kind. Without anticipating the account of his life, which, we underſtand, is to accompany his lectures, many of which he left ready for the preſs, we may obſerve, in general, that he poſſeſſed all the eſſential qualifications of a public teacher, in an eminent degree. Having been early initiated in claſſical and mathematical learning by a gentleman of uncommon ability, eſpecially as a geometrician, he was thus regularly prepared for his ſubſequent courſe of ſtudy at Edinburgh; where his application was ſuch, that we have heard him ſay, he allowed himſelf, for ſeveral years, only four hours ſleep, and very little relaxation during the day. What muſt have been the progreſs of a penetrating genius, combined with fuch induftry, and under the conduct of able teachers, (whom, by the way, he always mentioned with the greateft refpect,) our philofophical readers will eafily conceive. In fact, when the doctor left that univerfity, he might be faid to have been accomplifhed in all the effential parts of medical erudition, and thoroughly initiated in every collateral branch of knowledge. He had made himfelf well acquainted with the theory of the celebrated Brown; and the ability with which he fupported that theory is well known to the readers of his Lecture on Health, and will be ftill more apparent when his Lectures on Zoonomia, of which he left a correct copy, come to be laid before the public. He gave a decided preference to the modern chemiftry, which he treated with all that perfpicuity and precifion, which might be expected from a teacher who had been early habituated to the clofe and accurate reafoning which diftinguifhes the mathematical fciences. We have heard him feveral times fay that, in point of evidence, chemiftry, in its prefent ftate of improvement, is not inferior to the Newtonian philofophy: and although we might not be prepared to give our unqualified affent to this opinion; yet we cannot but acknowledge that fuch a declaration, from fo able a judge, is highly creditable to the fcience. As an experimenter, Dr. Garnett was at once dexterous and cautious; fo cautious, indeed, that we never knew or heard of any material accident happening at his lectures. His audience attended him with a fenfe of perfect fecurity, and his apparatus fuffered little or no damage in his hands. Many of the articles were improved by the alterations he had occafion to make in them; and, upon the whole, his apparatus, as it now ftands, is extremely valuable. We apprehend it will be difpofed of by private fale, which, however judicioufly conducted, cannot be expected to return any thing like its original coft. This is the more to be lamented, as upon that apparatus, the lecture-room which he lately built, and the many contingent expenfes attending a new eftablifhment, the doctor had expended fo much money, as to have left little or no provifion for his orphan children. A fubfcription, we underftand, is to be opened in their behalf, which, we hope, will place them in a fituation in fome degree fuitable to the profpects they might reafonably have entertained, if their father had lived to reap the fruits of his labours.

XXXV. *On Painting.* *By Mr.* E. Dayes, *Painter* *.

Essay III.

On the Elements of Beauty.

What art thou, Beauty? whence thy pow'r,
That thus persuasive charms the heart,
When thy fair hand adorns the roseate bow'r,
Or blooming virgin, pride of all thy art!

Langhorn. *Vide Grand Magazine.*

Upon mature consideration it will appear as if our inquiry should be after the beautiful itself; or, in other words, that which makes every thing beautiful by its presence. For, should any one assert that beauty is purely external, he must never have considered the subject. For, were it asked from whence a man is wise, should we not answer, From possessing wisdom? And should we not say the same of good things, that they were so from having good in them, and that an object is beautiful from possessing beauty? or shall we pronounce those things mere non-entities, and the words of no import?

Perhaps any two persons in opposite hemispheres, who should begin or invent a science (geometry for instance), would proceed in their discoveries nearly in the same way. Now, to invent is to find; and to find something presupposes its existence somewhere, internally or externally, scattered or in a mass. Or shall we say there is not any such thing as science? that it is only a knowledge of externals? But how could they assert the power of that Being who operated prior to all externals? If our knowledge is of externals, we must certainly labour under a deception; for it is not externals but their images only that we are acquainted with, the objects themselves not becoming the subject of speculation. So we shall not possess truth itself, but only certain images of truth, and of course possess what is false; while truth will abide in the externals. Hence should we not rather conclude that science cannot be taught by man, or be obtained through the means of externals only, but lies, as it were, latent in every mind, till excited and brought to light by diligent and deep inquiry? For, were the inquiries of art after visible objects, the point would soon be settled by diligently copying the images painted to sense: on the contrary, the artist, recurring to the reasoning energy, aims at a perfection beyond

* Communicated by the Author.

beyond matter. But some, having no knowledge of internal beauty, are constrained to seek it in the objects of sense, and of course present us with all the imperfections of an individual model. Hence, was beauty to remain external to the soul, it could never affect; but, being well and perfectly conceived, we are moved by it with the most exquisite delight.

Painting depends on two powers, the mind and the hand; or, in other words, reflection and practice. We should therefore, by an early application to drawing, particularly regular forms, qualify ourselves to embody our ideas with facility and ease when the mind has attained to maturity.

As the Great First, or that which is in the most exalted degree, contains all things in the immensity of his being; so all things being referred to and subsisting by him, he is considered as the good of the universe. Hence all desire the possession of good, as thinking thereby they shall become sufficient to themselves *. But all do not think the possession of beauty will be the completion of their wishes; not that the good can be destitute of beauty, as in the First must necessarily abide all things: so it will be superior to beauty, as not requiring the assistance of the senses.

The beauty of intellect is superior to that of matter, and appears to have had a previous existence; just as the conclusion will remain indubitably certain, whether the syllogistic energy be exerted or not; or as true science existed before theory, and it before practice †. It is from this the artist can never fashion beautiful forms equal to the perfection of reason from which he acts; for reason is a superior beauty, since in it is contained the beauty of art.

Again, as beauty argues perfection, it were in vain to seek it in sensibles, the objects of sense being imperfect. For, though we should grant it is rendered in a certain degree visible in matter, yet the higher degree of perfection is implied in the Venus Urania.

To carry on our inquiry, works of art cannot derive their beauty from the materials of which they are composed, but from the *reasoning energy*; not because the artist possesses hands and eyes, but that he is endowed with art. For it is

* The Supreme Author of our being has so formed the soul of man, that nothing but himself can be its last, adequate, and proper happiness.

ADDISON.

† True science belongs only to the great Artificer of the universe: all our exertions only place us in a middle station, between ignorance and perfect wisdom. It is scarcely necessary to observe, creation could not have been produced through the means of externals, as sensible objects had not then a being. It may be further necessary to remark, that the wise of all nations have thought that the sciences have vanished and appeared again under the various revolutions of the universe.

the duty of the artiſt to faſhion beautiful forms; as of a man, not any particular one is to be taken as a model, but he is bound to enter into the reaſons of art, and produce a perfect aſſemblage of beauty.

Something further than manual labour is neceſſary, otherwiſe we may miſtake ſeeing and hearing for underſtanding.

Some ignorantly miſtake magnitude for greatneſs; but if bulk is beautiful as bulk, it muſt follow that active reaſon, which is not bulk, is not beautiful. But the contrary is the fact, and fine works of art derive their excellence from reaſon infuſed and exiſting in matter.

It is from miſtaking the true end of art that many fall into painting large pictures, ſuppoſing what is big muſt alſo be great in art; whilſt others, from an exceſs of vanity, give their figures a gigantic proportion—highly improper in what may be termed *chamber pictures*. Wrong or bad taſtes delight in things monſtrous. The exceſs of Nero was ſhown in his ordering a picture of himſelf to be painted on cloth 120 feet high, which was ſet up in the gardens of Marius; in his golden palaces; and in his gilding ſome fine ſtatues *.

The love and admiration of beauty is implanted in our natures by the great Firſt Cauſe, and we are carried to it by an impulſe irreſiſtible; its influence is powerful; it tranſports the ſenſes beyond what is uſual, and, if its continuance be long, is accompanied with melancholy, and a ſilent ſadneſs.

————————She never told her love,
But let concealment, like a worm i' the bud,
Feed on her damaſk cheek: ſhe pin'd in thought,
And, with a green and yellow melancholy,
She ſat like Patience on a monument
Smiling at Grief. SHAKSPEARE.

Though the above is one of the effects cauſed by beauty, yet we wiſh to be underſtood as diſtinguiſhing between the ſatisfaction we feel upon contemplating any thing beautiful, of whatever kind it may be, and that paſſion of the mind ariſing from deſire or luſt.

Many definitions of beauty have been attempted. Johnſon calls it "that aſſemblage of graces or proportion of parts which pleaſes the eye." Locke, "a certain compoſition of colour and figure, cauſing delight to the beholder." A third, "perfection." The two former appear to come much nearer truth than the latter; for, if beauty was perfection, the toad muſt be beautiful, it being equally perfect with the reſt of creation.

* I think it was Caligula that deteſted the works of Virgil, and lamented he did not live in his time, that he might have had the *pleaſure* of putting him to death.

Fancy or opinion will go but a little way towards illuftrating a fubject that feems to influence on fome univerfal principle, and to affect all perfons, and at all times.

It appears pretty generally admitted that beauty (or the beautiful) is that which moves us with pleafure through the fight or hearing, as by the eye we are delighted with pictures, ftatues, or buildings; and in mufic, with the harmony of well meafured founds; alfo in poetry, with fentiment and meafure: but as whatever is produced by nature or art is the effect of a certain wifdom, hence it follows that wifdom becomes one of its qualities, and the fafcinating power of beauty will appear to arife from an union the moft delightful—wifdom and pleafure*; which will affect all perfons, and at all times, and will equally apply to painting, ftatuary, poetry, ethics, and laws.

We muft not confider apparent beauty as a fimple idea, or as exifting in proportion, fhape, foftnefs, &c. only; one conftituent is colour, and, in a more abftract way, light and fhade; for on the latter being well difpofed depends much of the general good effect of the picture, as from a bad difpofition of the light and dark a fine form may be defaced and broken.

Many imagine the arts operate by imitating nature merely: the fact is, they do not fimply copy fuch objects as are feen by the eyes, but, recurring to thofe reafons from which the energy of nature fubfifts, add fomething where any thing is wanting to the perfection of the whole. Thofe beautiful forms of the Greeks which happily exift among us are not imitations of any fpectacle proper to the fenfes, but are the refult of profound contemplation. Phidias, when he fafhioned his Jupiter, conceived the idea of the god fuch as he would appear if exhibited to our eyes, and, by a divine enthufiafm, produced a work faid to be more than mortal.

It is this lovely ideal that ftamps fuch a value on the beft works of art; it is this ideal perfection which may be truly called the goddefs of painting, the light of fcience, the fire from heaven with which Prometheus animated his ftatues; it is the loves, the graces, of genuine and legitimate art.

On the fenfible Qualities of Beauty.

Many reafons have been affigned why beauty charms and captivates the fenfes. The Platonifts believed our delight

* Hence the ftatue of Hercules as well as the Venus de Medicis will be beautiful in art from the above union; but, was the former animated, the pleafure would vanifh from a dread of his power.

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arose from its producing a recollection of those beautiful visions we had enjoyed in a previous and more perfect state of existence. Burke calls it "some quality in bodies acting mechanically upon the human mind by the intervention of the senses."

That there is a beauty superior to form and colour is unquestionable, as light, which, though in itself formless, is a source of form, and is perhaps the only thing visible: light is life, its opposite is darkness and death.

Ignorance of beauty and taste argues a defective animation, whilst a wrong or bad one proceeds from a weakness of judgment: hence some mistake deformity for beauty, and continue in that error through life. The young artist should therefore learn as early as possible to avoid gross and vulgar habits if he proposes to elevate the character of his works: if his apostles appear as if strayed from Rag-fair, and his heroes and princes possess the vulgar air of prize-fighters, they can never be expected to interest beyond people of similar habits, and will never attract the attention of those whose sentiments are delicately just: coarse intelligence may surprise the unthinking, but will not satisfy the discerning.

Mild, affable, and gentle, are qualities of beauty, and these we admire when we see them united (in temperance) with the three principal signs of life—heat, motion, and voice; but excess of either destroys.

There are three distinct characters of beauty, two of which may be considered as earthly; as the common, which depends on fashion, and satisfies common sense; the uncommon, as selected by judgment; and the perfect, which, as before observed, subsists in imagination.

If we diligently attend to the progress of the arts in Greece, or after their revival in Italy, we shall observe three distinct periods: first, when they went no further than merely copying an object; secondly, when they selected their object; and lastly, which marks the highest point of excellence, when they produced works of pure imagination.

The beauty of the naked requires several qualities to its perfection; as, that the form be in proportion, and well shaped; that it possess a free and easy motion, and be of a sound and fresh colour. The two latter will be treated of in their proper places, while here we shall content ourselves with offering the proportions found in De Piles, as some guide in the search of truth: besides, as the painter deals in foreshortening, they are not altogether of that importance as to the statuary.

"The antients have commonly allowed eight heads to their

their figures, though fome of them have but feven; but we ordinarily divide the figure into ten faces*, that is to fay, from the crown of the head to the fole of the foot, in the following manner:

"From the crown of the head to the forehead is the third part of a face.

"The face begins at the root of the loweft hairs which are upon the forehead, and ends at the bottom of the chin.

"The face is divided into three proportionable parts: the firft contains the forehead, the fecond the nofe, and the third the mouth and chin; from the chin to the pit betwixt the collar bones are two lengths of a nofe.

"From the pit betwixt the collar bones to the bottom of the breafts, one face.

"From the bottom of the breafts to the navel, one face †.

"From the navel to the genitals, one face ‡.

"From the genitals to the upper part of the knee, two faces.

"The knee contains half a face.

"From the lower part of the knee to the ancle, two faces.

"From the ancle to the fole of the foot, half a face.

"A man when his arms are ftretched out is, from the longeft finger of his right hand to the longeft finger of his left, as broad as he is long.

"From one fide of the breafts to the other, two faces.

"The bone of the arm called *humerus* is the length of two faces, from the fhoulder to the elbow.

"From the end of the elbow to the root of the little finger, the bone called *cubitus,* with part of the hand, contains two faces.

"From the box of the fhoulder-blade to the pit betwixt the collar bones, one face.

"If you would be fatisfied in the meafures of the breadth from the extremity of one finger to the other, fo that this breadth fhould be equal to the length of the body, you muft obferve that the boxes of the elbows with the humerus, and of the humerus with the fhoulder-blade, bear the proportion of half a face, when the arms are ftretched out.

"The fole of the foot is the fixth part of the figure.

* This muft depend on the age and quality of the perfons. The Apollo and Venus de Medicis have more than ten faces: the Hercules has feven heads, as fuiting great bodily ftrength.

† The Apollo has a nofe more.

‡ The Apollo has half a nofe more; and the upper half of the Venus de Medicis is to the lower part of the belly and not to the privy parts.—See Audran's Antient Statues.

"The

"The hand is the length of the face.

"The thumb contains a nofe.

"The infide of the arm, from the place where the mufcle difappears, which makes the breafts, (called the pectoral mufcle,) to the middle of the arm, four nofes.

"From the middle of the arm to the beginning of the head, five nofes.

"The longeft toe is a nofe long.

"The two outmoft parts of the teats, and the pit betwixt the collar bones of a woman, make an equilateral triangle.

"For the breadth of the limbs no precife meafures can be given, becaufe the meafures themfelves are changeable according to the quality of the perfons and according to the movement of the mufcles. DE PILES."

The meafures of the antient ftatues by Audran will be found highly ufeful, as they are accompanied with outlines of thofe the moft diftinguifhed for correctnefs.

The proportions of children differ from the adult as follow: The child of two years old has about five heads in its whole length, three of which go to the upper part, and two to the lower: one of four or five years old, has near fix heads; and at fifteen or fixteen, feven heads are the proportion.

In infants, the centre or middle part between the two extremities of the head and feet, is the navel; in the adult it is the *os pubis*.

It is the character of the man to be broadeft on the fhoulders; the woman on the hips. This will be found to hold good in the male and female in moft of the animal race.

It has been premifed that the proportion of the figure muft vary according to the character, as what would fuit an Hercules would by no means agree with Apollo.

By proportion, we wifh to be underftood a correfpondence and agreement of the meafures of the parts between themfelves and with the whole.

Much ingenious argument has been ufed by the author of "The Sublime and Beautiful" to prove that proportion is not the caufe, or rather one of the caufes, of beauty. In his inquiry that author appears to have expected, the proportion of one animal being laid down, admitting it beautiful, that it ought to ferve as a general ftandard for the whole of creation. "Examine the head of a beautiful horfe; find what proportion it bears to his body and to his limbs, and what relation they have to each other; and when you have fettled thefe proportions as a ftandard of beauty, then take a dog or cat, or any other animal, and examine how far the fame proportions between its head and its neck, between

 thofe

those and the body, and so on, are found to hold." That they differ in every animal is beyond all question, but that there is a general standard of proportion for each is equally unquestionable; for, were there not some such standard, nature would in time produce such a jumble of shapes, that it would be impossible to distinguish an ox from a greyhound; to the confusion of all order and symmetry. Besides, from the proportion laid down as rules of art, though an indifferent artist cannot insure beauty, yet he will be almost certain of general character.

The author before mentioned goes on to observe, with a view to establish his point: "It seems amazing to me that artists, if they are as well convinced, as they pretend to be, that proportion is a principal cause of beauty, have not by them at all times accurate measurements of all the beautiful animals, to help them to proper proportions when they would contrive any thing elegant, especially as they frequently assert that it is from an observation of the beautiful in nature that they direct their practice." Those measures the artist has by him as far as he can obtain them, the value of which is known to him from their great utility. Even the vulgar appear sensible of proportion; hence the nick name of *long shanks*, from those parts wanting the customary proportion. The "smoothness" of the skin of a dropsical person will never be pleasing, any more than that of a person over fat, from the want of proportion, the parts appearing too thick for the height.

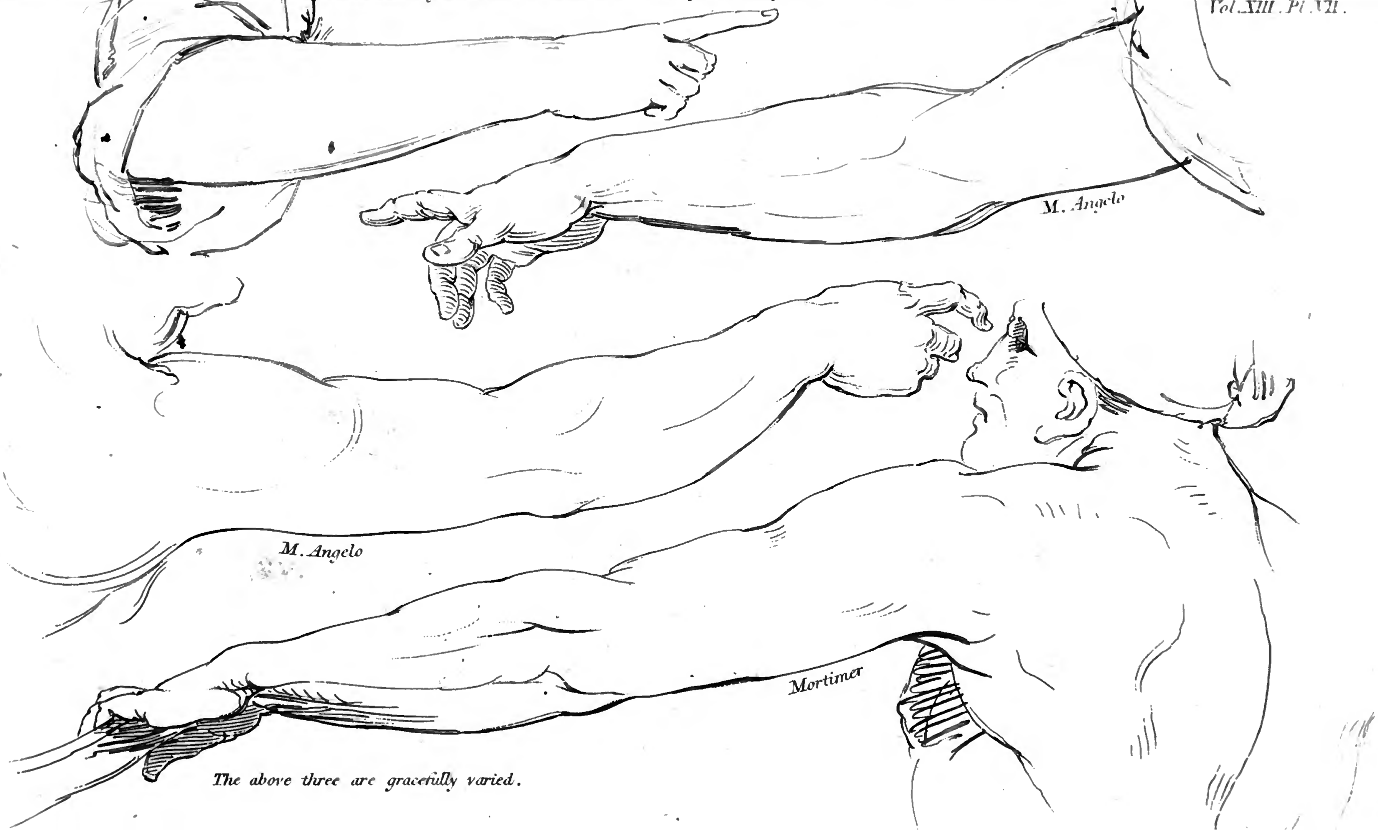
That smoothness in painting is not one of the causes of beauty is apparent from the pictures of Vanderwerf, the excess of which gives the flesh the appearance of ivory: besides, the smoothness must depend on the size of the picture in a great degree. It is true, we sometimes see a large picture highly finished, and a small one crude and slight; but such a practice is contrary to common sense: large ones require a boldness of handling, *not a slightness or indication of form only*; and small ones greater delicacy. It must also be evident that the style of execution must be governed by the nature of the subject: if it be dignified, the handling should be bold, as what would add a grace to a low subject would detract from a great one, as much as a common and vulgar idea would debase what is lofty.

It is not a single sensible quality that can constitute an object beautiful, but a combination of them, as we shall find by a recapitulation of the foregoing remarks.

We wish to be understood as confining ourselves to the beauty of the human figure, the qualities essential to which will

Examples of grace.

Destitute of grace from the hand & arm being too straight.



The above three are gracefully varied.

will be found to consist in a just proportion; that the parts be well shaped; a free, affable, mild, and easy motion; a sound and fresh colour, with the tints melting and tender; that the direction of its lines be gently varied, and by no means approaching to angular; and, lastly, that it is accompanied in a picture with a certain degree of softness and finishing.

The Greeks seem to have considered the existence of beauty and passion as incompatible: hence so little expression is found in the Niobes; they appear always to have sacrificed the latter to the former.

XXXVI. *Experiments and Observations on certain Stony and Metalline Substances which at different Times are said to have fallen on the Earth; also on various Kinds of Native Iron.* By EDWARD HOWARD, *Esq. F.R.S.*

[Continued from p. 141.]

Examination of the Stone from Benares.

THIS stone, as the Count de Bournon has already remarked, has the most distinguished characters. Indeed it is the only one of the four, sufficiently perfect (if I may be allowed that expression) to be subjected to any thing approaching to a regular analysis.

The crust, or external black covering, is the first substance to which the attention is naturally directed. When a portion of this crust had been detached with a knife, or a file, and finely pulverized, I separated the particles attractable by a magnet; and digested the unattractable portion with nitric acid, which was presently decomposed; but, owing to a strong adherence of some of the interior and earthy parts of the stone, it did not disentangle the coating or metalline part without some difficulty. The acid being sufficiently neutralized, the solution was passed through a filter, and saturated to excess with ammonia. An abundant precipitate of oxide of iron was produced; and, when this oxide was separated, I observed the saline liquor to have a greenish colour. I evaporated it to dryness; and redissolved the dry salt in distilled water. No precipitate was formed during the evaporation, nor was the colour of the solution entirely destroyed. It appeared to me like a triple salt, described by Mr. Hermstadt * as an ammoniacal nitrate of nickel. By examination

* *Annales de Chimie*, tom. xxii. p. 108.

with

with pruſſiate of ammonia, it yielded a whitiſh precipitate, inclining to a violet colour; and, by various properties, I was ſoon confirmed in the opinion that nickel was preſent. Since I ſhall have occaſion more than once to treat of the triple compound, and ſince it has been only mentioned by Mr. Hermſtadt, it is neceſſary now to detail ſome of its diſtinctive characters. The ſame chemiſt informs us, that the three mineral acids, with ammonia, enter into ſimilar combinations with nickel; and I have obſerved that oxide of nickel can be diſſolved by nitrate and muriate of ammonia. The muriate ſeems to take up the largeſt quantity. The colour of this ſalt is by no means uniform: it is ſometimes graſs green, violet, roſe colour, inclining to purple, and I have ſeen it almoſt colourleſs. It ſeems to be purple, and to incline to roſe colour and violet, when all the oxide of nickel is not united to both acid and alkali, but, from the deficiency of ſalt, is held in ſolution by an exceſs of ammonia. In this caſe, evaporation, of courſe, precipitates the nickel in the ſtate of oxide, which is of a whitiſh green colour.

The nickel cannot be *precipitated* from a perfectly formed triple ſalt by any reagent I have tried, except by a pruſſiate, or a hydrogenized ſulphuret of ammonia. Potaſh and lime, as well as, I preſume, other bodies, ſtanding in the order of affinities before ammonia, decompoſe the ſalt; but the nickel is then continued in ſolution by the diſengaged ammonia.

As it may be imagined that I have occaſionally met with copper, when I deſcribe a violet or purple ammoniacal ſolution, it is right to obſerve, that to avoid this error, I have either reduced the liquor to a neutral ſtate, and endeavoured, without ſucceſs, to obtain from it a precipitate, with a ſolution of ſulphureted hydrogen gas; or, by adding an acid to ſlight exceſs, and immerſing a piece of iron, I have not been able to detect a trace of copper. Theſe, and many other trials, when they do not appear to be made before the eſtimation of the quantities of nickel, have been conſtantly made afterwards.

But, to return to the incruſtation or coating of the ſtone, the decompoſition of the nitric acid ſhowed the preſence of matter at leaſt nearly metallic, although not attractable; and the examinations made of the liquor, from which the iron was precipitated, aſcertained the preſence of nickel beyond diſpute. The difficulty of obtaining the coating of the ſtone, either diſtinct from matter not belonging to it, or in ſufficient quantity, induced me to relinquiſh the idea of attempting to give the proportions of its conſtituent parts.

The ſtone being deprived of its covering, the ſhining particles

ticles irregularly diſſeminated next demand examination. I firſt examined the pyrites. Their very looſe texture made it exceedingly difficult to collect the weight of 16 grains, which was however effected by the dexterity of the Count de Bournon.

I digeſted theſe, at a low heat, with weak muriatic acid; which acted gradually, and diſengaged a trifling but ſenſible quantity of ſulphureted hydrogen gas. After ſeveral hours, I found the acid diſcontinued its action. The whole metalline part appeared in ſolution; but ſulphur and earthy particles were obſervable. The ſulphur, from its ſmall ſpecific gravity, was ſuſpended through the ſolution; whilſt the earthy matter, which could not be ſeparated by mechanical means, was fortunately left at the bottom of the digeſting veſſel. I decanted off the ſolution, holding ſuſpended the ſulphur; and, by repeated waſhing, ſeparated every thing belonging to the pyrites from the inſoluble earthy matter, the ſubtraction of which reduced the weight of real pyrites to 14 grains. I next obtained the ſulphur, by filtration. When it was as dry as I could make it, without fear of its being ſublimed, its weight was two grains. To the filtrated liquor I added nitrate of barytes, by way of detecting any ſulphuric acid which might have been preſent; but no cloudineſs enſued. I then ſeparated, by ſulphate of ammonia, the barytes thus added, and precipitated the iron with ammonia. The liquor, on the ſubſidence of oxide of iron, appeared of a violet purple colour: it contained nickel, which I threw down with ſulphureted hydrogen gas, there being already a ſufficient exceſs of ammonia in the ſaline liquor to form an alkaline hydrogenized ſulphuret. The oxide of iron, after ignition, weighed 15 grains; and the ſulphuret of nickel, reduced to an oxide, weighed, after the ſame treatment, ſomething more than one grain. The proportions of the ſubſtances contained in the pyrites of the ſtone from Benares may therefore be conſidered nearly thus:

	Grains.
Sulphur - - - - - - -	2
Iron - - - - - - -	$10\frac{1}{2}$
Since 15 grains of the oxide repreſent about that quantity of iron,	
Nickel, nearly - - - - - -	1
Extraneous earthy matter - - - -	2
	$15\frac{1}{2}$.

It is obſervable that, notwithſtanding the loſs appears to be only half a grain, it was probably more, becauſe the ſulphur

phur could not be reduced to the same state of dryness in which it existed when in combination with the iron; not to say that it was, in a small degree, volatilized with the hydrogen gas disengaged during the solution.

The weight of nickel is a mere estimation. We are not yet sufficiently acquainted with that metal to speak of it with accuracy, except as to its presence. Upon the whole, however, it may be concluded, that these pyrites are of a very particular nature; for, although Henkel has observed that sulphur may be separated from pyrites by muriatic acid, it is by no means the usual habitude of pyrites to be of such easy decomposition.

The other shining particles immediately seen, when the internal structure of the stone is exposed, are the malleable iron. Before I state the examination of this iron, I must remark, that preliminary experiments having shown me it contained nickel, I treated several kinds of the most pure irons I could obtain, with nitric acid; and precipitated the oxide from the metallic salt by ammonia. The quantity of oxide I obtained from 100 grains of iron was from 144 to 146. I may consequently infer, that 100 grains of pure iron acquire, by such a process, 45 grains of oxygen; and that, whenever a metallic substance, supposed to be iron, does not, under the same circumstances, acquire the same proportionate weight, something is either volatilized, or left in solution. Hence, when a metallic alloy of nickel and iron presents itself, a judgment may, at least, be formed of the quantity of nickel, by the deficiency of weight in the precipitated oxide of iron.

This mode of treatment was not allowed me in the examination of the coating of the stone, because it was impossible to know in what state of oxidizement the iron existed. But, as the particles disseminated through the whole mass are clearly metallic, a very tolerable idea of the quantities of nickel contained in them will be obtained, by noting the quantity of oxide of iron separated, as above described. 25 grains of these metallic particles were therefore heated with a quantity of nitric acid, much more than sufficient to dissolve the whole. Some earthy matter, which, as in a former case, was not separable by mechanical means, remained after a complete solution of the metal had been effected. This earthy matter, after being ignited, weighed two grains. The real matter of the present examination was therefore reduced to 23 grains, and was in complete solution. I added ammonia to a very sensible excess. The oxide of iron was thereby precipitated, and, being collected and

and ignited, it weighed 24 grains; whereas, according to my experiments, $33\frac{1}{2}$ grains ſhould have been produced from the ſolution, had it contained nothing but iron. I examined the ſaline liquor, when free from ferruginous particles, and diſcovered it to be the triple ſalt of nickel. Hence, allowing for loſs, the quantity of nickel may be eſtimated, by calculating the quantity of iron contained in 24 grains of oxide. Thus, if 145 grains of oxide contain 100 of iron, about $16\frac{1}{2}$ are contained in 24 of oxide. This would ſuppoſe the 23 grains of alloy to conſiſt of $16\frac{1}{2}$ iron and $6\frac{1}{2}$ nickel; which, if the uſual loſs be added to the $16\frac{1}{2}$ grains of iron, and deducted from the nickel, may not be very remote from the truth.

I ſhall next examine the globular bodies, alſo irregularly diſperſed throughout the ſtone. A number of them were reduced to fine powder; but nothing metallic could be ſeparated by the magnet. As a preliminary experiment, I ſought for pyrites, by digeſtion with muriatic acid; but no hepatic ſmell was in the leaſt perceivable, nor was white carbonate of lead at all altered by being held over the mixture. I therefore conclude theſe globular bodies do not envelope either iron or pyrites. By way of analyſis, I treated 100 grains with potaſh, in a ſilver crucible; and, after the uſual application of a red heat, ſeparated as much ſilica as poſſible, by muriatic acid and evaporation. The ſilica being collected on a filter, carbonate of potaſh was added to the filtrated liquor; by which a precipitate almoſt wholly ferruginous was produced. This precipitate was collected in the common way; then boiled with potaſh, to extract alumina; and, by ſuperſaturating the alkaline liquor with muriatic acid, and precipitating by carbonate of ammonia, an earth was gathered, which I afterwards found to be partly, if not entirely, ſiliceous. After rediſſolving, in muriatic acid, the portion of the ferruginous matter rejected by the potaſh, I precipitated by ammonia, what I took to be entirely oxide of iron; but, after igniting it, and again attempting to rediſſolve the whole in muriatic acid, more ſilica was left. The non-exiſtence of lime was proved, by the addition of carbonate of ammonia, immediately after the ſame alkali, pure, had thrown down what I took wholly for oxide of iron. I had now obtained every thing in the ſubject of my analyſis, except magneſia and nickel. The former, and a trace of the latter, were held by carbonic acid in the liquor, from which the ferruginous precipitate was, in the firſt inſtance, thrown down by carbonate of potaſh; and the latter was found in the laſt-named muriate of ammonia. I diſengaged the magneſia, by the aſ-

ſiſtance

ſiſtance of potaſh, and by evaporating to dryneſs. The oxide of nickel was precipitated by hydrogenized ſulphuret of ammonia.

Under all circumſtances, I am induced to ſtate the proportions of conſtituent parts thus:

Silica - - - - - -	50
Magneſia - - - -	15
Oxide of iron - - - -	34
Oxide of nickel - - -	$2\frac{1}{2}$
	$101\frac{1}{2}$

The exceſs of weight, inſtead of the uſual loſs, is owing to the difference of oxidizement of the iron, in the ſtone and in the reſult of the analyſis; which will be found to be the caſe in all analyſes of theſe ſubſtances; indeed it is always neceſſary to reduce the oxide to the red ſtate, as being the only one to be depended upon. To avoid future repetition, I ſhall alſo obſerve, firſt, that by preliminary experiments I could not detect any other ſubſtance than thoſe mentioned. Secondly, that the earth obtained as alumina appeared to me to be moſtly, if not entirely, ſiliceous; becauſe, after it had been ignited, and again treated with potaſh and muriatic acid, I found it was very nearly all precipitated by evaporation. Thirdly, I examined, and judged of, the ſilica collected from the oxide of iron, in the ſame way. Fourthly, the weight of the magneſia is given, not immediately, as obtained by evaporation, but after a ſubſequent ſolution in an acid, and precipitation by potaſh. And, fifthly, the proportions are taken from the mean of two analyſes.

Nothing remains to be examined, of the ſtone from Benares, except the earthy matter, forming a cement or matrix for the ſubſtances already examined. 100 grains of this matter were, by mechanical means, ſeparated as perfectly as poſſible, from the pyrites, iron, and globular bodies, and analyſed as above. The mean reſult of two analyſes gave,

Silica - - - - - -	48
Magneſia - - - -	18
Oxide of iron - - - -	34
Oxide of nickel - - -	$2\frac{1}{2}$
	$102\frac{1}{2}$

XXXVII. *Me-*

XXXVII. *Memoir on the Anatomy of Vegetables. Read before the Phyfical Clafs of the Inftitute by* C. Mirbel.

[Concluded from p. 179.]

Chap. VII.

Of the Pores.

THE pores are fmall apertures formed in the membranes; they favour evaporation, abforption, and the motion of the fluids. There are three kinds of them.

1ft, *The infenfible pores.*—Thefe are apertures which cannot be perceived by the eye even when affifted by the moft powerful microfcopes. Effects, however, do not permit us to doubt of their exiftence. Every vegetable tiffue is full of them, as is proved by infenfible tranfpiration. What fhows at the fame time their extreme finenefs is the phænomenon exhibited by an apple, or any other pulpy fruit, when placed below the receiver of an air-pump: the highly dilated air efcapes only by burfting the fkin.

2d, *The elongated pores.*—Thefe have been obferved by feveral naturalifts, and particularly Decandolle, who gave them the name of cortical pores. I fhall endeavour to complete his defcription, by uniting under the fame point of view his obfervations and thofe which I have fince made myfelf. For a knowledge of the principal facts I am indebted to his refearches; but, as he confidered this fubject rather in a phyfical than an anatomical light, his labour does not fuperfede the neceffity of publifhing mine.

The elongated pores exift only in the epidermis of the herbaceous parts expofed to the air and the light. If the exterior membrane of the vegetable be fkilfully removed, and if you then examine it with a microfcope, you will fee the interior fides of the epidermis ftill adhering, and which form as it were a hexagonal net-work; but here and there inftead of a hexagon you will obferve an ellipfe, and the part of the epidermis circumfcribed by that elliptical area is cleft in a longitudinal direction: the aperture is fometimes free, and fometimes obftructed: the latter cafe, in my opinion, arifes from the lips of the pore, longer than is neceffary to fhut the aperture, being applied one to the other, and intercepting the light. The elongated pores are found commonly in the ftems, the branches, the leaves, the bracteæ, and even the herbaceous pericarpia. In herbaceous plants the two furfaces of the leaves are covered with pores; in the fat plants they are lefs numerous than in the other vegetables. In trees and fhrubs the inferior furface only is in general pierced with thefe pores. The ftems when they

they become ligneous are destitute of them. These pores serve for the sensible and insensible transpiration and for the absorption of the fluids. They each correspond to a small cell, which, according as the air is moister than the cellular tissue, or the cellular tissue than the air, absorbs the fluids dispersed throughout the atmosphere, or throws off those which the vegetable contains. When the parts become stiff, and the liquors contained in the vegetable have no longer the same fluidity, these cells become filled with thick gum and resin; which not being able to escape through the pores, nor to return into general circulation, become entirely hard; and are at length thrown out, when the state of the vegetable, by not permitting the epidermis to dilate itself further, forces it to burst.

3d, *The glandular pores.*—These are apertures bordered with thick opake and unequal rolls. These pores serve for the movement and communication of the fluids in the interior of the vegetable. They are observed sometimes indeed in the epidermis, but this case is exceedingly rare. There are two kinds of glandular pores, the small and the large. The former are excessively small. To the most powerful microscopes they appear only like the small holes made in a sheet of paper with the point of a needle: sometimes they are scattered, and few in number; at other times they are very numerous, and disposed in regular series, always according to the breadth, and never according to the length of the tissue. The large glandular pores are only a modification of them: one might even suppose that the union of the small pores of one series produces the large ones, the direction of which is the same as that of the series. The reader must here call to mind what I have already said of the porous tubes, the false tracheæ, and even the tracheæ. There are some very striking relations between these different tubes, and the plan of nature is not equivocal.

Chap. VIII.

Of the Epidermis.

This name is given to the exterior membrane formed by sides of the outer cells; or rather the epidermis is only the term of the cellular tissue itself.

To relate every thing that authors have said on this membrane, would fill a volume. No part in the organization of plants has given rise to more researches, nor perhaps has led into more errors. The first fault is, to have compared it without restriction to the epidermis of animals. When this idea was once adopted, every thing else was considered as analogous. The epidermis, said some writers, exists in all organized ganised beings; it covers the nascent embryo, and the individual which has arrived at the state of decrepitude; it follows all the sinuosities of bodies, penetrates into their cavities, and protects the most delicate parts: thus in animals, after enveloping all the external parts, comprehending even the globe of the eye, it is seen falling back on the lips, penetrating into the intestinal canal, into the nostrils, and the auditory passage; and in plants, it covers the stems, branches, leaves, flowers and fruits. The epidermis (add they) is not similar in every part of the same being: sometimes it is exceedingly fine, and sometimes it assumes more consistence; but in all cases it is colourless and transparent. If it appears white on the trunk of the birch-tree, and brown on the young branches, ash-gray on the plum-tree, red and argenteous on the cherry-tree, green on the young shoots of the almond-tree, and ash-coloured on the old ones; this difference depends merely on the colour of the substances it covers, in the same manner as the white, black, and copper colour of the white, negro or caffre depend on the colour of the mucous body. By following this comparison, a new point of similitude is thought to be observed in the dilatability of the epidermis of animals and plants: it yields to all development, and extends in proportion as the being grows: it embraces only a small surface in the fœtus of the animal, but it dilates insensibly and covers a much greater surface when the animal attains to its utmost growth. It is thus that the epidermis which covers the seeds of plants dilates and yields to the increase of the fruit, and that the epidermis which covers the embryo yields also to the increase of trees. The extension of this membrane will be found to be prodigious, when we consider what the gourd was before its flower withered, and what the oak was when concealed in the acorn. But, as there are certain animals the old epidermis of which detaches itself, and at the end of a certain time gives place to another; in the same manner there are certain vegetables which throw off their epidermis in order to assume a new one. It is observed that the epidermis of the trunk and branches of the plane-tree detaches itself in scrolls like that of oviparous quadrupeds.

These comparisons, no doubt ingenious, are far from being exact in every point. It may even be said that they are founded on imperfect observations. To be convinced of this, it will be sufficient to reflect on the definition we have given of the epidermis of vegetables. This membrane is nothing but the exterior union of the cells of the circumference, and differs from the membranes which form the other sides only by the changes occasioned by its position. If it is less transparent, drier and firmer, it is becaufe it is continually expofed to the influence of the light and the air, and to the contact of all thofe bodies which float in the atmofphere: but it is not in reality a diftinct part; and it may be faid, ftrictly fpeaking, that vegetables have no organ analogous to the epidermis of animals. When vegetables grow large, the exterior membrane feems to dilate; but if this membrane becomes extended, it is becaufe the number of the cells is multiplied at the circumference as at the exterior, and that confequently the fides which compofe it are multiplied in proportion, and increafe its capacity.

One objection remains to be combated. It may here be faid, Why is it fo eafy in the fpring time to detach the epidermis from the young branches, if it does not really form a diftinct organ? This may be explained in the following manner:—All caufes which have an external action on the vegetable alter its furface, and detach from it the interior parts: but this feparation becomes more apparent when the vegetation is more vigorous, and when the fluids moiften the cellular tiffue, and fill the tubes; for, as the diforganized furface cannot then develop itfelf with the reft, it ceafes to adhere, and often comes off in fragments, or is infenfibly deftroyed. This is exactly what takes place in the fpring.

In a word, this exterior ftratum, which fo many circumftances tend to deftrcy, and which almoft always exhibits traces of its diforganization, is not compofed of the laft membrane only: the interior part of the cellular tiffue is found in it, as is evident in the plane tree, and ftill more in the green oak, which produces cork. What has been here faid is applicable only to the ftems and branches, which do not die in the courfe of the year; for in herbs, and the annual parts of ligneous plants, fuch as the leaves, flowers, bracteæ, &c. the furface does not detach itfelf from the reft of the tiffue.

But the epidermis of vegetables has no refemblance to that of animals; and, though it is certainly formed by the exterior part of the cellular tiffue, it is no lefs true that its nature is modified by fecondary caufes, and that it in fact becomes an organ, the functions of which are very diftinct, and highly important. In the infancy of the vegetable, when all the parts are foft and mucilaginous, it oppofes at the fame time the difunion of the nafcent organs, and the too ftrong action of the fluids. At a more advanced age, when the juices are lefs abundant, it prevents their too fpeedy evaporation, and maintains a juft equilibrium between the folids and the fluids. At all times it fecures the vegetable from

from the deleterious influence of meteors, and shelters it from excessive heat, cold, moisture, and drought. In a word, it protects it against all external causes which might hurt it. Besides this, it serves for sensible and insensible transpiration, and the absorption of gas, and of those fluids dispersed throughout the atmosphere. For this reason it is often pierced with very visible pores: I say often, because it is not indeed a general law; and the epidermis of pulpy fruits, for example, has no apparent pores. I must add, also, that these fruits transpire very little, as Dr. Hales has shown in his Vegetable Statics.

Chapter IX.

On the Organizing Substance, or Cambium of Duhamel. Hypothesis on the Formation and Development of the Cellular Tissue and the Tubular Tissue.

All the parts of the vegetable have, at first, been mucilaginous and fluid; and it is only in the succession of time that the tissue becomes firm and solid. This state of feebleness is visible in the seed. The embryo at first is but a drop of mucilage, in which the most powerful microscopes discover no organ. This substance has a vitreous appearance. It is speedily dried and destroyed by the contact of the air. Properly speaking, it is not a fluid; it is an organized substance, similar to the white of an egg. The organizing substance is formed during the whole time of the increase, and it deposits itself in that part of the tissue where the vegetable ought to acquire the greatest vigour. In the monocotyledons it is placed around each ligneous filament; in dicotyledons it is at the surface of the soft part of the wood and the medullary canal. Every day, therefore, the ligneous filaments of the cotyledons are seen to assume more volume, and the concentric strata of the dicotyledons to be multiplied, and their pith to be converted into wood. The organizing substance is the more abundant, and is renewed with more facility as the individual is younger and sounder; as it is in a more favourable situation, and as the season is better fitted for vegetation. This substance insensibly assumes determinate forms, whether the fluids develop in it, by their impulse, the cells and the tubes, or whether an unknown power acts in it alone, and determines these developments; or whether, as is probable, these two causes, united and combined, act in concert to change into membranous tissue the organizing substance, it is certain that the vegetable acquires a more considerable volume, and that it daily lengthens, and becomes

 thicker.

thicker. To explain the two phænomena of lengthening and becoming thicker, the action of which is simultaneous, we must acknowledge that the expansive force acting in the membranous tissue newly created is modified by the nature of the tissue itself. It is composed, as we have already seen, of two organic elements, one of which is cellular tissue, formed of the cells, whose diameter is nearly equal in every direction; the other is the tubular tissue, formed of the small and large tubes contiguous to each other. Let us suppose, for a moment, that the fluids imbibed by the vegetable are the cause of this dissimilarity in the tissue. We may do so the more, as this system is not void of probability. By way of example, let us employ the embryo: let us take the seed before fecundation: it is attached to the mother plant by the umbilical cord, the organization of which no doubt varies according to the species. By the help of the vessels which unite this organ to the seed, the fluids penetrate into the organizing substance; and their impulse being determined by the canals which afford them a passage, they then trace out the route which the fluids will afterwards pursue, and determine the order of the future developments. Being vigorously pushed in different points, which vary according to the species, they open the longitudinal tubes, and then filter slowly through their sides, deposit themselves in the organizing substance, and favour the development of the cells. In the first case, the fluids are pushed by the force which gives motion to the sap; in the second case, they issue forth and penetrate the organizing substance only, because they tend to assume an equilibrium. These two forces, balanced by each other, produce a multitude of intermediate shades between the longitudinal tubes and the perfect cellular tissue. But this theory is still far from explaining the phænomena of vegetable organization. There doubtless exist a thousand other physical causes, the influence of which cannot be calculated; and above all these causes ought to be placed the organizing power, the principle of which is totally unknown to us.

However, the cells and tubes being once formed, they increase till the inspissation and induration of the membranes present an obstacle to their development. During the growth of the membranous tissue, the fluids carried into the tubes, by several forces combined, determine the direction of the elongation by the impulse which they give to the organic moleculæ. But the cells suffer themselves to be penetrated by the fluids only in a slow manner; and, being subjected to no force which determines their development in one direction rather than in another, they grow and dilate themselves

ſelves in every direction. It would thence follow, if the cells grew equal in number to the tubes, that the cells ought to ſerve more for extending the thickneſs than the length of the vegetable, and that the inverſe would be the caſe with the tubes; but when the latter are greatly multiplied, their number compenſates for the ſmall thickneſs which each has, and they then contribute no leſs than the cells to the ſenſible thickening of the vegetable. Nay more, the maſs of the tubes is continually increaſed in trees, while the cells are not multiplied in the ſame proportion. In a word, ſeveral other cauſes, which I ſhall explain hereafter, contribute to diſorganize them, and even to transform them into tubes, ſo that at the end of a certain time the maſs of the latter is far ſuperior to that of the cells.

XXXVIII. *Experiments on Electricity excited by Evaporation. By a Correſpondent.*

SIR, *To Mr. Tilloch.*

I TAKE the liberty of communicating to you the following experiments on obtaining electricity by evaporation: and if you think them worthy of a place in your Philoſophical Magazine, by inſerting them therein you will very much oblige

June 9th, 1802. Your humble ſervant,

W. W.

THE apparatus I uſed for this purpoſe conſiſted of a gold leaf electrometer (hung in a phial, which had had the bottom cut off, that a conducting communication might be made between two ſlips of tinfoil, which were ſtuck on the inſide of the phial, and the earth,) and a tin diſh made in the form of the fruſtum of a cone. The top diameter of it is about 2 inches; the bottom diameter is about 1¼ inch, and its depth is about ½ inch. This diſh, about half full of water, is placed on the electrometer, and the red-hot ſubſtances dropped into it from a pair of tongs, at 3 or 4 inches above it. (See Fig. 2. Pl. V.) In relating the experiments I ſhall put P. and N. to denote the two ſtates, commonly denominated *poſitive* and *negative*.

1. Cinder of pit-coal about the ſize of a walnut, dropped into the water, made the electrometer diverge N. This was repeated five times with the ſame reſult. Sometimes the gold leaf would beat againſt the ſide of the bottle four or five

 times.

times. I next made the electrometer diverge P. with an excited glafs-tube, and while it was divergent dropped a hot cinder into the water: it immediately clofed, and opened again N. The electrometer was then made N. with excited wax, and a cinder dropped into the water made the electrometer open wider, and ftrike the fide of the bottle.

2. I made fourteen fimilar trials with coals of burnt wood, but could not find that any electricity was produced.

3. In fixteen trials with tobacco-pipe the electrometer diverged N. eleven times, and five times it did not diverge at all. In five out of the eleven, after the electrometer had diverged, it clofed again without touching the fides of the bottle; but not fo much as to lofe all its divergence.

4. In twenty-four trials with common white marble, the electrometer diverged P. twelve times, and ten times the gold leaf beat the fides of the bottle fo violently, that I could not determine which ftate was produced; (but, becaufe it was P. in all thofe when it could be determined, I fuppofe it was fo in thofe that could not) and twice it did not diverge at all: the pieces in thefe two were very fmall.

5. In twelve trials with mother of pearl, (fuh as common pearl buttons are made of) the electrometer diverged P. feven times. Three times I could not determine for the violent beating of the gold-leaf againft the fides of the bottle; and twice, when the pieces were very fmall and not very hot, the electrometer became flightly N. It is probable there were fome fmall fragments of cinder thrown into the water with the pearl; for it was heated in a common fire, and taken out with a fmall pair of tongs.

6. In eight trials with common white coral, the electrometer diverged P. every time.

7. In fix trials with oyfter-fhells, the electrometer diverged P. five times, and once it did not diverge at all: the piece was not hot enough to raife much vapour.

8. I made thirty-one trials with periwinkle-fhells; and in the firft feventeen trials the electrometer diverged P. fix times, five times N., and three times it did not diverge at all; and twice it diverged and clofed again directly, before I could determine which ftate was produced. In the other fourteen trials it diverged P. every time. It is to be obferved, that the fhells ufed in the firft feventeen trials were as they were when the fifh was boiled and falted in them; they were therefore foul with falt, &c., and alfo had their outfide fkins on: but in the fourteen laft trials the fhells were fuch as had been burnt, and thrown into water while red-hot, before they were made hot for the experiment, and by this

this treatment they were cleanfed from their fkins and other foulneffes.

9. In fix trials with unprepared mufcle-fhells, the electrometer diverged P. three times, once N.; once the gold-leaf beat the fides of the bottle fo violently, that I could not determine; and once it did not diverge at all. As thefe fhells were in the fame ftate as the periwinkle-fhells were in the firft feventeen trials with them, I therefore fuppofe the difagreement to arife from the fame caufe.

10. In nine trials with chalk, I could not find that there was any electricity produced.

11. In twelve trials with bones, I could not find that there was any electricity produced.

12. In eight trials with gravel-ftones, the electrometer diverged N. fix times, and twice the gold-leaf beat the fides of the bottle fo violently, that I could not determine which ftate was produced.

13. In five trials with clinkers, the electrometer diverged N. very gradually every time.

14. In eight trials with fmall pieces of iron, the electrometer diverged N. fix times, and twice not at all.

15. In fix trials with fome rufty nails (that had lain in the earth till they were quite rufted through, and from which I carefully wafhed the dirt, &c.), the electrometer diverged N. four times, and twice it did not diverge at all. Seeing this rufty iron did not produce P., agreeably to Cavallo's experiment, I fufpected that, notwithftanding all my care, the nails were not free from foulnefs. I next procured fome flakes of ruft which had fallen from an old anchor, which lies in Perry's dock-yard at Blackwall; and fuppofing thefe flakes to be pure ruft, I expected to find the electrometer diverge P., but in feven trials it was N. every time.

16. In eleven trials with pieces of fteel-file, the electrometer diverged N. eight times, once P.; once it did not diverge at all, and once it diverged and clofed again before I could determine which ftate was produced.

17. In two trials with pieces of china, the electrometer diverged N. both times.

18. In five trials with flate, the electrometer beat the fides of the bottle violently, with N. every time.

19. A piece of fullers-earth made the electrometer diverge N.

20. In eight trials with a copper halfpenny, the electrometer diverged N. four times, and four times it did not diverge at all. And in eight trials with a penny piece, it diverged N. every time.

21. To discover in what state (with respect to electricity) the vapour was, I used the apparatus represented by the annexed sketch, of which the upright A B is of glass covered with sealing-wax, and all the rest, except the bottle of the electrometer, is of metal. In thirteen trials with cinders of pit-coal, the electrometer diverged P. seven times; four times it opened and closed again before I could determine which state was produced, and twice it did not diverge at all.

22. In seven trials with marble, the electrometer diverged N. three times; three times it lost all its divergence before I could determine in which state it diverged, and once it did not diverge at all.

In the two last experiments, the electrometer retained its divergence so short a time, that I was obliged to hold an excited tube in one hand, while I dropped the hot substance into the water with the other, to be ready in time to determine the state produced by the vapour.

XXXIX. *Experiments and Observations on the Manufacture of Malleable Iron directly from the Ore. By* D. MUSHET, *Esq. of the Calder Iron Works* *.

IN a former communication I took occasion to remark that a variety of processes had been followed out, endeavouring to form a good quality of bar iron with coak-pigs and pit-coal; but as these had been attended with little or no alteration of principle, the results had been nearly similar. In no case has an uniform quality of bar iron been produced, able to cope for all uses with the superior marks of Sweden and Russia.

At this day, assisted by a variety of facts chemical and philosophical, we yet remain in comparative ignorance of what constitutes the real difference in point of quality betwixt home-made iron and that imported from foreign markets. We acknowledge with pain and humiliation our dependence on other countries for our steel-iron, and it is with regret that we see every industrious exertion made to obviate this dependence foiled by the nature of our fuel, or the defective qualities of our ores.

Those who have voluntarily made an offer of their time and abilities for the service of their country, in promoting a thorough knowledge of the principles of our manufactures, could not engage in a subject fraught with more important con-

* Communicated by the Author.

consequences. An acurate chemical analysis of the various states and qualities of British manufactured iron, accompanied by a similar development of the component parts of the foreign fabrics, would prove an interesting contrast, and could not fail ultimately of producing infinite advantage to that department of labour.

I shall not, at present, enter into an investigation of the probable reasons which constitute this difference, but confine myself to a succinct account of several processes in which I have obtained malleable iron, often superior to the common run of British manufacture. In contemplating these manipulations followed out in the large way, I uniformly found that, although some fabrics possessed comparative excellence, yet that all were deficient in obtaining a quality of iron equal in appearance and fracture to the foreign.

In all these processes it was evident that if the contact of pit-coal, considered as a more impure fuel than wood, was hurtful to the quality of the iron, then all our bar-iron would be so injured, as all of it is manufactured either in contact with such fuel, or the flame of it, or both. The point therefore wished to be gained was the making of bar-iron without bringing the metal, while in fusion, in contact either with the flame of pit-coal, or with the ignited coaks. My first crude attempt was in 1794 with crucibles and roasted ironstone. I conceived that by introducing just as much charcoal of wood as would remove the oxygen of the ore, that malleable iron would be the result. Experiment, in some measure, justified this conjecture: but a want of uniformity in the result proved the fallacy of this mode of operating. When the temperature was moderately raised, I found the iron partially separated, and, in a malleable state, entangled amongst the earths of the ore: but, when a higher degree of heat was brought on, the greatest part of the iron was found precipitated in the form of a button. The iron in this state was malleable: but so excessively red-short as to be incapable of drawing at any shade of heat beyond faint red.

In varying these experiments, and using a greater proportion of charcoal than usual, I was surprised to find, that after a long and violent heat no part of the iron had entered into fusion. The pieces of iron-stone were firmly connected together, possessed of the original acuteness of angle and fracture. Their appearance and surface was dark and metallic, and, upon attempting to part them, I found them attached to each other by a species of metallic fibre, which twisted repeatedly before breaking. This was a species of welding I had never before witnessed. I found the whole mass sufficiently

ciently metallic upon the ſurface to receive a conſiderable degree of poliſh from a file. The interior of each piece, from the want of a ſufficient doſe of heat, remained in a ſoft, eaſily pulveriſed form, perfectly magnetic, and burning with great rapidity when ſtrewed in the flame.

The apparent advantages which ſeemed to reſult from this chance diſcovery were ſufficient to induce me to perform, during the courſe of three or four years, ſeveral hundred experiments. In the proſecution of this ſubject, I ſoon abandoned the uſe of iron-ſtones. It was found requiſite to uſe them in a roaſted ſtate; and even afterwards, when heated in contact with charcoal for three or four days, it was with the greateſt difficulty that the proceſs of malleability could be made to penetrate to the centre without a general and premature fuſion, which was always carefully to be avoided. When raw iron-ſtone was uſed, it was difficult to prevent it from entering into fuſion, and ſeparating its iron in the ſtate of minute globules of crude iron. Having thus ſatisfied myſelf of the precarious reſults obtained in this proceſs by the uſe of iron-ſtones, I had recourſe to Cumberland ore, as a fit ſubſtitute, and my expectations in it were not diſappointed.

I ſhall ſimply ſtate the methods which I ultimately followed to produce bar-iron in this proceſs with the uſe of pit-coal and charcoal of wood. Having prepared a ſmall furnace with an oblong cavity, ſurrounded with a ſufficient number of holes to admit the heat all round, I introduced 50 to 60 lbs. of Cumberland iron ore reduced to pieces of nearly 3 ounces weight each. This was mixed with a ſufficient quantity of clean duſt produced in the charring of coal. The ore was ſurrounded by a layer nearly $2\frac{1}{2}$ inches thick, and this laſt of all was covered with a layer of moiſt ſand 2 to 3 inches thick. The fire was maintained at a temperature of nearly 100° of Wedgewood for 36 to 48 hours, according to circumſtances. It was then allowed to cool gradually. Upon examination, the pieces of ore were frequently found attached to each other ſo firmly as to require conſiderable force to part them. They filed, and were, when the cementation was continued long enough, malleable throughout. The ore, thus prepared, was piled up in a flat broad ſhallow crucible with a looſe top, and placed in a furnace heated with the flame of pit-coal. A welding heat was brought on the whole maſs, which was then carried to the hammer: the firſt blow deſtroyed the crucible, and the ore was ſhingled into a bloom at the firſt heat.

In this way excellent iron was produced. Its fracture was light

light blue, fibrous, and tearing confiderably in groups. It poffeffed, however, a flight degree of red-fhortnefs when very highly heated. It formed with equal facility horfe-fhoes and nails of the moft delicate ftructure. The produce of the raw ore never exceeded 47 per cent., and commonly was from 43 to 45. Iron of a more pure fracture was obtained by piling the ore upon a flat cake of fire-clay or fand-ftone. As the welding heat penetrated the mafs, part of the earth and unmetallized particles of iron were reduced into fufion, and run off into the furnace. The produce, however, in iron was reduced as low as 37 per cent. This reduction of metal, no doubt, arofe from the greater furface expofed in this way than when the balling pot was ufed.

To obviate this, and, at the fame time, infure an equal quality of iron, the piles were heated in the fame furnace with the gas of coaks, and the flue of the furnace nearly fhut up; fo that the circulation of air was much fmaller, and the heat, though equally great, yet more attenuated. This produced a better quality of iron than any of the former ways, but at a greater expenfe of fuel.

However fuitable this iron was for the common ufes of the fmithy, it was found to form but a very indifferent quality of fteel by cementation. The whole of it became in fome degree laminated, and incapable of ftanding great fatigue; and the red-fhortnefs, which before faintly marked the bar iron, was now confiderably increafed when in the ftate of fteel.

In varying this procefs of making bar iron, quantities of the prepared ore were thrown upon the top of a fmall finery fire, charged with foft coal coak, and funk to the bottom. The metallic mafs was found connected, and fo much purified as to afford iron of a clear fracture, but the produce was diminifhed to 28 and 30 per cent. from raw ore.

The fame ore, however, funk in a fmall fire of wood charcoal, yielded a very fuperior quality of the metal to any of the former. In point of quality and fracture, it was deemed no way inferior to many of the beft Swedifh marks. Still, however, it muft not be denied, that this iron formed comparatively but an inferior quality of fteel. In this ftate I left this procefs for making bar iron, and have not yet found time nor fufficient opportunity to refume it. Of late years I underftand a procefs, fomewhat fimilar, has been eftablifhed near Whitehaven, in the neighbourhood of the Cumberland iron-mines, but abandoned, not becaufe the quality of iron was inferior, but I believe from a want of œconomy in the procefs itfelf.

A thoufand unforefeen difficulties occur in ftriking out a new

new line of manufacture, before a good quality of product is obtained. These are seldom diminished, but often increased, in transferring it from the scale of experiment to that of manufacture.

In the present process followed out at the bar-iron forges in this country, the greatest drawback upon the profits and correctness of the business is the immense loss of metal. This is called waste, and it is generally believed that the more the waste the better the quality of the resulting iron. This circumstance I conceive is owing to the following facts—the combustibility of the metal, the high temperature requisite, and the tedious length of the process. The puddling process invented by Cortes avowed a degree of simplicity, which promised to lessen the waste by diminishing the variety of operations, and the length of the exposure. Experience however has proved, that, in general, what was gained in weight was more than lost by the inferior quality of the iron produced.

With a view to produce a quality of iron from coak pig equal or superior to what is obtained in the best processes now in use, it occurred to me that an operation which would unite the properties of the finery fire and of the puddling furnace would be productive of a good quality of iron, and with little comparative loss. With this view a small furnace was contrived, somewhat similar in shape to an iron-founder's air furnace. The depth of the grates below what is called the bridge of the furnace was more in proportion. A shallow cavity was formed in the middle of the furnace with sand, about two inches deep, fifteen inches long, and eight broad. The furnace was heated to a bright white heat with raw pit-coal: a small door was then opened, and nearly 84 lbs. of fragments of white crude iron introduced. The grates of the furnace were then charged with coaks, and a semifusing heat brought on, and continued for ten hours after. During this operation the metal continued to boil, and discharge a blue vapour, frequently accompanied with hissing explosions. At last, when the metal exhibited no further signs of ebullition, nor of fusion, the fire was allowed to die away. When cold, I found the whole, without stirring or agitation, resolved into a mass of malleable iron, which, even in this state, was broken with great difficulty. The lump, or plate, was divided into three pieces, one of which was drawn into a stout bar, and weighed 18 lbs. The quality of this iron was excellent for every purpose, steel-making excepted. In this process it disjoined, and formed laminæ; which rendered it unfit for any steel purpose. This experiment was frequently

quently repeated with similar results: but, from several circumstances not here necessary to be mentioned, I never ascertained the exact loss sustained in the operations. I am confident, however, that it would not amount to more than half what is experienced in the common processes.

I offer this slight sketch, as I did the former, merely as an outline of an operation, the perfection of which might be attended with great advantages, but which would previously require a considerable portion of time, and many experiments, to establish.

XL. *An Essay on Longevity.* *By Sir* John Sinclair, *Bart.*

[Continued from p. 172.]

APPENDIX.

No. I.

The preceding observations are only intended as a basis, for the purpose of obtaining the additional facts and observations which are necessary to elucidate so important an inquiry. It is particularly requested, therefore, that the following questions may be answered with as much minuteness and accuracy as circumstances will admit of.

Questions for the consideration of those intelligent persons by whom this Paper may be perused:—

1. What is the effect of the climate in which you reside, on the health and longevity of the human race?
2. What form is reckoned most conducive to health and longevity?
3. Is it found, that being descended from young and from healthy parents, is essential for good health and old age?
4. Is it found, that health and old age depend much on the disposition or temper of the individual?
5. Is there any perceptible difference in consequence of situation of life?
6. What professions are reckoned favourable to longevity or otherwise?
7. Is exercise or moderate labour found necessary for preserving health and long life?
8. Have the long-lived in general been in the marriage-state?
9. Have the greatest proportion of the long-lived consisted of males or females?

 10. Have

10. Have there been any instances of persons renewing their age, getting new teeth, new hair, &c.?

11. What are the other circumstances tending to promote long life?

12. What is the effect of diet on health and longevity?

13. What are the effects of clothing?

14. What the effect of habitation, and the difference of living in a town or in the country?

15. What are the effects of habits and customs, in regard to early rising, bathing, regular meals,—regular sleep,—and, in particular, what are those minute circumstances on which it is supposed that health and longevity principally depend?

16. What are the rules regarding medicine which are accounted the most useful and salutary?

17. What are the most remarkable instances of longevity, and how are they authenticated?

18. What are the rules adopted by those who have attained great age?

19. Have any tables of longevity been drawn up in your neighbourhood, and how do they agree with the one extracted from Hufeland?

20. Do any additional observations or particulars occur to you on the subject of health or longevity?

No. II.

Of such Rules and Habits as may contribute to the Preservation of good Health and long Life.

If persons were to live with the simplicity of ancient times, it is probable that they would attain long life, without experiencing any material illness, merely by a proper attention to air, exercise, clothing, and diet. But in the present state of society, the great bulk of the community must follow, not a natural, but an artificial mode of life, and thence are perpetually exposed to various temptations, which they find it difficult always to resist, and to dangers which they cannot always avoid. In luxurious times, therefore, persons in general cannot expect to live long, at least with any degree of satisfaction, unless by great care, and by an attention to a variety of minute particulars, which they either learn from others, or acquire by their own experience. The mass of useful facts and observations thus accumulating every day, and perishing daily with those who had acquired them, must be very great. Unfortunately, hitherto, no individual has taken the trouble of collecting them. Such a collection would certainly be a most acceptable offering to the public, more

more especially if written in a plain and distinct manner, and laying down such rules alone as were practicable according to the general style of modern life. With the view of contributing to so useful a work, I shall proceed to state such observations as have been either communicated to me by others *, or have occurred to myself on that interesting subject.

The

* Among other communications I received from a friend in the country, a number of rules of diet and regimen, written in Latin as far back as the year 1648, in answer to the general question; "By what means a "person might be enabled to prolong life to the latest period?" The following is a literal translation of that Paper:

A person will be enabled to prolong life to the latest period, by observing the following salutary rules.

1. The stomach ought never to be over-loaded with food, otherwise the body will be rendered unfit for exertion.
2. Moderation in exercise, food, drink, sleep, and venery.
3. No fresh food should be taken, unless the preceding meal has been properly digested.
4. The meals should not be uniform; but supper always lighter than dinner.
5. Excess in former meals must be corrected by a subsequent abstinence.
6. All food should be duly masticated before it be swallowed.
7. The quantity of drink should always be proportioned to that of solid food.
8. No drink should be taken until a due portion of solid food has been swallowed.
9. A variety of dishes ought not to be eaten at the same time.
10. It will be advisable to refrain from a meal (dinner) once a week, particularly when the body appears to require less food.
11. Bodily exercise should be so managed once a day, as to excite the natural heat (glow); and before a meal. The advantages resulting from such practice are thus described by FULGENTIUS: "Exercise," says he, "contributes to the preservation of human "life; it dissipates all superfluous humours of a plethoric habit; "it invigorates our faculties; it is a gain of time; the enemy of "idleness, the duty of the young, and the delight of the aged. "For exercise disengages and expels, through the pores, all superfluous humours; while the greatest injuries may ensue from "a contrary conduct: hence the Poet observes, 'Ease is not to "be acquired unless it be combined with toil: for indolence is "generally attended with dissolution.'"
12. In taking food, liquids and soft substances ought to precede those of a dry and solid nature.
13. Between meals, both solid and liquid food should be avoided.
14. The bowels should be regular every day, either by nature or by artificial means.
15. Extremes of heat and cold, with respect to food, drink, and air, are equally to be guarded against.
16. Sleep ought not to continue less than six hours, nor exceed eight.
17. Immediately after a meal; and with a full stomach, it is hurtful to engage in reading, writing, or deep reflections.

18. Violent

The particulars connected with food, clothing, habitation, air, and exercise, are so universally known, and the principles regarding each so fully established, that it is surely unnecessary to dwell upon them at any length.

In regard to food, experience will point out those articles which are best adapted for the constitution of each individual; and there cannot be a better general rule than to adhere to them as closely as possible. It may be observed, however, that people in general, especially those who do not labour, eat much more than nature requires; that a little abstinence or self-denial may often be of use, either to prevent or to cure disease *; and at any rate, that none but hard-working people, or those who are in the very prime of life, or growing fast, or travelling about, should eat more than one full meal each day.

18. Violent exercise, shortly after a meal, ought never to be undertaken.
19. When the body is in a languid state, all the limbs should be vigorously stretched.
20. Drink should never be taken on an empty stomach; as, in that state, it cannot fail to prove exceedingly hurtful by agitating the nerves. Galen says, in the second Aphorism, 21, If a hungry person drink wine before he eat, he will speedily be attacked with spasms and delirious symptoms. Nor should wine be taken (habitually) after meals; because it unnaturally accelerates the digestion, propels the food before it is properly digested, and lays the foundation of obstructions and putridity.
21. Wine should never be taken immoderately; and it would be advisable, as much as possible, to abstain from its use, because it affects the brain: hence, no person of a weak organization should venture to drink it, unless in small quantities, or diluted. Serapio remarks, "Wine fills the head with many vapours."
22. The bread should be of the best quality, soft, (not too stale,) and mixed with a small portion of salt.
23. Cheese, and all the artificial preparations of milk, ought to be avoided; though pure milk, when mixed with sugar, may not be deemed unwholesome during the summer. Milk and water, or whey, is a salutary beverage at all seasons.
24. Fish should be seldom eaten, and then they ought to be tender and well dressed, with the addition of vinegar, spices, and other sauces.
25. Oysters, and all shell-fish, should be avoided, because they afford only a cold, slow, and viscous nourishment."

There are many useful hints in these Rules, though some of them are not applicable to general use, according to the modern style of living.

* After a disease is removed, if there is much lassitude and weakness, nothing will be found more useful than to take a crust of bread and a glass of very old and rich sweet wine at noon. This plan was strongly recommended to me by some intelligent persons on the Continent, who had reaped much benefit from it.

As

As to clothing, much must depend on situation and climate *; but, on the whole, it is generally found a useful practice to wear woollens next the skin. It is remarked in many parts of Scotland, that since the use of flannel shirts has been given up by the lower orders, the rheumatism, and other diseases formerly unknown, have become very frequent, and are daily increasing. In the West India Islands, if care be taken to make the troops wear flannel shirts, they are likely to be exempted from various disorders, which otherwise would probably have attacked them. Even the negroes themselves, I understand, prefer flannel to cotton or linen, and find it a much more comfortable and useful dress. In regard to clothing suited to the climate of Great Britain, there is reason to believe that we use furs much seldomer than we ought to do. Nothing can be more absurd than to consider the use of fur as a mark of effeminacy, and on that account to suppose that it is merely calculated for delicate women. In the piercing cold to which we are often subjected, furs might be worn with much advantage by the stoutest and hardiest men.

The nature of the house where any individual resides, is a very important consideration. Formerly they were very ill fitted up, and were what would now be considered extremely uncomfortable. It was said of old, that no house was wholesome "where a dog could not get in under the door, or a bird through the window." There was then no use for ventilators. The case is now much altered. The art of finishing houses closely, and the management of fuel, have been brought to such perfection, as greatly to exclude a free circulation of air, and to overheat that which the room contains. From the great expense of building and fitting up houses, also, the apartments in them are in general much smaller and less lofty than they ought to be. As it is impossible to make any great alteration in these particulars, more especially in the metropolis, and in large towns, which contain so large a proportion of the population of the kingdom, the only remedies are, to ventilate the houses whenever the weather will admit of it; and for the inhabitants of towns to be as much in the open air, and as frequently in the country, as circumstances will permit †.

* See an Essay, Philosophical and Medical, by Dr. Vaughan, concerning Modern Clothing. Printed *an.* 1792.

† It has been remarked, that persons residing in Scotland in summer, and in England in winter, generally enjoy excellent health; and it is believed that nothing would tend more to promote the health of the citizens of London, than an annual excursion to the mountains of Wales, or the highlands of Scotland.

In regard to exercise, it cannot be too much recommended; and as, from various circumstances, persons in large towns, and engaged in various sedentary occupations, cannot take all that exercise abroad that may be necessary for their health, they ought as much as possible to accustom themselves to be walking about even in their own house, instead of sitting so much as is usually the case. This rule is peculiarly necessary to be attended to by literary men; and though such a practice does not make up for the want of exercise abroad, yet it certainly is the best substitute for it.

But the principal object of any extensive paper on this subject should be, to point out those habits, or minute particulars, which contribute to good health and old age. We frequently see persons living luxuriously, and keeping even irregular hours, without being much troubled with disease. It is not improbable, were the truth known, that this is owing to trifling attentions, the result of observation and experience, which prove of infinite service to them, and which might be of equal advantage to others, were they collected by some public-spirited individual, and universally disseminated.

I believe there is no habit that contributes more to good health and good spirits, or renders a man fitter for going through a great deal of business, than that of taking a sufficient quantity of sleep, from six to eight, and even nine hours, if nature requires it. I understand that the late lord Mansfield frequently inculcated the advantages to be derived from a rigid adherence to such a system; and it is well known the quantity of business he went through, and the good health and good spirits he enjoyed for a great number of years. To continue long in bed without sleeping, is weakening and injurious; but a person may take all the repose that nature requires, and will have time sufficient, during the remainder of the day, to go through all the necessary business, and to enjoy all the real pleasures of life.

It is generally supposed, that early rising is also essential to good health *. Without being an advocate for what are called fashionable hours, which are carried to so preposterous an excess, converting night into day, and day into night, some doubts may be expressed regarding the propriety of carrying the opposite system to too great a height. In antient times, when people depended almost entirely on the sun for light, they were under the necessity of rising with that luminary, and of going to bed when it disappeared. Hence a prejudice arose

* The old maxim was,
Early go to bed, and early rise,
Makes a man healthy, wealthy, wise.

in

in favour of that practice; but the case is greatly altered since the means of obtaining artificial light to so great an extent have been discovered. I question much, whether the morning air is so wholesome as many imagine. The sun must necessarily extract from the earth, when it first appears, a variety of vapours, which strong constitutions may withstand, but which must be injurious to weak ones: even in large towns, it is some time before the morning fogs are dissipated. On the whole, late rising cannot be approved of, but very early rising is not probably so essential for health as is commonly imagined.

There is nothing that can tend more to long life than for a person to obtain a complete command of his passions, and in particular to preserve his mind from being ruffled. Perhaps there is no maxim more likely to promote good health, than that of paying a proper attention to *temper*, *temperance*, and *sleep*. By good temper, the mind is preserved from disease; and by temperance, the body; and both the mind and the body, when exhausted, are again recruited and restored to their former strength by a sufficient quantity of repose.

In so variable a climate as that of the British Isles, it is of the utmost importance to contrive the most effectual means of preventing various disorders arising from checked perspiration, as colds, coughs, consumptions, sore throats, rheumatisms, &c. by which so many thousands are cut off every year. The following hints are the result of some attention to that particular subject.

1. It is generally acknowledged that the use of flannel next the skin is a great preservative against catching cold, and all the disorders connected therewith. This is a point so well established that it is unnecessary to dwell upon it*.

2. There is not a better mode of being able to withstand the variableness of our climate, than to adopt the Spanish practice of wearing an under waistcoat made of thin shamoy leather, which tends to preserve the body in an equal temperature. This is particularly useful when persons are in a weak state after indisposition, or are likely to be affected with rheumatic complaints.

3. Many persons are apt to be frequently attacked by complaints in the throat, which may, in general, be prevented by attention to the following circumstances. It is usual for persons to make use of hot water for shaving, the consequence of

* The principal objection to wearing flannel is its tendency to excite too great perspiration in bed; but this is easily obviated by wearing a flannel waistcoat with buttons at the shoulders, so that it can be taken off at any time without inconvenience.

which is, that the glands of the throat are much relaxed, and very apt to be affected by cold. It has been found by experience, an excellent custom to use cold instead of hot water, though the latter may be employed in warming the razor, which adds to the comforts of shaving. Persons apt to have sore throats, if they suspect they have caught cold, should, as soon as possible, gargle their throats with spirits, which may also be applied with much advantage to the outside of the throat.

4. Persons who hunt or ride much, are greatly exposed to get wet, and catch disorders in consequence thereof, of which multitudes of all ages have perished. The remedy, however, is a very simple one. Whenever such a circumstance happens, particularly to any person not accustomed to get wet, he should as quickly as possible rub his feet with a towel dipt in rum or any other sort of spirits, the effect of which in restoring the animal heat of the whole body is almost instantaneous. This practice, I understand, has been found of the greatest service abroad, and the great Frederick of Prussia recommended it strongly to his soldiers to adopt it; though, in general, they were much more inclined to drink their brandy than to make this use of it.

The next particulars which it may be proper to advert to, are the skin, the teeth, and the eyes.

It is well known that the health of the individual depends much upon the state of the skin, and that good health can never be enjoyed unless when it performs its functions properly. For that purpose, it is necessary that it should be kept in a clean state. The attention paid to this subject by antient lawgivers, and founders of religious systems, cannot be too much recommended. They actually made the keeping the body clean, by frequent washing, part of the sacred duty of each individual. The use of linen, and the custom of throwing off the dress of the day, when going to sleep, (which is not the case with Asiatic, but fortunately is now so general with European nations,) renders bathing much less essential, but still the practice is too much neglected in this country; and in large towns, furnishing the people with the means of bathing commodiously ought to be a part of the general police*.

It is impossible too strongly to recommend an early and constant attention to the teeth. In former times, when persons lived with great simplicity, the teeth seldom failed until the body was on the verge of dissolution; but now, it is hardly

* The shower baths, and washing the body with wet sponges, have been found of great use in various complaints, and a great preservative against catching cold.

to

to be credited, how few pay such attention to their teeth as will preserve them in any tolerable order for a long period. This is the more surprising, as a good set of teeth is so ornamental, so essential for distinct pronunciation, and so necessary for a proper mastication of the food. In a paper of this description, it is only possible to touch upon this important subject. It may be proper, however, to observe a common mistake, that tooth-brushes, as they are called, are intended for rubbing the teeth, whereas their proper business is to rub the gums, and to excite a circulation there. It is diseases in the gums that principally occasion the destruction of the teeth, and preserving the one in good order materially contributes to the safety of the other*.

The little attention that is shown to the preservation of the eyes, is fully as blameable as the negligence above alluded to in regard to the teeth. Any imperfection in the sight is such a calamity, that every person of common prudence would certainly wish to prevent it by every possible means; and there is certainly no mode more likely to be effectual, than that of bathing them night and morning in a bason of cold water, and opening the eyes in the water. Any disorder that attacks the eye itself, from the pain and uneasiness which it occasions, must be attended to. But the eye-lids become often diseased and ulcerated; and though there are various ointments which would cure this disorder at the commencement, yet, as it is not very bad or troublesome, people are too apt to put it off from time to time, until the eye itself is affected, and a cure becomes hardly practicable.

It is imagined by some, that taking of snuff is a useful practice in preventing disorders in the head, and in the eyes in particular; and in the list subjoined of the In-pensioners in Greenwich Hospital who have exceeded the age of 80 years, a very large proportion use tobacco in some shape or other. The taking of snuff is certainly refreshing, and loaded as it is with a heavy tax, it still is a cheap luxury for the poor; and the evidence from Greenwich Hospital sufficiently proves, that the use of snuff and tobacco, though not to be universally recommended, yet is not incompatible with long life.

In a book published on the subject of longevity†, some circumstances are occasionally mentioned regarding the food and habits of persons who lived to a great age. Among these, the following seem to be the best entitled to notice; "1. John

* Some people have their teeth so regular and well set, that little attention is necessary; but wherever there is any irregularity, nothing but the greatest care, and the skill of an able dentist, can preserve them long.

† By Mr. James Easton, of Salisbury, printed in 8vo. *an.* 1799.

Hussey, of Sydenham, in Kent, who lived to be 116. For above 50 years his breakfast was balm tea sweetened with honey, and pudding for dinner, by the use of which he acquired long and regular health. 2. Judith Bannister, aged 108. She lived upon biscuit and apples, with milk and water, the last 60 years of her life. 3. John Riva, of Venice, aged 116, always chewed citron-bark. 4. Elizabeth Macpherson, of the county of Caithness, aged 116. Her diet was butter-milk and greens. 5. Francis Consit, of Burythorpe, near Malton, Yorkshire, aged 150, occasionally ate a raw new-laid egg. 6. Fluellyn Price, of Glamorgan, aged 108. Herb teas were his breakfast, meat plainly dressed his dinner, and instead of a supper he refreshed himself with a pipe of tobacco. 7. Val. Cateby, of Preston, near Hull, aged 116. His diet for the last twenty years was milk and biscuit. 8. Edward Drinker, of Philadelphia, aged 103. He lived on very solid food, drank tea in the afternoon, but ate no supper. 9. Lewis Morgan, of Radnorshire, aged 101. He lived chiefly on vegetable diet, and drank frequently of the famous rock water of Llandrindod. 10. Mr. Smith, of Montgomeryshire, aged 103. He was never known to drink any thing but buttermilk. 11. William Riddle, of Selkirk, in Scotland, aged 116. For the last two years of his life, his chief subsistence was a little bread infused in spirits and ale. 12. Honourable Mrs. Watkins, of Glamorganshire, aged 110. For the last 30 years she subsisted entiely on potatoes. 13. Rebecca Joseph, of Monmouthshire, aged 100. Her chief subsistence, for the last two years of her life, was brown sugar and cold water. 14. Charles Macklin, Esq. of London, aged 107. For the last 40 years of his life, his principal beverage was white wine and water, made pretty sweet; and after he had lost his teeth, his food principally consisted of fish, eggs, puddings, and spoon-meat. Having been attacked by a severe fit of the rheumatism, he discontinued the use of sheets, and slept in blankets. He used to be frequently rubbed all over with warm brandy or gin, (which seems to be a good practice for aged people,) and occasionally steeped his feet in warm water. It was his custom not to sleep on a feather bed, but on a mattress, on a couch without curtains, placed in the centre of the room, upon which he reposed whenever he found himself sleepy. Instead of attending to regularity, he observed the dictates of nature, ate when hungry, drank when thirsty, and slept when nature seemed to require repose.

Among practices which might be of service to aged people, I should imagine that rubbing the body with oil would be particularly useful. It might tend to preserve the skin in a soft

soft and healthy state, and to furnish the body with that unctuous matter, which very old people seldom have to the extent that is necessary; and hence those wrinkles which are so peculiar a characteristic of old age.

I am also persuaded, that in regard to various disorders, particularly those with which the aged are apt to be afflicted, a great source of benefit still remains to be explored, in the practice of electricity, by the use of which, not through the medium of violent shocks, but by gradually diffusing that important fluid throughout the whole frame, the body is reanimated with fresh vigour, and rendered fitter to go through its various functions with renewed spirit and strength.

There is certainly nothing that would tend more to preserve health and longevity, than improvements in the medical art, which, though it has made considerable progress in some particular departments, yet continues deficient in many others. When it is considered the number of able men who are employed in the medical profession, the importance of the objects to which their attention is directed, and the multitude of cases which are daily and even hourly coming under their review, one would think that hardly a circumstance could possibly happen that might not be foreseen and guarded against. Perhaps one mode of improving the art would be, requiring all physicians to communicate to the College an account of any case that seemed to throw light upon the mode of curing any particular disease. Honorary premiums might be given to those who make any useful discovery; and it is to be hoped that the munificence of Parliament to Dr. Jenner will show what may be expected by medical men who make any improvement of real and essential importance.

I shall conclude with observing, that man has been compared, and with some truth, to a machine; but he ought not to be considered as a machine that wears out by mere use, without the possibility of being repaired; but like one whose movements may be improved, whose wheels, after being disordered, may be again put into their former, and perhaps even an improved state, and whose frame may be long preserved by care, by attention, and by the ingenuity and exertions of skilful artists.

No. III.

On the Longevity of the Pensioners in Greenwich Hospital.

Being convinced that much light would be thrown on the subjects of health and longevity, were accurate returns made from hospitals and other public institutions, of the diet, age, and other particulars regarding the persons who resided in them, I was thence led to apply to Greenwich and Chelsea Hospitals for such information; and it is with much pleasure that I subjoin the following important facts with regard to Greenwich Hospital, which Dr. Robertson, at the desire of the respectable Master of that most excellent institution, (lord viscount Hood,) transmitted to me.

I shall insert the Tables as prepared by Dr. Robertson, and shall offer such observations as may occur on the results to be drawn from each of them respectively.

Observations on the annexed Table.

Doctor Jameson, of Bloomsbury-place, has made the following remarks on the Table:

"Dr. Robertson certainly deserves much praise for his attention in transmitting so particular a statement of the longevity of Greenwich Hospital; and if something similar could be procured from other public institutions in Great Britain and Ireland, it would not be difficult to form an arrangement of facts, that would afford important conclusions concerning the lives of mankind.

"The Table communicated by Dr. Robertson favours an opinion, that the watery element is not unfriendly to the human frame, especially when it is aided in advanced life by the comforts of Greenwich Hospital.

"The list of ninety-six men in that Hospital still alive, in extreme old age, is uncommonly great; and it appears from the table, that there is one man living above a hundred years old, and 13 above 90 years of age.

"That the greatest number are natives of Scotland, and a large proportion from Ireland.

"That one half belonged to aged families, many of whom had both parents very old.

"That more than two thirds had been upwards of 20 years in the king's service, and in various climates;

"That they were almost all married, and four of them after 80 years of age.

"That they almost all used tobacco, and most of them acknowledged the habit of drinking freely.

"That the parts of the human body which had most generally failed, were the teeth. Some of them had no teeth for 20 years, and 14 only had good teeth.

"That the organ of vision was impaired in about one half, and the organ of hearing in about a fifth part of them."

As Dr. Robertson proposes publishing a new edition of his interesting work on the Diseases incident to Seamen, it was unnecessary to touch upon that branch of the inquiry. He has very obligingly, however, communicated the following additional observations, connected with the subject of longevity in general.

1. The number of In-pensioners being 2,410, and the number of those who are from 80 years of age and upwards being 96; the proportion of the aged to the whole is only as $\frac{10}{96}$ less than $\frac{1}{25}$.

2. Some use tobacco for particular complaints, which they think are relieved by the use of it, or use snuff; and the rest say that they cannot do without it.

3. John Moore (the oldest man in the house) says, that he has had four new FORE teeth within these five years; one of which he has lost he knows not how. This is commonly counted a great mark of old age.

4. The proportion of aged marines is $\frac{12}{96}$, or $\frac{1}{8}$ of the whole number of persons above 80 years of age, in the Hospital.

5. The number of Out-pensioners is about 2,500, to whose ages when they were admitted, the number of years they have been on the list being added, it appears there are only 23 from 80 years of age and upwards; a sufficient proof of the great attention paid to the health of the In-pensioners at this excellent institution.

6. The number of ruptured men among the In-pensioners, on the 3d of May, was 161, or $\frac{1}{15}$, the number being 2,410. Among the Out-pensioners, amounting to 2,500, the number was only about 50, or nearly $\frac{1}{50}$.

ROYAL HOSPITAL AT GREENWICH.

Deaths of Pensioners from the 1st of January 1782 to the 31st of December 1798, inclusive, the Complement being 2350.

Year.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Number in each year.
1782	16	19	15	21	24	31	18	16	16	16	17	19	228
—83	18	15	17	14	12	17	13	15	16	17	15	19	188
—84	17	25	21	25	22	14	13	6	6	10	10	17	186
—85	20	16	14	16	14	18	21	19	15	15	10	1[illegible]	195
—86	11	20	20	12	13	20	8	18	15	17	24	8	186
—87	36	14	2	20	11	16	14	11	14	16	2[illegible]	21	212
—88	13	15	22	20	13	11	10	15	15	14	12	26	192
—89	27	23	15	1[illegible]	16	14	15	13	18	21	12	11	203
—90	15	12	10	14	22	11	15	21	10	13	21	15	179
—91	18	19	18	2[illegible]	22	25	21	14	12	16	13	20	218
—92	21	15	24	11	14	16	13	12	12	13	17	20	188
—93	23	15	17	10	19	8	14	11	13	17	15	16	178
—94	33	15	13	16	14	17	16	14	19	13	13	26	209
—95	32	27	45	24	24	15	15	12	18	14	11	11	248
—96	19	13	10	23	17	12	8	13	10	13	12	23	173
—97	14	25	13	19	26	20	17	9	13	20	23	21	220
—98	18	2	25	20	20	17	15	16	17	14	15	24	222
Total	351	309	311	303	303	282	252	235	239	259	26[illegible]	314	17)3425
													201 $\frac{8}{17}$

ROYAL HOSPITAL AT GREENWICH.

Deaths of Pensioners from the 1st of January 1799 to the 31st of December 1801, inclusive, the Complement being 2410.

Year.	January	February.	March.	April.	May.	June.	July.	August.	September.	October.	November	December.	Number in each year.
1799	23	20	23	23	36	16	12	11	20	14	12	26	236
1800	25	19	17	19	8	15	7	15	26	23	19	15	208
1801	18	9	15	20	9	15	11	15	16	13	16	17	174
Total	66	48	55	62	53	46	30	41	62	50	47	58	3)618
													206

The

The following obſervations have occurred to Dr. Jameſon on the two preceding tables.

That during the ſpace of twenty years, the number of annual deaths was very ſimilar, varying very little in any year, or in any month of theſe years. And as it appears no uncommon incident occurred during that time to alter the natural order, we have a tolerably certain eſtimate, which may be ſaid to be 203 annual deaths out of 2400 penſioners.

That theſe men, who were moſtly in advanced years, died in greateſt number in the three winter months, reckoning December the firſt; and in the ſmalleſt proportion, in the three ſummer months, reckoning June the firſt, and that the ſpring was more mortal than autumn.

Viz. From November till March		1146.
	—June	1087.
	—Sept.	886.
	—Dec.	924.

Table of the Diet at Greenwich Hoſpital.

Days.	Bread. lb.	Beer. quarts.	Beef. lb.	Mutton. lb.	Butter. lb.	Cheeſe. lb.	Peaſe. pints.
Sunday	1	2	—	1	—	$\frac{1}{4}$	—
Monday	1	2	1	—	—	$\frac{1}{4}$	—
Tueſday	1	2	—	1	—	$\frac{1}{4}$	—
Wedneſday	1	2	—	—	$\frac{1}{16}$	$\frac{1}{2}$	$\frac{1}{2}$
Thurſday	1	2	1	—	—	$\frac{1}{2}$	—
Friday	1	2	—	—	$\frac{1}{16}$	$\frac{1}{2}$	$\frac{1}{2}$
Saturday	1	2	1	—	—	$\frac{1}{4}$	—
Total *per* week.	7	14	3	2	$\frac{2}{16}$	$2\frac{1}{4}$	1

Broth is made of the meat.

The diet of the ſick varies at the diſcretion of the phyſician.

It appears by the Table of Diet, that the allowance is well calculated for the purpoſes of health, and very much reſembles the victualling of his majeſty's navy, two banian days in the week.—The proportions of animal and vegetable food are equally balanced.

XLI. *Description of an improved Gas-holder, by Dr.* WARWICK.

SIR, *To Mr. Tilloch.*

AS simplicity and cheapness are objects of considerable importance in the construction of chemical apparatus, I shall make no apology for recommending to your readers a less expensive alteration in the air-holder of Mr. Watt, than that described by Mr. Pepys in your last number. I contrived it upwards of two years since, and find it answers every purpose for which it was intended. A stop-cock, soldered to the shorter tube in the top of the gas-holder, and a rim sufficiently deep to permit the water to rise an inch above the stop-cock, will enable those fond of pneumatic experiments to transfer oxygen (or any other) gas with the utmost readiness to any vessel they please. (See Fig. 3. Plate V.) The stop-cock has no screw, the blow-pipe having a socket fitting the tube with sufficient accuracy to prevent the escape of air. A perusal of the communication of Mr. Pepys will render a more minute description unnecessary. Those persons to whom expense is of no consequence will most likely prefer that contrived by Mr. Pepys, which is in some respects, perhaps, more convenient than that of which I have sent you a sketch; but of this every one must judge for himself. I remain, Yours, &c.

Rotherham, Aug. 9, 1802. T. O. WARWICK.

XLII. *Remarks on the* CLATHRUS *cancellatus* (Linn.) *and two other Species of Fungus. By* B. M. FORSTER, *Esq. Communicated by the Author.*

THE very near resemblance which the CLATHRUS *cancellatus* bears in several respects to the PHALLUS *impudicus* and PHALLUS *caninus*, appears sufficiently strong to justify the arrangement of them all under one genus, although not so considered by Linnæus, and I have ventured to form generic and specific characters as follow:

Generic Character.

CLATHRUS.

Volva coriacea. *Corpus* cavus, cellulosus, pertusus. *Semina* in glutine immersa.

Specific Characters.

CL. *cancellatus*, corpore globoso, fenestrato.
CL. *pileatus*, corpore cylindrico, pileo favoso.
CL. *capitulatus*, corpore cylindrico, capitulo corrugato.

For

For good figures of the C. *cancellatus*, Micheli may be referred to, and for the two latter, Curtis's Fl. Lond. and Sowerby's Englifh Fungi, called in both publications PHALLUS.

I am not aware that any other Fungus will arrange with the above three fpecies, although fome have been placed under the genus PHALLUS, by Linnæus and other botanifts, which have very little agreement with the P. *impudicus* and P. *caninus* of thofe authors.

XLIII. *An Attempt towards a Theory of the Refiftance experienced by two and four-wheeled Carriages on different Kinds of Roads; and to determine the Circumftances under which the one are preferable to the other.* *By* NICHOLAS FUSS, *Profeffor of the higher Mathematics at Peterfburgh, Member of the Imperial Academy of Sciences, &c.*

[Continued from p. 122.]

SECOND DIVISION.

Of the Refiftance on folid and uneven Roads.

I. *Four-wheeled Carriages.*

Section 19.

IF the road AB, Plate II. fig. 4. be naturally rough and ftony, or paved artificially, or covered in fome places with trees laid acrofs it, new impediments arife from thefe inequalities, and the refiftance found in the preceding divifion, fection 9, which takes place here alfo, acquires an increafe, which is determined in the following manner:

Let the wheel touch in G and G′ two equally large and folid inequalities of the road, and for the fore-wheels let the angle GOG′ $= 2\phi$, but for the hind-wheels GOG′ $= 2\psi$. Now as a part of the moving power OV, which we fhall call OU $=$ K, muft be employed to overcome a part of the power of gravity acting in a direction perpendicular to AB, which is $(\frac{1}{2}P + p) \cos. \alpha$, and to raife the fore-axle together with its part of the load over the fixed point G, the momentum of thefe powers OU.GU and OR.GR muft be equal to each other; that is, K.GO $\cos. \phi = (\frac{1}{2}P + p) \cos. \alpha$. GO $\sin. \phi$; fo that the increafe of refiftance arifing from this impediment will be for the fore-wheels $K = (\frac{1}{2}P + p) \cos. \alpha \text{ tang. } \phi$. A fimilar increafe will be found for the hind-wheels $= (\frac{1}{2}P + p') \cos. \alpha \text{ tang. } \psi$. Confequently the whole refiftance on roads of the fecond clafs for four-wheeled carriages is:

$$\left.\begin{array}{l} R = \frac{1}{2}(m+n)\lambda P \cos. \alpha + (P + p + p') \sin. \alpha \\ \quad + (\frac{1}{2}P + p) \cos. \alpha \text{ tang. } \phi + (\frac{1}{2}P + p') \cos. \alpha \text{ tang. } \psi \end{array}\right\}$$

II. *Two-*

II. *Two-wheeled Carriages.*

Section 20.

The resistance found in the preceding division, section 12, for carriages of this kind, acquires here an increase, which, if we make the angle GOG′ = 2ω, will be found in the same manner as in the preceding section = $(P+\pi)$ cos. α tang. ω. The whole resistance for two-wheeled carriages on roads of the second class will therefore be expressed as follows:

$$R' = \mu\lambda P \cos.\alpha + (P + \varepsilon P + \pi)\,\text{fin.}\,\alpha + (P+\pi)\cos.\alpha\,\text{tang.}\,\omega$$

III. *Comparison of the two Kinds of Carriages.*

Section 21.

If the comparison be made in general according to the five different points of view mentioned in the 16th section, it will be found that four-wheeled carriages are preferable to two-wheeled when any of the five following conditions take place:

1st, $$\frac{m+n-2\mu}{2} < \left\{\frac{(\varepsilon P+\pi-p-p')\,\text{tan.}\,\alpha + (P+\pi)\,\text{tan}\,\omega}{\lambda P} - \frac{(\frac{1}{2}P+p)\,\text{tang.}\,\varphi - (\frac{1}{2}P+p')\,\text{tang.}\,\psi}{\lambda P}\right\}$$

2d, $$p+p'-\pi < \varepsilon P - \left\{\frac{(m+n-2\mu)\,\frac{1}{2}\lambda P + (P+\pi)\,\text{tang.}\,\omega}{\text{tang.}\,\alpha} - \frac{(\frac{1}{2}P+p)\,\text{tang.}\,\varphi - (\frac{1}{2}P+p')\,\text{tang.}\,\psi}{\text{tang.}\,\alpha}\right\}$$

3d, $$P > \frac{(p+p'-\pi)\,\text{tang.}\,\alpha + p\,\text{tang.}\,\varphi + p'\,\text{tang.}\,\psi - \pi\,\text{tang.}\,\omega}{\varepsilon\,\text{tang.}\,\alpha + \text{tang.}\,\omega - \frac{1}{2}\,\text{tang.}\,\phi - \frac{1}{2}\,\psi - \frac{1}{2}\lambda(m+n-2\mu)}$$

4th, $$\varepsilon > \left\{\frac{(m+n-2\mu)\,\frac{1}{2}\lambda P + (p+p'-\pi)\,\text{tang.}\,\alpha + (\frac{1}{2}P+p)}{P\,\text{tang.}\,\alpha}\,\frac{\text{tang.}\,\varphi + (\frac{1}{2}P+p')\,\text{tang.}\,\psi - (P+\pi)\,\text{tang.}\,\omega}{P\,\text{tang.}\,\alpha}\right\}$$

5th, $$\text{Tang.}\,\alpha > \left\{\frac{(m+n-2\mu)\,\frac{1}{2}\lambda P + (\frac{1}{2}P+p)\,\text{tang.}\,\varphi}{\varepsilon P+\pi-p-p'} + \frac{(\frac{1}{2}P+p')\,\text{tang.}\,\psi - (P+\pi)\,\text{tang.}\,\omega}{\varepsilon P+\pi-p-p'}\right\}$$

EXAMPLE I.

Section 22.

Let the road be composed of round pieces of timber six inches in diameter laid across it, and let $\alpha = 0$. Let the mean diameter of the fore and hind axle-trees of the four-wheeled carriages be $3\frac{1}{4}$ inches; that of the axles of the two-wheeled carriages $3\frac{3}{4}$; and the diameter of the wheels in the fame order, 26, 39, and 45 inches; fo that $m = \frac{1}{8}$, $n = \frac{1}{12}$, and $\mu = \frac{1}{12}$: alfo, let P = 1000 lib., p = 74 lib., p' = 106 lib., and π = 130 lib.; and let the coefficient of the friction be $\lambda = \frac{2}{9}$. In the laft place, as TG = TF = 3 inches, we fhall have for the wheels in the above order TO = 16, $\frac{45}{2}$ and $\frac{51}{2}$ inches, and becaufe fin. TOF = $\frac{TF}{TO}$; the angle TOF, that is to fay, $\varphi = 10° 48'$; $\psi = 7° 40'$; $\omega = 6° 45'$. From thefe elements we obtain,

$$\tfrac{1}{2}(m+n)\lambda P = 23\cdot148$$
$$(\tfrac{1}{2}P + p)\ \text{tang.}\ \varphi = 109\cdot496$$
$$(\tfrac{1}{2}P + p)\ \text{tang.}\ \psi = 81\cdot575$$
$$R = 214\cdot219$$

$$\mu\lambda P = 18\cdot518$$
$$(P + \pi)\ \text{tang.}\ \omega = 133\cdot744$$
$$R' = 152\cdot262$$

For a horfe, then, whofe ftrength M = 400 lib. and velocity G = 13 feet on fuch a road, we have $g = 3\cdot484$ feet, and $g' = 4\cdot979$ feet in a fecond.

It might be conjectured that four-wheeled carriages, the fore-wheels being fo fmall, would experience a refiftance confiderably greater than the two-wheeled. Were $m = n = \frac{1}{12}$, and $p = p' = 106$, we fhould have R = 181·669, and $g = 4\cdot238$.

Example II.

Section 23.

Let the road be fteep and compofed of ftones, the angle of elevation being $\alpha = 14°$, and let the pavement be of fuch a nature, that the diftance between the points of contact G, G' = 3 inches, confequently the angle $\varphi = 5° 45'$; $\psi = 4° 6'$, and $\omega = 3° 49'$. Let the burden be P = 1800 lib., the mean diameter of the axle-trees of the fore-wheels = 3 inches, of the hind-wheels $3\frac{1}{2}$ inches, that of the two-wheeled carriages $3\frac{1}{4}$ inches; let the diameter of the wheels in the fame order be 30, 42, and 45 inches; fo that $m = \frac{1}{8}$, $n = \frac{1}{12}$, and $\mu = \frac{1}{12}$. The weight of the wheels we fhall fuppofe to be p = 80 lib. p' = 110 lib., and π = 120 lib. In the laft place, let $\lambda = \frac{1}{3}$, and $\varepsilon = \frac{1}{24}$. Hence we obtain

$$\tfrac{1}{2}(m+n)\lambda P\cos.\alpha = 33\cdot960$$
$$(P + p + p')\ \text{fin.}\ \alpha = 481\cdot425$$
$$(\tfrac{1}{2}P + p)\cos.\alpha\ \text{tang.}\ \varphi = 95\cdot750$$
$$(\tfrac{1}{2}P + p)\cos.\alpha\ \text{tang.}\ \psi = 70\cdot247$$
$$R = 681\cdot382$$

$\mu\lambda$ P

$$\mu \lambda \text{ P cos. } \alpha = 29{\cdot}109$$
$$(\text{P} + \varepsilon \text{ P} + \pi) \text{ sin. } \alpha = 482{\cdot}634$$
$$(\text{P} + \pi) \text{ cos. } \alpha \text{ tang. } \omega = 124{\cdot}282$$

$$\text{R}' = 636{\cdot}025$$

Three horses, therefore, whose strength is M = 1200 lib. and their velocity on this kind of road G = 10 feet, could draw the burden P = 1800 lib. on a four-wheeled carriage at the rate of $g = 2{\cdot}47$ feet per second, and on a two-wheeled carriage about $g' = 2{\cdot}72$ feet.

Section 24.

On a horizontal road of the above nature we shall have for the same carriages and load R = 206·08 and R′ = 158·09. For a horse therefore whose strength M = 400 lib., and velocity on this horizontal road G = 15 feet, we shall have $g =$ 4·23 and $g' = 5{\cdot}58$ feet.

Third Division.

Of the Resistance on soft and even Roads.

Section 25.

If the surface of the road be composed of soft sand, slate, earth, clay, dirt, &c. the wheels will sink into it, and the depth to which they sink will be greater the softer and more fluid the matter is of which the road consists.

Now as the increase of resistance depends on the depth to which the wheels sink, and as this depth depends on the nature of the matter, that is to say, its hydrostatic power, which can be determined only by experiment, I shall assume that a prismatic body the thickness of which is dd square inches and its weight 9 lib. sinks merely by its gravity c inches deep in the fluid matter, or displaces ddc cubic inches of it before it comes into equilibrium: this matter, then, in regard to hydrostatic power produces the same effect as would be produced by an aqueous fluid a cubic foot of which weighs $\frac{12^3 q}{ddc}$ lib.

A load Q, Pl. II. fig. 5. will press down both wheels on the axis O till they have displaced $\frac{ddcQ}{q}$ cubic inches of the fluid matter. If FR be the depth to which the wheels sink, and π' the circumference of a circle whose diameter = 1, the superficial content of the sunken segment GFG′R $= \text{GO}^2 \left(\frac{\pi' . \angle \text{GOR}}{180^\circ} - \frac{1}{2} \text{ sin. GOG}' \right)$. And if the fellies

be

be b inches broad, we ſhall have for both wheels:

$$2b\,GO^2\left(\frac{\pi'.\angle GOR}{180°} - \tfrac{1}{2}\text{ ſin. }GOG'\right) = \frac{ddcQ}{q}.$$

Hence we find,

$$\frac{\pi'.GOR}{90°} - \text{ſin. }GOG' = \frac{ddcQ}{bq.GO^2};$$

from which equation the angle GOR neceſſary for determining the reſiſtance is found.

I. *Four-wheeled Carriages.*

Section 26.

As the wheels in this caſe have ſunk to the points G, G′ of their circumference, there ariſes in the point G an impediment to the motion, which will be greater or leſs according as the ſurface of the road is covered with more or leſs fluid matter; that is, according to the greater or leſs extent of the angle which the ſides of as ſteep an accumulation as poſſible of this matter forms with the level ſurface. This angle, which gives the moſt convenient meaſure of the fluidity, I ſhall in future call β.

Now if GFG′ were an excavation in a perfectly ſolid road, G would oppoſe the moving power OV in conſequence of the power of gravity OQ = S with a power OR = S cos. α, the momentum of which is OR.GR = S cos. α. GO ſin. GOR. If the part of the moving power employed for this purpoſe be K, its momentum K.GU = K.GO cos. GOR; ſo that K = S cos. α tang. GOR. If the angle for the fore-wheels be GOR = ξ, and for the hind-wheels GOR = n, the reſiſtance for the former = $(\frac{1}{2}P + p)$ cos. α. tang. ξ, and for the latter = $(\frac{1}{2}P + p')$ cos. α tang n; conſequently, the increaſe of reſiſtance for the four-wheeled carriages = cos. α $[(\frac{1}{2}P + p)$ tang. $\xi + (\frac{1}{2}P + p')$ tang. $n]$. With this power G oppoſes a reſiſtance as a fixed point, but, as a fluid, it yields and oppoſes a leſs power the greater its fluidity, the coefficient of which is ſin. β. The increaſe of reſiſtance on roads of this kind is therefore = cos. α ſin. β $[(\frac{1}{2}P + p)$ tang. $\xi + (\frac{1}{2}P + p')$ tang. $n]$; conſequently the whole reſiſtance for four-wheeled carriages:

$$\left.\begin{array}{l} R = \frac{1}{2}(m+n)\lambda P \text{ cos. }\alpha + (P + p + p')\text{ ſin. }\alpha \\ \quad + \text{cos. }\alpha\text{ ſin. }\beta\,[(\frac{1}{2}P + p)\text{ tang. }\xi + (\frac{1}{2}P + p)\text{ tang. }n.] \end{array}\right\}$$

II. *Two-wheeled Carriages.*

Section 27.

If we make the angle GOR = ϑ, it will be found in the fame manner as in the preceding fection, that the increafe of refiftance on roads of this clafs is $= (P + \pi) \cos. \alpha \text{ fin. } \beta \text{ tang. } \vartheta$; and the whole refiftance for two-wheeled carriages will be,

$$\left. \begin{array}{l} R' = \mu \lambda P \cos. \alpha + (P + \varepsilon P + \pi) \text{ fin. } \alpha \\ \quad + (P + \pi) \cos. \alpha, \text{ fin. } \pi, \text{ tang. } \vartheta. \end{array} \right\}$$

III. *Obfervations on thefe Formulæ R and R'.*

Section 28.

Thefe expreffions for R and R' as above found contain, as we fhall foon fee, a complete folution of the problem, as they anfwer for all the three claffes of roads.

1ft, For folid and even roads where $\xi = 0$, $\eta = 0$, $\vartheta = 0$, and $\beta = 90°$, they give for R and R' the fame values as thofe found for refiftance in the firft divifion.

2d, For folid and uneven roads where $\xi = \phi$, $\eta = \psi$, $\vartheta = \omega$, and $\beta = 90°$, we have the fame values for R and R' as thofe found in the fecond divifion.

3d, For roads with ftanding water on a folid bottom (which, however, muft not reach to the fpokes, becaufe in this cafe the refiftance muft be determined in another manner), where $\beta = 0$, we fhall have R and R' as in the firft divifion. In this cafe, no perceptible increafe of refiftance arifes: on the other hand, on fuch roads G and confequently V is lefs than on roads of the firft clafs.

4th, When one of the angles ξ, η, or ϑ, is a right angle; that is, when P is fo great that the wheels fink up to the axle in the foft furface, the refiftance becomes infinitely great, except in that cafe only where the fluid is very thin, and $\beta = 0$; in which cafe inftead of an infinitely great refiftance we fhall have only an indefinite increafe $= 0.\infty$, which cannot be determined from the grounds mentioned in the third obfervation.

In the laft place, it is to be obferved in regard to thefe expreffions,

5th, That when the foft tender furface has a folid bottom, and is not fo deep that the wheels can penetrate into it according to the laws of hydroftatics, the angle GOR muft not be determined according to the abfolute finking, but according to the depth of the folid bottom.

6th, That for lefs fluid matters, fuch as moift fand, moift earth, ftiff clay, dirt, &c. in the expreffion for the refiftance of four-wheeled carriages, R the laft member for the hind-wheels $(\frac{1}{2} P + p') \cos. \alpha, \text{ fin. } \beta, \text{ tang. } \eta$, vanifhes, becaufe thefe wheels run in the ruts formed by the fore-wheels.

IV. *Com-*

IV. *Comparifon between the two Kinds of Carriages.*

Section 29.

On roads of this clafs, four-wheeled carriages are to be preferred to two-wheeled, when one of the five following conditions takes place:

$$\text{1ft, } \frac{m+n-2\mu}{2} < \frac{(\varepsilon P+\pi-p-p')\text{ t. }\alpha+\text{fin. }\beta\,[(P+\pi)\text{t. }\vartheta}{\lambda P} \left.\begin{matrix} \\ \\ \end{matrix}\right\} \frac{-(\frac{1}{2}P+p)\text{ tang. }\xi-(\frac{1}{2}P+p')\text{ tang. }\eta]}{\lambda P}$$

$$\text{2d, } p+p-\pi < \varepsilon P-\frac{(m+n-2\mu)\frac{1}{2}\lambda P+\text{fin. }\beta\,[(P+\pi)\text{ t. }\vartheta}{\text{tang. }\alpha} \left.\begin{matrix} \\ \\ \end{matrix}\right\} \frac{-(\frac{1}{2}P+p)\text{ tang. }\xi-(\frac{1}{2}P+p')\text{ tang. }\eta]}{\text{tang. }\alpha}$$

$$\text{3d, } P > \frac{(p+p'-\pi)\text{ t. }\alpha+\text{fin. }\beta\,(p\text{ t. }\xi+p'\text{ t. }\eta-\pi\text{ t. }\vartheta)}{\varepsilon\text{ t. }\alpha+\text{fin. }\beta\,[\text{t. }\vartheta-\frac{1}{2}\text{t. }\xi-\frac{1}{2}\text{t. }\eta]-\frac{1}{2}\lambda\,(m+n-2\mu)}$$

$$\text{4th, } \varepsilon > \frac{(m+n-2\mu)\frac{1}{2}\lambda P+(p+p'-\pi)\text{ tang. }\alpha+\text{fin. }\beta}{P\text{ tang. }\alpha} \left.\begin{matrix} \\ \\ \end{matrix}\right\} \frac{[(\frac{1}{2}P+p)\text{ tang. }\xi+(\frac{1}{2}P+p')\text{ tang. }\eta-(P+\pi)\text{ tang. }\vartheta]}{P\text{ tang. }\alpha}$$

$$\text{5th, Tang. }\alpha > \frac{(m+n-2\mu)\frac{1}{2}\lambda P+\text{fin. }\beta\,[(\frac{1}{2}P+p)\text{ t. }\xi}{\varepsilon P+\pi-p-p'} \left.\begin{matrix} \\ \\ \end{matrix}\right\} \frac{+(\frac{1}{2}P+p')\text{ tang. }\eta-(P+\pi)\text{ tang. }\vartheta]}{\varepsilon P+\pi-p-p'}$$

That thefe five conditions are general, and contain the conditions found for the two claffes before treated, fection 16 and fection 17, it is fuperfluous to mention, after what has been faid in the firft two remarks of the preceding fection.

Application to fome determinate Cafes.

Example I.

Section 30.

I poured very dry coarfe red fand, Pl. II. fig. 6. after I had found the angle $\beta = 30° 42'$ (that is to fay, AB = 16 inches and CD = $4\frac{1}{4}$ inches), into a veffel, and, fmoothing the furface of it after each experiment by fhaking it fo as to obtain the fame degree of foftnefs, I took a fteel rod weighing 5 lib., which I had caufed to be conftructed for magnetic experiments, and which was juft an inch fquare, and pufhed it feveral times into the fand in a gentle manner, to prevent the acquired velocity from making it fink deeper than the equilibrium fought for. Sixteen experiments of this kind, in which the greateft difference did not amount to half a line,

 gave

gave as a medium of the sinking $\frac{7}{24}$ inches; so that $ddc = \frac{7}{24}$ inches, and $q = 5$ lib.

Let the road consist of such soft sand; let the inclination $\alpha = 4°$; the load $P = 1200$ lib., the weight of the wheels $p = 84$ lib. $p' = 110$ lib., $\pi = 132$ lib.; their diameter in the same order as before, $31\frac{1}{2}$, 42, and 49 inches. Also let $m = \frac{1}{9}$, $n = \frac{1}{12}$, $\mu = \frac{1}{14}$, $\lambda = \frac{1}{5}$; OS $= 2\frac{6}{7}$ feet and OI = 12 feet; so that $\varepsilon = \frac{1}{60}$. In the last place, let $b = 3$ inches, consequently,

$$\frac{\pi'\xi}{90°} - \text{sin. } 2\,\xi = 0{\cdot}05361, \text{ and } \xi = 19°\ 47'$$

$$\frac{\pi'\eta}{90°} - \text{sin. } 2\,\eta = 0{\cdot}03130, \text{ and } \eta = 16°\ 30'$$

$$\frac{\pi\,\vartheta}{90°} - \text{sin. } 2\,\vartheta = 0{\cdot}04315, \text{ and } \vartheta = 18°\ 23'$$

$\frac{1}{2}(m + n)\,\lambda\,P$ cos. α	=	23·276
$(P + p + p')$ sin. α	=	97·242
$(\frac{1}{2}P + p)$ cos. α, sin. β, tang. ξ	=	125·303
$(\frac{1}{2}P + p')$ cos. α, sin. β, tang. η	=	107·112
	R =	352·933
$\mu\,\lambda\,P$ cos. α	=	17·101
$(P + \varepsilon P + \pi)$ sin. α	=	94·311
$(P + \pi)$ cos. α, sin. β, tang. ϑ	=	225·450
		336·862

If we suppose for two horses M = 800 and G = 11 feet, we shall have $g = 3{\cdot}696$ feet and $g' = 3{\cdot}861$ feet in a second.

However well the two-wheeled carriages may be constructed, however small the burden, the inclination of the road, and the height of the centre of gravity, the resistance is only a little less than for four-wheeled carriages. To show how much depends on the proportion of the wheels, and particularly in regard to carriages of this kind, I shall in the following examples change only the wheels of the two-wheeled carriages.

Example II.

Section 31.

Let every thing be as before, only for the two-wheeled carriages let GO = 16 inches, $\pi = 85$ lib., and $\mu = \frac{7}{64}$; therefore $\vartheta = 24°\ 15'$, and

$\mu\,\lambda\,P$ cos. α	=	26·186
$(P + \varepsilon P + \pi)$ sin. α	=	91·032
$(P + \pi)$ cos. α, sin. β, tang. ϑ	=	294·808
		412·026

Therefore

Therefore we shall have as before R = 352·933 lib., but R′ = 412·026 lib.; consequently g = 3·696 feet, and g' = 3·102 feet.

EXAMPLE III.

Section 32.

After a series of similar experiments with somewhat coarser and very moist red sand, I found $\beta = 43°\ 19'$, and $c = \frac{5}{12}$ inch at a medium. But it is to be observed that the impressions made by immersing the steel rod did not disappear as from the above dry sand, but remained after it was drawn out; and therefore after each experiment I was obliged to make the sand even and soft by shaking it, and to render its surface smooth by a slight pressure proportioned to the exact measurement of the depth; by which means it lost a little of its natural softness. When I placed the rod again in the remaining impression it did not become deeper. Hence follows what we are taught by experience in general in regard to moist sand, moist earth, thick mud, &c. that the hind-wheels when they revolve in the ruts formed by the fore-wheels do not make them deeper, and consequently experience no resistance from sinking down; so that in the value of R, section 26, found for four-wheeled carriages, in such cases the last member $(\frac{1}{2}\,P + p)$ cos. α, sin. β, tang. η vanishes.

Let us suppose then, as in the first example, section 30, that the angle $\alpha = 4°$ the weight of the wheels, p = 84 lib., p' = 110 lib., π = 132 lib.; and their semidiameter in the same order, GO = $15\frac{3}{4}$, 21, $24\frac{1}{2}$ inches, and b = 3 inches; also let $m = \frac{1}{9}$, $n = \frac{1}{12}$, $\mu = \frac{1}{14}$, $\lambda = \frac{1}{5}$, $\varepsilon = \frac{1}{86}$, and g = 5 lib. If the load be P = 900 lib., and $ddc = \frac{5}{12}$ cubic inches, we shall have

$$\frac{\pi\,\xi}{90°} - \text{sin. } 2\,\xi = 0·05980, \text{ and } \xi = 20°\ 32'$$

$$\frac{\pi'\eta}{90°} - \text{sin. } 2\,\eta = 0·03527, \text{ and } \eta = 17°\ 10'$$

$$\frac{\pi'\vartheta}{90°} - \text{sin. } 2\,\vartheta = 0·04776, \text{ and } \vartheta = 19°\ 10'$$

$\frac{1}{2}\,(m + n)\,\lambda\,P$ cos. α	=	17·457
$(P + p + p)$ sin. α	=	76·313
$(\frac{1}{2}\,P + p)$ cos. α, sin. β, tang. ξ	=	136·878
R	=	230·648
$\mu\,\lambda\,P$ cos. α	=	12·826
$(P + \varepsilon\,P + \pi)$ sin. α	=	73·035
$(P + \pi)$ cos. α, sin. β, tang. ϑ	=	243·414
R′	=	329·275

If for a horſe on this road $M = 400$ lib. and $G = 12\frac{1}{2}$ feet, we ſhall have $g = 3{\cdot}012$ and $g' = 1{\cdot}162$ feet in a ſecond.

Alſo if the hind-wheels do not run exactly in the ruts formed by the fore-wheels, and if the member $(\frac{1}{2}P + p')$ cos. α, ſin. β, tang. $\eta = 118{\cdot}389$, cannot be entirely omitted, we ſhall ſtill have $R < R'$ even when only the fourth part of it vaniſhes.

[To be continued.]

XLIV. *Some Account of* EDWARD JENNER, *M. D.*

THIS gentleman, who has diſtinguiſhed himſelf ſo much in the annals of medicine by bringing forward the vaccine inoculation to public notice, and who has been thought worthy of national remuneration on that account, is a ſon of the Rev. Stephen Jenner, formerly vicar of Berkley in Glouceſterſhire, a man highly reſpected by all thoſe who had the pleaſure of his acquaintance. Edward was born about the year 1749, and received his education at Cirenceſter in the ſame county. Having made a conſiderable progreſs in claſſical learning, and ſhowing an early attachment to the ſtudy of phyſic, he was placed under the care of Mr. Ludlow, an eminent ſurgeon at Sodbury, a large market-town between Briſtol and Wotton under Edge. After remaining with this gentleman ſome time, during which he applied with aſſiduity, and made rapid improvement, he repaired to London to complete his medical education, and became a houſe-pupil to the celebrated John Hunter. In this ſituation he continued two years, and availed himſelf with great ſucceſs of the inſtruction of ſo able a maſter. At the expiration of this period he removed to Berkley, where he commenced practice, and met with conſiderable encouragement. In the mean time he ſtill kept up his intimacy with Mr. Hunter by a regular correſpondence; and the frequent mention which Mr. Hunter has made of him in his works is a ſtriking inſtance of the favourable opinion which he entertained of his abilities. An ingenious paper on the natural hiſtory of the cuckow, in a letter addreſſed to Mr. Hunter, was communicated by him to the Royal Society, and was inſerted in the Philoſophical Tranſactions for 1788. Several other papers of his on intricate ſubjects in natural hiſtory were publiſhed about the ſame time. In 1778 he married miſs Catherine Kingſcote of Kingſcote in Glouceſterſhire, by whom he he has two ſons and a daughter. Of late he has reſided with his family in London during the winter, but the ſummer ſeaſon he general ſpends at Cheltenham or Berkley. For ſome years paſt he has devoted himſelf chiefly to reſearches and obſervations in regard to the vaccine inoculation, one of the moſt important diſcoveries of modern times, as it gives reaſon to hope that the ſmall-pox, ſo fatal to the human race, may at length be totally eradicated. But as this ſubject has been ſufficiently illuſtrated by various publications, and particularly thoſe of Dr. Jenner, Dr. Pearſon, Dr. Woodville and others, to whom the world is much indebted for the introduction and propagation of this practice, it is needleſs here to ſay any thing further reſpecting it. In 1800 Dr. Jenner publiſhed a continuation of Facts and Obſervations relative to the Variolæ Vaccinæ, or Cow-Pock, which was ſoon followed by an Appendix to the Treatiſe on the Cow-Pock. The facts relating to this diſcovery have been ſo fully eſtabliſhed by unqueſtionable evidence and authority, that every friend to mankind ought to uſe his utmoſt endeavours to promote a practice attended with ſuch valuable benefits to the human race. It muſt give pleaſure to every benevolent heart to find that, in conſequence of the prevailing perſuaſion of the uſeful tendency of this practice, thoſe at the head of the naval and military departments of government have lent their ſanction to it, and given orders for the general introduction of it into thoſe branches of the public ſervice; ſo that it is now practiſed with the fulleſt ſucceſs in the naval and military hoſpitals, and in the regiments and ſhips of war upon ſervice; and it can be ſaid, as an additional recommendation in its favour, that it does not prevent thoſe who are under it from doing their duty. Nations even which, in conſequence of their ignorance, have long been under the wretched influence of the moſt childiſh ſuperſtition, and who, on that account, have been hoſtile to many valuable improvements received and eſtabliſhed among more enlightened ſtates, have begun to open their eyes to the advantages of this new practice; and hence it has been adopted in Spain, Ruſſia and Italy, and even made its way into the Ottoman dominions, and among the American Indians. But, notwithſtanding the importance of this diſcovery, like all others that have benefited mankind, it has had violent opponents. The facts alleged were doubted, tales were fabricated to prejudice the impartial, and this laudable undertaking was attacked, and cenſured as a *beaſtly* attempt. Eſſays were publiſhed on both ſides: but a great majority approved of the practice; and it, at length, was found worthy the confideration of the Imperial Parliament, which, after examining various documents, and hearing the teftimony of feveral profeffional men of the firft eminence, acknowledged the value of the difcovery by voting a reward of 10,000l. to Dr. Jenner.

XLV. *Defcription of the different Methods of blowing up Rocks under Water.* *By* A. Baillet, *Infpector of Mines**.

1ft, THE operation of blowing up rocks, which the French call *tirage des mines*, is not in general attended with much difficulty, when the hole of the mine is pierced in dry compact ground without any fiffure or cavity. When the ground is cavernous or hollow, or when water oozes through its pores, it becomes more troublefome, and requires particular care. When it is neceffary to blow up rocks at the bottom of the water the difficulties are increafed. In that cafe the ufual proceffes muft be abandoned, and others muft be reforted to.

2d, The method of blowing up rocks in the latter cafe is little known, and not much practifed: it may, however, be of great utility in many cafes, not only in the working of mines, but in the execution of public works of importance. Thefe motives have induced me to give a defcription of the three principal methods of blowing up mines under water.

The firft is that ufed in the mines in the northern part of the republic: it is proper to be reforted to when the depth of the water which covers the ground intended to be blown up is not above 15 or 18 decimetres.

The fecond has a great refemblance to the procefs ufual in mines when the ground fuffers the water to ooze through it. It is fimpler and lefs expenfive than the preceding, and appears to me to be very proper for cafes when there are only a few decimetres of water above the ground.

The third is fuited to great depths of water, fuch as 4, 5, or 6 metres: it is that employed at Carlfcrona. It is very ingenious, and feems hitherto to have been unknown to the French miners.

3d, But, before I begin to defcribe thefe methods, it may be of fome ufe to mention here an interefting memoir, printed in the Journal de Phyfique for the year 1779, on the conftruction of air-boats proper for facilitating the execution of all forts of works under water, without employing pump-

* From the *Journal des Mines*, No. 56.

ing,

ing. C. Coulomb, the author of this memoir, after defcribing the method of conftructing the air-boat, fhows in what manner it is to be ufed. He points out the means by which it may be made to fink at pleafure, of placing the workmen under the box, of continually renewing the air, of removing the rubbifh and laying a foundation of mafon-work at the bottom of deep water. He then calculates the time neceffary for removing a metre in height from the bank of Quilleboeuf, which interrupts the navigation of the Seine; and forefeeing the cafes in which mattocks or pick-axes would be infufficient for clearing obftructions from the bottom of the water, and where the hardnefs of the rock might require the ufe of gun-powder, he propofes two methods of blowing up rocks under water.

In one, the workman placed under the box bores the rock, and introduces into the bottom of the hole a box of tin plate filled with gun-powder, to which is foldered a fmall tube, alfo of tin plate, which rifes above the water at ebb-tides, and which is ftopped with fome greafy matter, after having been filled with a very weak compofition to ferve as a train. The fea, as it rifes, makes the air-boat float; and when its lower edge has rifen higher than the extremity of the tube it is then removed, and when the ebb-tide uncovers that extremity a perfon goes in a boat and fets fire to it.

In the other method, which the author propofes for the Mediterranean, and rivers where the affiftance of the tide cannot be employed, the tube of tin plate which contains the train rifes only 3 decimetres above the rock, but is terminated by a leather pipe covered on the outfide with fome water-proof fubftance, and in the infide with an incombuftible varnifh, and fecured from the preffure of the water by a fpiral winding made of wire. Its extremity muft be carefully clofed, and a buoy attached to it carries it to the furface of the water when the air-boat is afloat.

4th, I fhall fay nothing further of thefe methods, which fuppofe, as may be feen, the affiftance of the air-boat. I only wifhed to point them out, becaufe they may be ufeful in many cafes, and may, befides, give rife to new ideas, and ferve to modify the three particular methods which are the object of this memoir.

I. *Method of blowing up Rocks at the Depth of* 15 *or* 18 *Centimetres under Water.*

5th, This method confifts in the following operations;

Firft, bore the hole at the bottom of the water by the help of borers, and inftruments of proper length.

 Then

Then place in the hole a tube of tin plate closed at the lower extremity. The exterior diameter of this tube is of such a size that, when introduced into the bore, it may fill it; and its length must be such as that it shall rise some centimetres above the surface of the water.

Then send down to the bottom of this tube the cartridge filled with powder; introduce the priming rod, and ram round it clay or plaster according to the usual process, and only to the height corresponding to the summit of the hole.

In the last place, draw the priming rod and introduce the train, and set fire to it with all the necessary precautions, that the workmen may be sheltered from danger at the time of explosion.

Observation.

6th, This method has been often employed with advantage in several mines of the republic: it may serve either for deepening wells, or making other excavations, when the means used for keeping the ground and bottom of wells constantly dry are insufficient.

II. *Method proposed for blowing up Rocks some Decimetres below Water.*

7th, When the ground or rock to be blown up is covered only by some decimetres of water, the miner can see the rock which he bores, and the hole to be loaded, with as much ease as if there were no water, and can work with the same facility. In this case, to save expense, the tube of tin plate may be omitted, and a cartridge of pitched cloth, such as that employed in ground through which the water oozes in every part, may be employed, adapting to it a rod of hollow wood * destined to contain the train that conveys the fire to the powder. The diameter of the aperture of this rod may be only a few millimetres, and its length must exceed the upper level by some centimetres.

8th, If this method be adopted, first construct a cylindric cartridge of cloth or pasteboard, and fill it with gunpowder; insert into it the rod, which must descend to the middle of the length of the cartridge without approaching the interior surface of the wrapper; pinch closely the upper part of the cartridge around the rod, and cover the cartridge and whole rod with pitch or some kind of varnish †. Then send down the cartridge furnished with its rod into the hole of the rock,

* This rod might be made of the elder or honeysuckle.

† A solution of Spanish wax in alcohol is attended with the advantage of drying speedily, and of remaining water-proof for a long time.

and

and drive in ſtrongly two plugs of dry wood to ſerve as wadding. Theſe plugs muſt have a longitudinal groove, that they may glide along the rod and ſuffer the water to eſcape.

Obſervation.

9th, Inſtead of a rod of hollow wood you may employ, with advantage, either a tube of tin plate about four millimetres in diameter, terminating at the lower extremity, which muſt be inſerted in the cartridge in a truncated cone, and an orifice of two millimetres; or a leaden pipe drawn in the manner of wire-drawers, having the ſame dimenſions as the above, and whoſe reſiſtance may be ſufficient, if you take care to introduce into it, while you drive in the wadding, a rod which may exactly fill the interior vacuity.

If you have at hand any kind of compoſition capable of acquiring hardneſs in a little time* at the bottom of the water, you may ſubſtitute for the rod and metallic tubes a flexible tube of cloth done over with pitch or gum. In this caſe, it will be neceſſary to introduce the priming rod into the tube, while you drive in the wadding to prevent its depreſſion. The cloth of the tube, the upper extremity of which is deſtined to riſe above the hole in the rock, muſt be ſufficiently thick and ſtrong that the preſſure of the water, which I ſuppoſe to be ſome centimetres above the ground, may not flatten it, even if the liquid ſhould introduce itſelf between the tube and the compoſition.

III. *Method of blowing up Rocks under Water at any Depth.*

10th, This method, on the firſt view, has a reſemblance to that firſt deſcribed, ſince a tube of tin plate is employed in it; but it differs eſſentially from it in this reſpect, that inſtead of wadding above the charge, according to the uſual method, you employ an inflexible ſhank charged with a weight at its upper extremity, and terminating at the lower in a ſegment of an iron cylinder, which performs the office of a wedge, and is applied exactly upon another ſimilar wedge inverted and reſting on the upper end of the cartridge.

The effect of this diſpoſition, as may be readily conceived, is to force the wedge which adheres to the cartridge to aſcend a little at the time of the exploſion, and to ſqueeze itſelf cloſely againſt the upper wedge ſo as to cloſe the hole in the rock.

11th, The deſcription of this proceſs may be ſeen in the

* A mixture of quicklime and plaſter newly calcined would, perhaps, be of this kind.

twelfth

twelfth volume of the Memoirs of the Academy of Stockholm; I shall therefore give a literal translation of it *.

IV. *New Method of blowing up Rocks under Water, by Daniel Thunberg.*

A profile of the rock which has been bored, and into which the charge is introduced, is represented Pl. V. fig. 1.

The charge is contained in a tube of tin plate impermeable to water, a vertical section of which is represented in the same figure. The lower extremity of this tube must be adjusted properly to the hole which has been bored in the rock.

The charge consists of a paper cartridge filled with gunpowder, and attached to the iron wedge *b* with a thread such as that used for sewing sails.

To this first wedge *b* is applied another *c*, which adheres to an iron rod that rises above the tube.

On the plane face of these wedges is a groove made with a file which reaches to the powder: this groove is continued throughout the whole length of the tube of tin plate by means of a wooden rod *d*, hollow on the side turned towards the iron rod, to which it is made fast with strong packthread.

Before this rod is attached to the iron one, a match, which proceeds from the upper extremity and communicates with the interior of the cartridge, is placed in the groove.

e is a train applied to the end of the match.

B, C, are two rafts which enable the workmen to bore the rock and blow it up.

D is a weight which prevents the iron from being repelled too far when the explosion takes place.

E F G H I are different pieces necessary for charging. E is the cartridge furnished with its wedge, seen sideways; F the wedge seen in front; G the wooden rule and its groove; H the upper wedge and its iron rod; I the tube of tin plate.

When the rock has been bored according to the usual method by employing a borer pretty strong and of such a length as the depth of the water may require, introduce into it the tube into which the charge has been put; then apply the train *e*, and, having placed the weight D above the rod, set fire to it. The explosion will immediately take place: the wedge *b* would be expelled but for the wedge *c*, which cannot give way; and the two wedges being thus united confine the charge, the effect of which will never fail, as has been proved by experience.

* Details respecting this process may be found also in a large work entitled *Description des Travaux executés à Carlscrona, par* Daniel Thunberg.

Four

Four feet of the tube and the lower wedge are in general loſt; but the upper wedge may be employed for new charges, becauſe it is never damaged.

Obſervation.

12th, This method, the ſucceſs of which is proved, deſerves, no doubt, to be known by all thoſe engaged in great undertakings, and who have frequent occaſion to apply it *. It is, perhaps, ſuſceptible of being modified; and it appears to me that, without employing the impermeable tube, a varniſhed cartridge might be uſed, with a flexible tube proceeding from it, lodged in the groove between the two wedges, and then riſing above the water.

Fire alſo might be conveyed to the powder below the water by means of a ſtrong diſcharge of electricity; but little can be expected from this method in the hands of workmen.

In the laſt place, the lower wedge might be made of hard and very dry wood.

13th, But in whatever manner this method may be employed it will not require great expenſe, and it may be uſed with great advantage for deepening ports, rendering certain harbours more convenient and ſafe, and for freeing rivers and ſtreams from thoſe rocks which obſtruct their courſe and impede the navigation of them.

XLVI. *Account of a North-Eaſt Storm, or Memorandums towards a Theory of the Winds in the Region between the Gulf-Stream and the Great Range of Mountains* †.

ON the Atlantic coaſt of America north-eaſt ſtorms begin in the ſouth-weſt, and proceed thence to windward at the rate ſometimes of about one hundred miles an hour. It has been remarked long ago by Dr. Franklin, that ſtorms from the north-eaſt, on the eaſtern ſide of this continent, begin in the oppoſite point, or to leeward. Whether this rule univerſally obtains may perhaps as yet admit of ſome doubt:

* M. Daniel Thunberg employed the ſame means to raiſe large blocks of ſtone from the bottom of the water. For this purpoſe a hole is bored in the block with a miner's borer to the depth of twenty or twenty-five centimetres. Two wedges are introduced into it, forming by their junction a cylinder ſo as to fill the hole. Several blows are then ſtruck on the iron bar which adheres to the upper wedge: the two wedges are then cloſely ſqueezed together, and the block is raiſed out of the water by means of a windlaſs and a cord attached to a ring fixed in the lower wedge.

† Communicated by Dr. Mitchill.

but

but during the uncommonly mild winter of 1801—2, there was a ſtrong confirmation of it.

On the 21ſt, 22d, and 23d of February 1802, there was one of the moſt remarkable and long-continued ſnow-ſtorms that had been known for twenty years. It raged with extreme violence on the land, and was the cauſe of ſeveral ſhipwrecks along the ſea-coaſt. Many lives and much property were loſt. The movements in the atmoſphere were felt firſt to the ſouthward, and gradually progreſſed northward, ſo as to be ſenſible there; but not until after ſome hours.

The facts were collected by Dr. Mitchill, at Waſhington, the ſeat of the national government, during the ſeſſion of congreſs, when they could be aſcertained with the greateſt expedition, correctneſs, and care, and are as follow:

After a fine, warm, and clear morning, the air toward evening grew cloudy, and it became rainy and ſtormy. The time of its commencement near the capitol, on the banks of the Potomack, as obſerved by general Smith, was about half an hour paſt five in the afternoon; and before eight the rain was exceſſive, and the wind boiſterous. Here the weather did not become cold enough for ſnow until towards morning.

The city of New-York, which is ſituated rather more than 240 miles to the north-eaſt, did not feel this commotion of the atmoſphere until about eleven. Then the city watchmen obſerved that the weather was changed from clear to cloudy, and that ſnow began to fall; and at twelve Mrs. Mitchill, who opened a window and looked out, obſerved that the ground was already white with ſnow. The tempeſt was brewing, and, properly ſpeaking, was formed at two.

That night Mr. Humphrey Wood was on board a ſloop bound from Newport (R. I.) to New-York. The tempeſt drove the veſſel aſhore before morning on Mount Miſery Neck, upon Long Iſland. They ſailed from Fiſher's Iſland, where they had been waiting for a fair wind, at ten o'clock at night, with a wind at eaſt-ſouth-eaſt, and warm and pleaſant weather. But by midnight it hauled eaſt-north-eaſt, and blew a gale, with ſnow. Fiſher's Iſland may be computed to be about 140 miles eaſt-north-eaſt of New-York.

Mr. Webſter obſerved ſome of the phænomena of this change of weather, in its beginning, at New-Haven. This place is 89 miles from New-York, or 331 from Waſhington. Here the weather was clear in the early part of the evening, but was overcaſt by nine. The ſtormy commotion of the atmoſphere ſeems to have begun about twelve. At Boſton it was rather more than an hour later.

Mr. Blair, an officer who was on board one of three ſhips from Salem, in Maſſachuſetts, that were loſt on Cape Cod during the ſtorm, related, after his eſcape, that the weather, on the day of their ſailing, Sunday, Feb. 21, was remarkably fine and favourable. At ſun-ſet they were about four leagues from Cape Ann light-houſe, with a light breeze from ſouth-eaſt. After midnight the weather grew very threatening; and at half paſt two in the morning of the 22d the wind veered to the north-eaſt, and it ſnowed ſo faſt that the ſhips could hardly diſcern each other. The ſhipwrecks during this ſtorm were numerous and dreadful. Many perſons were frozen to death. Salem is diſtant from Waſhington 499 miles, or 257 from New-York; ſo that this latter place is about midway between the two places.

At Portland, in Maine, diſtant 603 miles from Waſhington, the ſnow began between daylight and ſunriſe. It was obſerved by young Mr. Vaughan, who was travelling on the morning of the 22d. At 8 A. M. the wind blew violently.

The ſtorm began ſtill later at Hallowell, on the Kennebeck river. This place is 683 miles from Waſhington. There the ſun roſe clear on the morning of the 22d. The air became cloudy in about a quarter of an hour. The ſnow began about eleven, and the ſtorm had become furious within two hours after. Profeſſor Waterhouſe and Benjamin Vaughan, eſq. have particularly attended to theſe curious meteorological facts.

At Poughkeepſie, 82 miles north of New-York, and ſituated beyond the firſt range of mountains, the ſtorm began about four o'clock on the morning of the 22d. And at Albany, 165 miles north of New-York, it did not begin until a little before day-break on the morning of the 22d.

At Providence (R. I.) Dr. Wheaton obſerved the evening of the 21ſt to be clear and pleaſant. The watchmen informed him "the weather changed before 12 o'clock, and continued cloudy, with variable winds, until the violence of the ſtorm began, which was at half paſt three on the morning of the 22d." Providence is 439 miles from Waſhington.

Accounts from Charleſton (S. C.) ſtate that it began there on the 21ſt, between two and three o'clock in the afternoon. The diſtance of Charleſton from Waſhington is 550 miles. By the newſpapers it appears to have been felt in the Bahama iſlands.

It will be found, on calculation, that between Charleſton and Cape Ann, along the coaſt, this ſtormy movement proceeded to windward at the rate of nearly one hundred miles an hour: for, as it began at Charleſton, ſay at three o'clock, at New-York at eleven, and off Cape Ann at two the next morning,

morning, there is a difference of eight hours between Charleston and New-York, and of three hours between the latter city and Salem, making in the whole eleven hours. Now, computing the distance from Charleston to New-York at about 800 miles, and from New-York to Cape Ann more than 250, there will be a sea-coast of almost 1100 miles swept over by this storm in somewhat more than eleven hours. But this computation applies only to the sea-coast; for, if we take any given point, as the city of New-York for example, and instead of north-east reckon due north, it will be found that the progress is considerably slower: for it took all the time between eleven at night and day-break next morning to reach Albany, only 165 miles distant in that direction.

Now, these remarks explain some meteorological facts, which, though of common observation, have hitherto seemed paradoxical or unaccountable: for mariners know that, to form a good judgment of wind and weather, they must keep a look-out for clouds and changes of atmosphere to leeward. In New-York, the rain or snow which accompanies a north-east storm can be seen by labourers along the docks and wharves in the south-west at Staten island, ten or eleven miles distant, for some time before it begins in the city, so as frequently to break off work, and put away their tools. And it is confirmed by long observation among the farmers in that vicinity, that snow-banks, as they term them, are to be seen in the south-west many hours before the atmosphere where the observers are is clouded in the smallest degree, or any current of air perceptible. They remark further, that a judgment can be formed of the weather by noting whether the gathered clouds lowering in the distant horizon are visible to the northward or southward of the setting sun. If at sun-set they are to the south of the sun, they predict a north-east storm, with snow; if to the north, a south-east storm with sleet or rain.

XLVII. *Note on the Memoir of* Clement *and* Desorme, *entitled Experiments on Charcoal**. *By* C. Berthollet †.

C. Clement and Desorme remark very properly, that all gases contain, at the same temperature, the same quantity of hygrometric water. This is shown by the observations of Saussure and Deluc. Volta assured himself of it

* See the last two numbers of The Philosophical Magazine.

† From *Annales de Chimie.*

by

by direct experiments, which he made known when at Paris, and which are already old; and Priestley announced, that all gases dissolved the same quantity of ethereal gas, except a small difference exhibited by the carbonic acid, which may be easily accounted for.

If the experiments described by Clement and Desorme had been exact, they would have found in a cubic foot of saturated atmospheric air, at nearly 7 degrees of the thermometer*, the same quantity which they obtained at 12 or 13 degrees of the thermometer.

The elastic vapour of water has a specific gravity, which is to that of air, at the same degree of compression and temperature, as 10 to 14; but, besides this, there is, in some gaseous substances, water combined and more condensed, which has no influence on hygrometric phænomena; a distinction which I indicated in the *Annales de Chimie.* by announcing that I should treat this object in another place, and with the necessary details.

It is this combined water which is more or less wanting in natural carbonate of barytes, as has been very properly remarked long ago by Withering: hence it happens that the acid of this carbonate cannot be disengaged by heat, though it may be disengaged from artificial carbonate, which has retained enough of water to give some of it to the carbonic acid; but, by employing very dilute nitric acid, the carbonic acid is disengaged from the former as well as the latter, as has been also remarked by Withering.

Priestley has shown, that, by making the steam of water to pass upon native carbonate, carbonic acid is easily obtained from it: he justly ascribes the effect to the part which the carbonic acid ought to take up: he made experiments to determine the quantity of it, and though the means seem exact, his results appear to me exaggerated.

It is only by this water that we can explain the quantity of hydrogen gas which is obtained by subjecting carbonic acid to the action of the electric spark, as done by Dr. Priestley, Van Marum, Monge and Henry, without decomposing the carbonic acid.

It is not the hygrometric water which experiences this decomposition, or it forms only a very small part of it; for the quantity of hydrogen gas is too considerable, and Henry made the experiment with very dry carbonic acid.

C. Clement and Desorme, who pronounce with so much confidence that I am wrong, and who did not deign to wait

* We suppose Reaumur's thermometer is meant.—Edit.

for the publication of my labour on charcoal and carbonated hydrogen gas, that they might refute the reafons on which I have founded my opinion, pretend that 48 parts of oxygen can diffolve 52 of charcoal, a folid fubftance, the fpecific gravity of which is confiderable, and yet the combination refulting from it, their gafeous oxide of carbon, has a fpecific lightnefs greater even than that of oxygen gas.

I could wifh they would point out fome other compound gas in which a fpecific levity greater than that of the lighteft of its elements can be obferved. Nitrous gas is fpecifically heavier than azotic gas; fulphurous gas, and oxygenated muriatic gas, heavier than oxygen gas; the vapour of water is heavier than hydrogen; ammoniacal gas, carbonated, fulphurated, and phofphurated hydrogen are heavier than hydrogen gas.

Here 48 parts of oxygen diffolve, at firft, 17 of charcoal, to form carbonic acid, which is heavier than oxygen gas, fince they diffolved 35 parts more of the fame charcoal, which was folid; and the combination has a fpecific levity greater not only than that of carbonic acid, but even than oxygen gas.

The phænomenon becomes more ftriking when a fimilar gas is fubjected to the action of the electric fpark; for Auftin and Henry obferved, in making the experiment on that extracted from the acetite of pot-afh, that its volume was doubled *.

Confiderations on the action of the affinity which produces here a phænomenon fo diftinct from others, and fo contrary to the ideas which we have of that action †, would not be unworthy of their refearch. Thefe general confiderations ought not always to be rejected as deceitful analogies: in my opinion, they ought much rather to ferve as a guide to chemifts, and to inform them in particular of their miftakes.

C. Clement and Deforme unite to their ftrictures fome interefting experiments on a new combination of fulphur; they appear to me to have proved that it contains charcoal, and that it is neither fulphurated hydrogen nor hydrogenated

* In the *Annales de Chimie*, No. 124, I mentioned this gas as one of thofe that contain water combined; but new obfervations have proved to me, that the decompofition of water could have only a very fmall fhare in the dilatation it experiences.

† Affinity, or chemical attraction, fays Guyton, proceeds from the reciprocal tendency of all the moleculæ to a perfect contact. Nature has not force to feparate, to remove to a diftance; it has only force to bring together and unite.——*Encyclopædia*, word Affinity.

fulphuret;

fulphuret; but if I might be allowed a conjecture on a fubject with which I am not yet acquainted, it appears that we cannot refufe to acknowledge in it the exiftence of hydrogen. In my opinion, its great volatility cannot refult from two fubftances, fuch as charcoal and fulphur, which not only are much more fixed, but which contain no other fubftances difpofed to affume the elaftic ftate.

I fhall here remark, by the bye, that they fay, that by heating in a retort a mixture of fulphur and charcoal, nothing is obtained but a little gas, of a bad odour, infoluble in water; and that Kirwan, on the contrary, fays, fpeaking of hepatic air, that having treated with fire, fulphur and charcoal which he had before kept a long time in a red heat, he obtained hydrogen gas in great abundance.

It is not exact to fay, "that an experiment proved to them, that 100 parts of carbonic acid are compofed nearly of 28 parts of charcoal and 72 of oxygen;"—a refult given by Lavoifier. This great man, in the conclufion of his memoir, in which the refults prefented differences, expreffes himfelf as follows:—"The experiments made fince incline me to believe, that the proportions in charcoal are forced; and I am of opinion, that the quantity of carbon contained in a quintal of carbonic acid does not exceed 24 pounds, and that of oxygen is at leaft 76 pounds."

His opinion would be very different from that of C. Clement and Deforme, if they fhould ftill prove that charcoal is an oxide which contains already 32 per cent. of oxygen, though it is more inflammable than the bafe to which it is indebted for its inflammability, carbon, or the diamond.

XLVIII. *Memoir on the tenth Planet difcovered by Dr.* Olbers. *Read in the Public Sitting of the French National Inftitute, July 5th, by* Jerome Lalande.

WHEN we announced, in the laft public fitting, the difcovery of a planet by M. Piazzi of Palermo, we were far from thinking that, in three months, we fhould have to make known a difcovery of the fame kind. It was alfo by a fortunate accident that this tenth planet was difcovered; but accident could favour none but an intelligent and indefatigable aftronomer.

On the 28th of March, at nine in the evening, Dr. Olbers of Bremen was obferving Piazzi's planet, with which aftronomers have been engaged for a year. He was examining with his telescope all the small stars in the Virgin's wing, to ascertain their positions, that he might be better able to establish the place of the planet, and had come to the 20th star of the Virgin, near which he had observed the planet in the month of January. He was surprised to see, near this star, which is of the 6th magnitude, another smaller of the 7th magnitude. He was very certain that it had not been there at the time of his first observations: he therefore hastened to determine its position; and, having continued to view it for two hours, he perceived that it had changed its place in the course of that interval. The two following nights afforded him the means of being certain of its motion, which was 10 minutes per day. On the 28th of March, at 9^h $25'$ mean time, at Bremen, it had $184^\circ.56'$ right ascension, and 11° $33'$ north declination.

Astronomers have been accustomed to consider as comets, all stars that have motion. This was the case with the planets of Herschel and Piazzi at the time when they were discovered. That of Dr. Olbers had no more resemblance to a comet than the rest. With an achromatic telescope, the magnifying power of which was 180, it could not be distinguished from stars of the 7th magnitude. It was better defined than the planet of Piazzi; and, with a telescope of 13 feet, which magnified 288 times, it seemed to have a diameter of 4 seconds: but this was an effect of irradiation, or of the dispersion of the rays of light, which always makes the diameters appear too large; for the satellites of Jupiter appear much larger than the new planets, and yet we know that their apparent diameter is not a second.

Dr. Maskelyne, by means of diaphragms placed before the object-glass of his telescope, ascertained that the light of Piazzi's planet is stronger by one half than that of the new planet.

Dr. Olbers having observed the new star for four days, he sent notice to different astronomers; and on the 10th of April, C. Burckhardt, when he received his letter, went immediately to the military school to search for it, and next day sent his observation to the Institute.

He began to calculate its orbit, trying first a circle, and then the parabola known to be that of comets; but, at the end of three days, his elements were found to err 30 seconds. He tried also ellipses of different dimensions.

On the 15th of May we were informed, by a letter from baron von Zach, the celebrated astronomer of Gotha, that Dr. Gauss, an astronomer of Brunswick, had found an ellipsis which corresponded to the first observations. On the

22d we received the details. He found the revolution to be four years seven months, and the inclination 35°. This great inclination seemed to remove it from the order of planets, and some astronomers called it a comet; but its proximity, and continual appearance, will not allow of its being placed among the number of those stars of which we often lose sight for so long a time, and which go to enormous distances.

C. Burckhardt, on his part, made similar researches; he made several trials with ellipses very much elongated, which gave him a result very near that of Dr. Gauss.

On finding that this planet, like that of Piazzi, was between Mars and Jupiter, and that its motion must be affected by the attraction of Jupiter, C. Burckhardt undertook to calculate these perturbations. The calculation is long and difficult, but it is indispensably necessary to obtain the orbit with more exactness.

At last, on the 4th of June, he finished these laborious calculations, and found the following elements:

Distance 2.791, or 95,890,000.

Revolution, 4 years, 8 months, and 3 days.

Eccentricity, 0.2463; equation of the orbit, 28° 25′.

Epoch of 1802, $4^s 23° 50'$; aphelion, $10^s 2° 3'$; node, 5^s 22° 28′; inclination, 34° 50′ 40″.

These elements corresponded to five observations of the 4th, 16th, and 27th of April, and the 7th and 20th of March; the last two made by C. Burckhardt, and Lalande the nephew, who, as well as C. Mechain, Messier and Delambre, continued to observe it as long as it could be seen in the meridian, because such observations are the surest. After the 21st of May, other instruments and other stars were necessary; but it still passed through some included among the 15000 stars which we have published. On the 15th of June these elements corresponded, within a few seconds, with the observations of Mechain and Messier; which confirms the exactness of the elements found by C. Burckhardt, and assures us, that the motion of the new planet is already known. Baron von Zach has published a great many observations respecting it in his Journal.

C. Cabrol de Murol has calculated for us an ephemeris, which gives the situation of this planet to the 21st of October, on which day it will have 227° 7′ of right ascension, and 6° 8′ of declination. It will then set at 7^h 51′: there is therefore reason to think that it may be still observed. It will be above Libra near the Serpent, after passing the legs of the Cow-herd. He finds that, in 1806, it will have $33\frac{1}{2}°$

of

of south declination, and that it will then be difficult to see it at Paris: but C. Vidal, who has already observed it this year, will then be better able than we to follow it.

Its greatest northern declination will not exceed $26\frac{1}{2}$ degrees, a term at which it will be a year hence. It will be easier to be seen, but its distance will be double, and its light four times less than the present year. In the month of March 1804, it will be at three times the distance; its light will be nine times less, and, in all probability, it will be difficult to observe it.

As the orbit of this new planet intersects that of Piazzi, I was curious to know whether the two planets might not meet; but I found that, when they are in the same plane, there will be an interval of about 19 millions of leagues between them.

The planet of Dr. Olbers is very small. If we suppose its apparent diameter to be half a second, I find that its real diameter cannot be more than 160 leagues. Dr. Herschel, in a paper which he read before the Royal Society on the 7th of May, makes it to be four times less. He says, that on the 22d of April Piazzi's planet was only 22 hundredths of a second, and that of Olbers 13 hundredths; but it appears to me, that we have no means of determining, with certainty, quantities so small.

Dr. Olbers calls his new planet, Pallas; but, as I see no sufficient motive for this fabulous denomination, I prefer giving it the name of the person to whom we are indebted for this valuable discovery.

Dr. Olbers distinguished himself in 1797 by an excellent treatise on comets, and was worthy of the good fortune with which his labours have been crowned.

(For a further account of Dr. Olbers, see the last number of the Philosophical Magazine, where an engraving of him is given.)

XLIX. M-

XLIX. *Notices respecting New Books.*

An Examination of the Report of the Committee of the House of Commons on the Claims of Remuneration for the Vaccine Pock Inoculation, containing a Statement of the principal historical Facts of the Vaccina. By GEORGE PEARSON, *M.D. F.R.S. Physician to the Vaccine Pock Institution, Senior Physician to St. George's Hospital, Honorary Member of the Board of Agriculture, &c.* Johnson, 8vo. 1802.

THE inoculation of the cow-pock having always appeared to us to be interesting, not only on account of the improvement of the practice of medicine from it, but also as a very curious fact in natural history, we have noticed several publications, and received many papers and notices concerning it. It is not our design to give a complete analysis, or even copious extracts; but the present work demands an early account, as, no doubt, many of our readers will be eager to know what is the object of the present examination, which the author states to be—

"1. In order to submit to the judgment of the public, whether or no more honourable and just grounds might not have been asserted for the remuneration of the petitioner.

"2. In order to offer evidence for the manifestation of several truths, and for the exposition, perhaps, of some errors and mistakes; and

"3. With the view of obtaining the opinion of the public, whether or no any credit be due to others for the discovery of facts; the detection of ill-grounded assertions; and for labour, expenditure of time, and other sacrifices, in introducing and maintaining the vaccine inoculation."

The author, in the very first page, sets out with declaring to the public that Dr. Jenner is the discoverer of the vaccine inoculation, and in this point of view he considers him as entitled to the remuneration by a prior right to every other person; but in the course of the work he brings out a great variety of facts in evidence, to show that neither the necessary facts for the present practice were discovered by Dr. Jenner, nor were the facts which he published even established by a sufficient number of experiments. The author brings out a great number of extracts from publications, to show that he had no small share in investigating the vaccine inoculation practice; but that the petitioner claims, or rather the committee in their report affirm, the whole practice to have been established by him. To show the contrary, the author exhibits the amount of Dr. Jenner's experience, the value of which he allows to be great, and that it was the direct occasion of all that has been done since his publication.

1st, He states that the whole amount of Dr. Jenner's experience was but seven or eight cases of inoculation of the cow-pock.

2d, That he gave no description of the cow-pock; so that, after the practice was begun, mistakes on this account were made, which were rectified by the characters of the eruption ascertained by the author and Dr. Woodville.

3d, That they brought out the evidence of several hundred cases in two or three months time, which before were, as above asserted, only seven or eight.

4th, That Dr. Jenner in giving plates of the cow-pock did not mention what day after inoculation, which made them of little use, and misled by affirming that the inoculated eruption was so like the small-pox that the most experienced inoculator could not distinguish them from the small-pox. To show the inexperience of Dr. Jenner, the author gives a plate of the two inoculated diseases, from which it appears, Dr. Pearson says, incredible, on account of the difference, how Dr. Jenner could ever have spoken of such a resemblance, if his experience had not been confined to a few cases?

5th, That Dr. Jenner's experience must have been very limited, from his recommendation of applications of a caustic nature, found to be subsequently unrequired—from his deriving the cow-pock from the grease of horses—from his affirming that a person could, again and again, have the vaccine disease; and even after the small-pox—from expecting so much inflammation that the safety to infants was dreaded—from his not knowing that very commonly there is no sensible constitutional disease; and yet not describing the cow-pock to know when it really takes place, the practice was not understood, and mistakes were committed which have been set right by other persons. Partly from these errors disgusting the public, and from the deficiencies not leaving a foundation to practise upon, Dr. Jenner's claims to ample and exclusive remuneration are rejected by this author, who yet considers him as the origin of all the benefits of the new inoculation, and very happily quotes two verses from Ovid to show that the power now in our hands of extinguishing the small-pox is from Dr. Jenner.

> Jam labor in fine est. Obstantia fata removi,
> Altaque, posse capi faciendo, Pergama cepit.

The

The author scrutinises the several claims of the petitioner, and endeavours to show that those given to the house of commons, as found valid by the committee, are not true according to history. But, says he, a very just and dignified ground might have been taken, equally favourable for remuneration, as follows: "That the petitioner had proposed a new kind of inoculation, and actually furnished some instances of the success of it, founded upon facts: of which some were brought to light and use, which heretofore had been only locally known to a very few persons; and, that in consequence of considerable subsequent investigations, by the author and others, such a body of evidence had been obtained, and such further facts had been discovered, as demonstrated the advantages of the new practice."—p. 165.

Although it appears, according to the evidences, that inoculation was practised even from human subject to human subject before Dr. Jenner, yet the author neither considers Dr. Jenner nor the public as under any obligations to them, and that such cases are proper to be recorded in history, but ought not to affect the remuneration. How far this reasoning will be allowed to be convincing, we are in doubt.

The author appeals to the public, whether or no he has not proved by evidence that exclusive claims of credit were not due to Dr. Jenner, but that he himself and Dr. Woodville, although they asked for no pecuniary reward, were entitled to the consideration of having principally established the practice.

In this Examination, most indeed all the valuable facts of the vaccine disease come under review: in particular, full evidence is delivered concerning the effects of matter according to the age of the pock; the subject of spurious cow-pock is fully explained; the propriety of local applications; the characters of the cow-pock; the coincidence of the cow-pock with the small-pox, and other facts are explained very fully.

Although the author disclaims any design of setting aside the petitioner's claim to remuneration, he fully proves vaccine inoculation to have been carried on to a great length by others: among these is the experience of the late Mr. Nash, in the West of England, whose manuscripts show that he was prepared to write on the cow-pock inoculation as far superior to the small-pox—1. Not being infectious; 2. Not being attended by eruptions; 3. Being a certain security against the small-pox; 4. Gives cases of inoculation of cow-pock; 5. Cicatrix after cow-pock inoculation is larger than after small-pox; 6. Persons who cannot take the small-pox cannot

cannot take the cow-pock; 7. He is to be the first writer on the cow-pock, as Dr. Heberden was on the chicken-pock; 8. Differs from small-pox in affecting brute animals; 9. Describes the cow-pock on cows; 10. Cows can take the cow-pock but once; 11. Does not yet know whether a person who has had the small-pox can take the cow-pock; 12. In those who have had the cow-pock, on inoculation for the small-pox, there is more inflammation than in those who have not had the disease. Mr. Nash wrote his last observations in 1781. Dr. Jenner's first experiment of inoculation, as stated from his own book, was in May 1796, and the remaining seven cases in 1798. The author was asked by the committee whether he thought Dr. Jenner got his information from any preceding inoculator, and he answered (p. 36:) "That he imagined they were independent of each other."

It appears that Dr. Pearson, having had no credit allowed by the committee of the house of commons, submits his evidences to the public, to determine in what light he is to be considered, as well as Dr. Woodwille, by posterity.

We are happy to announce that the *Journal des Mines*, the editors of which are C. Brochant, Haüy, A. Baillot, I. L. Tremery, N. L. Vauquelin, and Collet Descostils, is still carried on upon the same liberal and extensive plan. The editors are all men distinguished by their talents and attachment to the sciences; and the work, of which sixty-eight numbers are already published, contains a variety of useful and interesting papers on mineralogy, and every thing that relates to mines and the art of mining in general. Such subjects as require it are illustrated by plates.

L. *Proceedings of Learned Societies.*

ROYAL SOCIETY OF LONDON.

THE reading of Mr. Chenevix's paper on the chemical analysis of corundum was finished on the 27th of May.

On the 3d of June a description of the anatomy of the ornithorhynchus hystrix, by Everard Home, esq. F.R.S. was laid before the Society. This animal is a native of New South Wales, and several specimens have been brought over in spirits: its length is about 17 inches; it is covered with hair and with quills. Its bill somewhat resembles that of the ornithorhynchus, but wants the lateral lips. Its teeth are horny,

horny, and confined to the tongue and the palate: the hind legs are furnished with a spur. The stomach has a number of horny papillæ near the pylorus: it is much larger than that of the ornithorhynchus paradoxus: the animal appears to swallow a considerable quantity of sand with its food. The second branch of the fifth pair of nerves is extremely small, so that this species has probably no peculiar sense of feeling on its bill: that of smell appears to compensate the deficiency. The small bones of the ear are only two, corresponding to the malleus and stapes; the divisions of the cochlea are cartilaginous. The contents of the pelvis agree with those of the ornithorhynchus, in greatly resembling the class of birds. Mr. Home has examined several other species of manis and myrmecophaga, but finds that they all are furnished with mammæ. The peculiar characters of the genus ornithorhynchus appear to be the spur on the hind legs, the absence of nipples, the smooth beak, and the horny teeth. From all these considerations, Mr. Home infers that the genus forms a connecting link between the mammalia, aves, and amphibia.

This animal was described before, by Dr. Shaw, under the name *myrmecophaga aculeata*; but, from the absence of the mammæ, and its greater internal resemblance to the ornithorhynchus, Mr. Home places it in the same genus.

On the 17th an analysis of a pulmonary calculus, by P. Crampton, esq. was read.

Mr. Crampton found in 100 parts of this calculus, 45 of lime, 37 of carbonic acid, and 18 of animal matter and water; this was probably albumen, being coagulable in acids. He thinks it probable that this specimen may have been of a different nature from those which are described by Fourcroy, and which have been supposed to contain phosphate of lime. Mr. Crampton thinks it easier to understand how phosphate of lime might have been separated from the blood than carbonate; but he conceives that even this may be deposited in the lungs by a morbid process, similar to the healthy one by which it is secreted to form a considerable part of the bones.

The same evening a letter from Mr. Carlisle to the president was read, containing a description of two kinds of eyes observed in the gryllus gryllotalpa, with other circumstances respecting the structure and natural history of that animal.

On the 24th of June a method of examining refractive and dispersive powers by prismatic reflection, by Dr. Wollaston, F. R. S. was read.

It was suggested to the author by a consideration of the prismatic

prismatic speculum employed by Sir Isaac Newton in his reflecting telescope. The angle at which the total reflection of light of any kind first takes place at the surface of a rarer medium depends on the comparative density of the two mediums in contact; and hence the measurement of this angle readily furnishes a determination of the ratio of refraction at the common surface for the kind of light observed. Thus by means of a triangular prism, a drop of each of two or more fluids being placed side by side on the under surface, it may easily be found, by inclining the prism more and more, which of the dark spots first disappears, and it follows that the respective fluid has the weakest refractive power. But when a solid is examined, it must in general be united by the interposition of some fluid of a higher refractive density, otherwise the contact will be too imperfect; and it is easily shown that this interposition does not affect the ultimate result. But for determining at once the numerical ratio of the sines, Dr. Wollaston has invented an apparatus where, by means of a rectangular prism of flint glass, the index of refraction of each substance is read off at once by a vernier, the three sides of a moveable triangle performing the operations of reduction of the ratios in a very compendious manner. In this method it is obviously unnecessary that the substances to be examined should be of any determinate form; and it is as easy to ascertain the refractive density of the most opaque as of the most transparent bodies, provided they be less refractive than the prism employed. It may also serve as a chemical test, for example in essential oils, which when adulterated are generally rendered less refractive; and a very minute quantity is sufficient for the experiment. Where the medium is of variable density, this is almost the only mode in which its refractive power can be ascertained; hence it is of singular utility in examining the refraction of the crystalline lens. (Philosophical Transactions, 1801, p. 41.) A copious table of the refractive powers of various substances is here inserted. The dispersive powers of different substances are inferred from similar observations upon the fringes which usually accompany, or rather constitute, the boundary of reflection: the author observes that they are sometimes wanting, or even reversed, when the dispersion is equal at different angles of deviation, or when it is greater even with a less deviation, as when oil of sassafras is applied to a prism of flint glass, as well as in many cases of spars with fluids. Solutions of metallic salts in general are found to be very highly dispersive: by weakening the solution till the line of separation became colourless, and then noting the refractive density, Dr. Wollaston has been

been able to compare the dispersive powers of several such substances with that of plate glass. He has also arranged a number of substances in a table in the order of their dispersive powers, at a given deviation; an order materially different from that of their refractive density. A very important observation concludes this part of the essay. Dr. Wollaston observes, that, by looking through a prism at a distant crevice in a window-shutter, the division of the spectrum may be seen more distinctly than by any other method; and that the colours are then only four, red, yellowish green, blue, and violet, in the linear proportions of the numbers 16, 23, 36, 25; and that these proportions will be the same whatever refractive substance be employed, provided that the inclination of the prism remain unchanged. In the light of the lower part of a candle, the spectrum is distinguished by dark spaces into five distinct portions.

Another communication from Dr. Wollaston, on the oblique refraction of Iceland crystal, was also read the same evening.

It contains a confirmation of the experiments of *Huygens* on this substance, with additional evidence, deduced from the superiority of Dr. Wollaston's mode of examining the powers of refraction. He observes, that Dr. Young has already applied the Huygenian theory with considerable success to the explanation of several other optical phænomena, and that it appears to be strongly supported by such a coincidence of the calculations deduced from it, with the results of these experiments, as could scarcely have happened to a false theory.

On the 1st of July was read a paper, by Dr. Young, F.R.S. giving an account of some cases of the production of colours not hitherto described.

A paper on the composition of emery, by Smithson Tennant, Esq. F. R. S. was also read.

Mr. Tennant finds that emery is dissolved with some difficulty in a strong heat by carbonate of soda, and, after the subsidence of a little iron, the earth contained in the solution is almost purely argillaceous. This result is exactly similar to Mr. Klaproth's analysis of diamond spar or corundum. From 100 parts Mr. Tennant procured 80 of argil, 3 of silex, and 4 of iron, with an undissolved residuum of 3 parts, and a loss of 10, great care having been taken to separate the parts attracted by the magnet: some portions however contained almost one third of iron. The hardness of emery and diamond spar appears to be equal. The emery used in England is brought principally from the island of Naxos; it is imported

imported in the form of angular blocks, incrusted with iron ore, with pyrites, and mica; substances which usually accompany the corundum from China.

A catalogue of 500 new nebulæ, nebulous stars, planetary nebulæ, and clusters of stars, was laid before the Society by William Herschel, LL.D. F.R.S.; and the preliminary remarks on the construction of the heavens were also read.

Dr. Herschel takes a very enlarged view of the sidereal bodies composing the universe, as far as we can conjecture their nature; and enumerates a great diversity of parts that enter into the construction of the heavens, reserving a more complete discussion of each to a future time. The first species are insulated stars; as such the author considers our sun, and all the brightest stars, which he supposes nearly out of the reach of mutual gravitation; for, stating the annual parallax of Sirius at 1″, he calculates that Sirius and the sun, if left alone, would be 33 millions of years in falling together; and that the action of stars of the milky way, as well as others, would tend to protract this time much more. Dr. Herschel conjectures that insulated stars alone are surrounded by planets. The next are binary sidereal systems, or double stars: from the great number of these which are visible in different parts of the heavens, and the frequent apparent equality of the two stars, Dr. Herschel calculates the very great improbability that they should be at distances from each other at all comparable to those of the insulated stars: hence he infers that they must be subjected to mutual gravitation, and can only preserve their relative distances by a periodical revolution round a common centre. In confirmation of this inference he promises soon to communicate a series of observations made on double stars, showing that many of them have actually changed their situation in a progressive course, the motion of some being direct, and of others retrograde. The proper motion of our sun does not appear to be of this kind, but to be rather the effect of some perturbations in the neighbouring systems. The same theory is next applied to triple, quadruple, and multiple systems of stars, and particular hypothetical cases are explained by diagrams. Some such cases, Dr. Herschel is fully persuaded, have a real existence in nature. The fourth species consists of clustering stars, and of the milky way: the stars thus disposed constitute masses, which appear brighter in the middle, and fainter towards the extremities, being, perhaps, collected in a spherical form. Groups of stars the author distinguishes from these by a want of apparent condensation about a centre of attraction; and clusters of stars, by a much more complete compression near such

such a centre, so as to exhibit a mottled lustre, almost resembling a nucleus. The eighth species consists of nebulæ, which probably differ from the three last species only in being much more remote; some of them, Dr. Herschel calculates, must be at so great a distance that the rays of light must have been nearly two millions of years in travelling from them to our system. The stellar nebulæ, or stars with burs, form a distinct species. A milky nebulosity is next mentioned, which may in some cases resemble other nebulæ, but in others appears to be diffused, almost like a fluid: the author is not inclined to consider it as either resembling the zodiacal light of the sun, or as of a phosphorescent nature. The tenth species is denominated nebulous stars; these are stars surrounded with a nebulosity like an atmosphere, of which the real magnitude must be amazingly great; for the apparent diameter of one of them, described in the catalogue, was 3′. The planetary nebulæ are distinguished by their equable brightness and circular form, while their light is still too faint to be produced by a single luminary of great dimensions. When they have bright central points, Dr. Herschel considers them as forming a twelfth species, and supposes them to be allied to the nebulous stars, which might approach to their nature, if their luminous atmospheres were very much condensed round the nucleus.

On the 8th of July, the first part of a paper on the rectification of the conic sections was laid before the Society by the Rev. John Hellins, B.D. F.R.S. It contained nine theorems for the rectification of the hyperbola by means of infinite series, one only of which had been before published, each having its particular advantages in particular cases of the proportions of the axis and of the ordinates, so that they appear to contain a complete practical solution of this important problem, and they are illustrated by a variety of examples.

On the same evening were read observations on heat, and on the action of bodies which intercept it, by Mr. Prevost, professor of natural philosophy at Geneva. They consist chiefly of inferences from Dr. Herschel's important experiments on the transmission of heat by different refracting mediums, especially the different kinds of glass. Mr. Prevost sets out with the law of the interchange of heat as ascertained by the experiments of MM. Kraft and Richmann, that while the time flows equably, the differences of the temperature of two contiguous bodies flow proportionally, or are in geometrical progression. Hence from three observations of the actual temperature of a thermometer, at given intervals of time, we may determine the progression of the differences, and consequently the actual heat of the medium. The author

thor applies this method to Dr Herschel's experiments on the heat of a solar ray transmitted through different mediums, and the conclusions are very different from what we should at first sight infer: for instance, in Dr. Herschel's 24th experiment, the blue glass intercepted one-tenth only of the rays of heat, and not one-fourth, as the thermometer seemed to indicate. But the immediate interception must have been somewhat greater than one-tenth, for a certain portion of heat actually communicated to the glass must have radiated afresh towards the thermometer, and contributed to produce the temperature observed; and accordingly as this circumstance took place in a greater or less degree, the thermometer must have been variously and irregularly affected. Of such an irregularity almost every one of the experiments shows evident marks; and the apparatus is not minutely enough described to furnish data for calculating its magnitude. From these principles an experiment of Mr. Pictet on the interception of heat, is reconciled with Dr. Herschel's experiments.

In the second part of this paper Mr. Prevost treats of the reflection of heat and of cold. He observes that Bacon suggested the inquiry respecting the concentration of invisible heat by glasses. Lambert attributed the effect of the reflection from a common fire to its invisible heat. Mr. de Saussure suggested to Mr. Pictet to confirm Lambert's suspicion by experiment, and the success is well known. His experiment on the reflection of cold Mr. Prevost has already employed in support of the opinion that the equilibrium of heat is not a quiescent equilibrium, or an equilibrium of tension, but an equilibrium of motion, where the interchanges of heat on either side are equal; and this theory has been adopted by professor Pictet, and by other philosophers. Hence the author endeavours to deduce the law already inferred from Richmann's experiments. Mr. Prevost observes that this theory would be equally applicable to the opinion of those who consider heat as consisting in the undulations of an elastic medium; although he thinks that opinion liable to many objections, especially on account of the resistance which the motions of the planets must suffer from it. In a note added by Dr. Young, who communicated the paper, the assertion of Newton is quoted in answer to this objection, yet Doctor Young confesses that Newton appears to have calculated erroneously; but he observes, that if the slightest difficulty of this kind should occur from astronomical considerations, it might be avoided by considering the luminiferous ether as unconcerned in the phænomena of cohesion, and then its rarity might be assumed as great as we chose to make it.

The Society adjourned to November 4.

FRENCH

FRENCH NATIONAL INSTITUTE.

Account of the labours of the Mathematical and Phyfical Clafs, during the fecond quarter of the year 10.—Continued from No. 47.

Zoology.—C. Cuvier communicated to the clafs a great number of obfervations, which he made on the worms which contain a greater or lefs quantity of red blood, and fimilar to that which circulates in animals that have vertebræ. A fluid more or lefs red had long been remarked in the earth-worm; but, as a fluid of the fame colour had been feen in the larvæ of feveral infects, it was not known whether that of the earth-worm was real blood. About four years ago C. Cuvier removed all doubt on this fubject, and, after defcribing the vafcular fyftem of the earth-worm and leech, proved that the red fluid of thefe two animals is a real fanguine fluid. In the courfe of laft autumn this naturalift was enabled to extend his refearches on this part fo interefting to the phyfiology of animals. He obferved phænomena far more general, and confequently more remarkable, than thofe he had difcovered before. He found that all articulated worms, fuch as the naïades, nereïdes, aphrodites, amphinomes, terebellæ, amphitrytes, and ferpules have red blood; that this fluid circulates in a complete fyftem of arteries and veins, and that it proceeds to the branchiæ, or to the furface of the fkin, to affume a red colour, by an operation analogous to refpiration in man and animals with vertebræ.

Medicine.—C. Percy, affociate, read medical and philofophical obfervations on an univerfal ancylofis, or immobility of all the articulations, and exhibited to the clafs the fkeleton of the unfortunate fubject, who lived twelve years in that ftate, worfe than death, of which, according to C. Percy, it was a dreadful image and a long precurfor.

This furgeon in chief of the armies, after quoting inftances of ancylofis obferved by different phyficians, and particularly by Réal, Colomb, and C. Portal, informed the clafs that C. François-Maurice Marcieu de Simorre, an officer in the army, had contracted, during the campaigns in Corfica, a rheumatic gout which fucceffively deprived him of the ufe of his fingers, hands and feet; which, after producing the moft violent pain, made it impoffible for him to move any part of his body, and even his lower jaw; and which at length put an end to his exiftence. He fpent feveral years in an eafy chair, without enjoying a moment's fleep, notwithftanding the ftrongeft dofes of opium. Being reduced to fuch a ftate, as to be able to fuck only a little foup or wine through the ſmall interval left between the upper and lower teeth; he cauſed two of the inciſive teeth to be drawn, and by means of the aperture produced by this operation, he ſpoke with more freedom, and could ſuck up liquids through a pipe, and even ſwallow a little minced meat.

His body, a kind of animated ſtatue, or living carcaſe, formed only one piece; all his bones were cemented to each other: and notwithſtanding this ſtate of extreme miſery, Simorre often converſed with great cheerfulneſs, and dictated every year an almanack in verſe, which the public eagerly bought up, to relieve his misfortune without wounding his delicacy. That of the year 5 was diſtinguiſhed by the following motto:

> Privé de la lumière, et perclus de ſon corps,
> Il ſe rit de la vie, en attendant la mort.

Simorre's countenance, however, diſplayed great expreſſion, and even hilarity. The muſcles of his face had acquired a ſingular mobility; they were continually in action, either to ſupply the want of geſtures, which he could no longer employ, or to wrinkle his ſkin and drive away the inſects which continually tormented him.

C. Percy has deſcribed the origin and progreſs of this diſeaſe, fortunately very rare: he has examined the cauſes and explained the alteration of the bones, and particularly thoſe of the articulations of Simorre, whoſe ſkeleton, a terrible and at the ſame time valuable monument of human miſery, is now depoſited in the conſervatory of the ſchool of medicine at Paris.

In a ſecond memoir C. Percy has deſcribed all the effects of a monſtrous voracity, to which he gives the name of *polyphagia* A young man, in the environs of Lyons, named Tarare, at an early period of life, having followed a company of mountebanks, had accuſtomed himſelf to ſwallow pebbles, large offals of meat, coarſe fruits, knives, and even living animals. Terrible colics and other violent affections were not able to make him renounce this dangerous habit, which ſoon became an imperious want.

Having enliſted in the beginning of the laſt war in one of the battalions of the army of the Rhine, he ſought in the neighbourhood of a flying hoſpital the neceſſary aliment. The refuſe of the kitchen, the remains of the ſoldiers' allowance, rejected articles and putrid proviſions were not ſufficient to ſatiate his appetite. He often conteſted with the vileſt animals for their diſguſting food, and he was in the continual purſuit of cats, dogs, and ſerpents, which he de-

voured

voured alive. It was neceſſary to drive him away by force or threats from the apartments of the dead, and from the places where the blood drawn from the ſick had been depoſited. Attempts were made, but in vain, to cure this voracity, by giving him in turns fat bodies, acids, opium, and even *la coque du Levant.* The diſappearance of a child ſixteen months old having excited ſtrong ſuſpicions againſt him, he deſerted: but in the year 6 he was admitted into the hoſpital of Verſailles, in a ſtate of conſumption, which had ſucceeded this horrible appetite, and which, according to his own account, was occaſioned by a ſilver fork that had remained in the inteſtinal canal.

As he died ſoon after, C. Tuſſier, chief ſurgeon of that hoſpital, had the courage to open the body, notwithſtanding the inſupportable odour which it exhaled: but the fork was not found. The ſtomach was of an extraordinary ſize; the inteſtines, completely ulcerated, exhibited remarkable ſwellings; and the gall-bladder was of a very great capacity.

Tarare was of a ſmall ſtature, delicate and weak; his look had nothing in it ſavage. When young, the ſkin of his belly could almoſt be wrapped round his body, and after a full meal one might have almoſt believed him to be dropſical: a thick vapour iſſued in torrents from his mouth, his whole body ſmoked, the ſweat flowed in abundance from his head, and, like ſeveral of the moſt voracious animals, he fell aſleep to digeſt.

C. Percy terminated his memoir by explaining the internal organization of thoſe wretches condemned by nature to experience this cruel and inordinate hunger: he explained the greater part of the phænomena they exhibit; and he concludes, from numerous inſtances of *polyphagia* which he has collected, that the unfortunate perſons ſubject to it, find, for the moſt part, an end to their torments by death, before they attain to the age of forty.

Account of the labours of the Claſs of the Phyſical and Mathematical Sciences during the third quarter of the year 10.

ASTRONOMY.—*Obſervations on the new Planet diſcovered by M. Olbers, of Bremen; and the Oppoſition of Ceres, the Planet diſcovered by M. Piazzi.*

A conjecture as eaſy to be formed as uſeleſs to aſtronomy had given reaſon to preſume the exiſtence of a planet betwen Mars and Jupiter; but the law which aſtronomers were pleaſed to eſtabliſh from the diſtances of the planets known, appeared verified for a moment by the difcovery of Piazzi's planet, but was foon belied in the moft formal manner by the obfervation of a new planet very near the firft. Here then we have an inftance of the fall of opinions founded on deceitful analogies, and on the falfe ideas which we form of what conftitutes order and regularity in the defigns of nature. It will doubtlefs not cure men of the propenfity they have to indulge in vain fpeculations, which, after making a noife for a while, foon fall into the deepeft and well merited oblivion; and notwithftanding the numerous leffons which the pofitive fciences never ceafe to offer, they will always be found fearching for the caufes of effects when the data neceffary for that purpofe are entirely wanting, and even when no relations perceptible to our fenfes feem to be connected with the nature which they affign to the unknown caufe.

The new ftar of which we here fpeak, exhibits one remarkable fingularity, which contradicts the fyftems conceived to explain the formation of the planets according to the probability of a caufe in virtue of which their orbits have been confined within a very narrow zone, named the zodiac. The great inclination of the orbit of this ftar obliges us to extend confiderably the breadth of the zodiac; and gives reafon to believe that it has perhaps no boundaries: thefe reflections are founded on the following facts borrowed from Delambre.

"On the 20th of Germinal, C. Burckhardt having received information that M. Olbers, of Bremen, had difcovered a new ftar, which had the appearance of a planet, he communicated this intelligence the fame evening to all the aftronomers of the Inftitute, who fought for it the night following. Next day, C. Meffier, Mechain and Delambre gave to the clafs an account of their obfervations: the new ftar had a fenfible motion, both in right afcenfion, and declination. It prefented no appearance of a tail, nor even of a nebulofity, and could be diftinguifhed by nothing but its movement from ftars of the eighth magnitude which were in its neighbourhood. They continued to obferve it in the meridian till towards the end of Floreal: it always prefented the fame appearances, only that its light was ftill weaker, becaufe it began to recede from the earth.

"Attempts were made, but in vain, to find a parabola which would correfpond with the obfervations. A circle was attended with no better fuccefs. An ellipfe was neceffary, and one even very eccentric. In this refpect the new planet differs very little from Mercury; but what is more extraordinary in regard to it is, that its inclination is about 35°, while that of Mercury is only 7, and that of the planet Ceres discovered in 1801 by Piazzi, 10° 37′. Thus we shall be obliged to enlarge considerably the zodiac, if we continue to denote by that name the zone of the heavens in which the planets perform their revolutions. Another very remarkable peculiarity is, that the mean distance of this planet differs very little from that of Ceres. We are not yet acquainted in the solar system with two planets the orbits of which are so near.

"So many singularities render this new planet highly interesting to astronomers; for it is besides so small, that it can have no sensible influence on the neighbouring planets: while, on the other hand, it must experience very considerable perturbations from Jupiter. C. Burckhardt has kept an account of the principal of them, in order to determine an elliptical orbit. We have indeed great need of a pretty correct theory, to be able to find this planet when it shall issue from the solar rays, into which it is about to enter; otherwise its small size would render the search for it very uncertain. It is even highly probable that it would have remained still a long time unknown, had it not been found exactly in the place which Ceres had quitted, and quite close to stars which had been much observed by astronomers for several months. It was a curious union, that of three new planets with which astronomy has been enriched in our days, they were all three seen to pass the meridian in a few minutes of time. M. Olbers has given to his planet the name of Pallas."

The perfection to which instruments and methods are now carried, has enabled astronomers to deduce from a small number of observations, the determination of the elements of the planetary orbits, which they were formerly obliged to leave to future ages. One of these stars is no sooner discovered, than its motions are assigned with remarkable precision, as is proved by the opposition of Ceres, or Piazzi's planet, observed at the military school by Lalande junior and Burckhardt.

They have determined the moment of the opposition, on the 26th of Ventose, year 10 (March 17th 1802), at 3^h 46′ 8″ mean time of the national observatory, Paris.

The true longitude freed from the effects of aberration, nutation and parallax, 176° 21′ 26·″5
Northern geocentric latitude 17 7 57·5

The tables constructed by C. Burckhardt, differed from observation + 5″·4 in latitude, and + 21″·8 longitude. The latter of these errors indicates that the radius vector must be a little increased; but the author still waits for new obſervations before he can make the neceſſary corrections. In the calculation of this oppoſition, C. Lalande junior and Burckhardt from three obſervations of the ſun which agreed very well, diminiſhed by 11″ the longitude of this planet given by the tables.

MATHEMATICS APPLIED TO PHILOSOPHY.—*Remarks on the Difference between the Velocity of Sound deduced from Theory and that given by Obſervation. New Demonſtrations of the principal Theorems in regard to the Attraction exerciſed by Spheroids; ſpecial Determination of the Conditions of the Equilibrium of a Body made to balance freely on a Flexible Wire or on a Fluid.*

The reſult found by Newton for the velocity with which ſound is propagated in the atmoſpheric air, and ſince confirmed by various analytical reſearches of ſucceeding geometricians, differs however about a ninth from that given by experiment: the former is only 297·2 metres, and the ſecond is comprehended between 337·2 metres and 350·8. This point of philoſophy being one of thoſe to which analyſis applies with the greateſt rigour, it was impoſſible to aſcribe to the errors or imperfection of calculation, the difference between theory and obſervation. Newton therefore himſelf and ſome of the philoſophers who wrote after him on this ſubject have formed different hypotheſes, in regard to the conſtitution of the atmoſphere, in order to account for the difference in queſtion. But as none of theſe hypotheſes, which explained the fact only in a very vague manner, could accord with the diſcoveries of the modern chemiſtry, reſpecting the nature of the air, it has ſince been aſcribed to the influence which the variations of the temperature that accompany the dilatation and condenſation of the air reſulting from its vibrations may have on the velocity of ſound.

C. Biot, aſſociate, has endeavoured to determine by calculation, the effect which theſe vibrations that cannot be doubted, produce on the velocity of ſound. He has proved that it might be very ſenſible, and even ſufficient to carry the velocity of ſound beyond the term fixed by experiment. For this purpoſe he ſet out from ſome experiments on the dilatation of the air, and of gas, made under the direction of Berthollet, by C. Guy-Luſſac, and he has combined them with a plauſible hypotheſis on the quantity of caloric diſengaged by the compreſſion of the air, viz. that this fluid, under theſe circumſtances, abandons as much of it as is neceſſary to be taken from it by ſimple cooling in order to reduce it to the bulk it is made to occupy.

As

As this hypothesis gives a result too great, C. Biot then resumes the question in an inverse order, and, from the observed velocity of sound, endeavours to find what ought to be the quantity of caloric abandoned by the air, when it is reduced by compression to the half of its volume; and he finds that the same quantity would raise Reaumur's thermometer to about 69°.

C. Biot has communicated also to the class researches on the attraction of spheroids. This subject, treated first in a synthetic manner by Maclaurin, was a long time the quicksand of analysis, which, however, in the hands of Lagrange, Legendre, and Laplace, has successively assumed a superiority over synthesis, and conducted to results which could not have been obtained without its assistance. But there remained in the analytical demonstrations of the principal theorems on this subject, a complication which C. Biot made to disappear in a very happy manner, by combining a theorem, for which we are indebted to Lagrange, with a partial differential equation, found by Laplace, and applying to this equation a process, which he presented himself some years ago to the class, to integrate by series partial differential equations.

The equation to which we allude is among three of the differential co-efficients of the second order of the function which expresses the sum of the moleculæ of the spheroid divided by their distance from the point attracted; its integration gives for this quantity a series containing two arbitrary functions arranged according to the powers of one of the co-ordinates of the point attracted. By successively taking, in regard to each of these variable quantities, the differential co-efficients of the series which expresses the attractions exercised by the spheroid in a direction parallel to the axes of the co ordinates, C. Biot obtained developments of these attractions, determined entirely by three quantities, independent of the variable one, according to the powers of which the developments are arranged.

It thence results, 1st, that to have the attractions of any spheroid on any point of space, it is sufficient to take at pleasure a plane, and to calculate the attractions of the spheroid on the points situated in that plane: those which are within the spheroid will determine the general expression of its attraction on the interior points; the other will determine those which belong to the exterior points.

2d, That if two spheroids are such that their attractions on all the points of the same plane parallel to three rectangular axes are to each other in a constant ratio, the attrac-

 tions

tions of these spheroids on any point of space will preserve the same ratio.

These general theorems, when the question relates to revolving spheroids, are modified in the following manner:

To have the attraction of a revolving spheroid on any point of space, it will be sufficient to know these attractions on any point of a right line perpendicular to the axis of revolution, and drawn through a point, taken at pleasure, in that axis.

If two revolving spheroids are such that their attractions on any point of the same straight line, subject to the preceding conditions, are to each other in a constant ratio, the attractions exercised by these spheroids on any point of space will retain the same ratio.

C. Biot applies in succession various theorems to any elliptical and revolving spheroids, and thence deduces the well-known theorems; then transforming, in a general manner, the variable quantities of his formulæ, he concludes, that to have the attraction of any spheroid on any point of space, it is sufficient to know, for the points of any surface that may be assumed at pleasure, the two first terms of the development of the function which expresses the sum of the moleculæ of the spheroid divided by their distance from the point attracted; and that, if there are two spheroids, the attractions of which on the same points of that surface are to each other in a ratio independent of the primitive co-ordinates, the attractions of the two spheroids on any point of the space whatever will be to each other in the same ratio. He concludes his memoir by the application of these last theorems to revolving spheroids.

LI. *Intelligence and Miscellaneous Articles.*

COMMERCIAL COLLEGE.

MANY of our readers will peruse with some degree of interest the following proposals for establishing by subscription a commercial college at Hull. It would give us much pleasure to be able to announce that similar institutions were about to be established in other places.

"The object of this institution is, to obtain for the man of business precise information on the nature and value of every article of commerce, whether the raw material or manufactured: to point out to him the country where such articles may best be procured: to bring him acquainted with the various processes by which they are rendered marketable: and,

and, to instruct him in the languages of the different countries whither the objects of commercial pursuits may lead him.

"The plan is, to appoint professors, to form a museum, and to erect a building for the accommodation of professors, and the reception of specimens of the raw materials and manufactured articles of commerce.

"One professor to teach the southern languages; a second, the northern; and a third to have the charge of the musæum, and to be capable of explaining to the pupils the various specimens of nature and art under his care.

"Every subscriber of fifty pounds to be a governor, and to possess a right of transferable property in the building, and to have the privilege of appointing pupils.

"Subscribers of twenty pounds to have the power of recommending pupils during life; and subscribers of two guineas to be considered as annual subscribers, and, for the time, to have the power of recommending .

"In order to render the professors independent of gratuitous subscription, I propose that the three corporations of the town should each endow a professorship with fifty pounds per annum, and, in return, that they should each have the privilege of recommending a certain number of the poor, intended for commercial pursuits, or the sea, to all the advantages of the institution.

"To obtain a royal charter of institution.

"The estimated expense is:

For ground and building - -	£. 2000
For collecting specimens and fitting up the musæum	500
	£. 2500

"It will perhaps be thought by many that the foregoing statement does not hold out sufficient interest to warrant a man in putting down his money for the purposes; and by others, that charitable institutions are already sufficiently numerous in the town; and that those established have the first claim to our benevolence. To the latter I need only say, I do not consider the present institution as a charitable one; and to the former, that I hope to prove it will eventually be the real interest of every subscriber.

"As the father of a large family, I certainly should not think myself at liberty to subscribe fifty pounds merely for the personal pleasure that results from the contemplation of a charitable action; but in subscribing fifty pounds to the above institution, I consider my interest and the welfare of my family. I am convinced it will add to the wealth and importance

importance of the town; and in both of these I am deeply interested: but the greatest interest I have is in the facility it will give to the education of my children. In a commercial country and a seaport town, the acquisition of knowledge, that evidently leads to the improvement of trade, becomes an object of the first moment in the education of youth, and the mode now proposed offers advantages which no private school can possess. To bring together under the immediate observation of youth, (while yet the memory is most retentive,) perfect specimens of the different articles of commerce, both of the raw material and the manufactured, will enable him to bear in mind the precise value of any article he may be called upon to appreciate: to point out the country where every article is first procured or manufactured, will qualify him to go to the cheapest market; and, by teaching him the language of such country, he will be at all times capable of transacting his own concerns without the intervention of interpreters, often a very serious source of imposition.

"The views and pursuits of the different public bodies in the town are now so enlarged and liberal that I have no doubt, should there be a sufficient number of subscribers, they will be induced to do their part from the conviction that they thereby pursue the positive if not immediate interest of their respective charges.

Hull, May 13, 1802. J. Alderson, M.D.

"Subscribers' names will be received at the Library, at the Banks, and at Messrs. Rawson and Rodford's, booksellers, Lowgate; and as soon as there are twenty subscribers a meeting will be called."

VACCINE INOCULATION IN WALES.

The following account has been communicated from the learned Dr. W. Turton, being an extract from a printed paper distributed in Swansea.

"Having very nearly lost my son in the small-pox from inoculation, I was naturally uneasy about the event of it in my daughter; and went to London, anxious to make the most minute inquiries concerning the success of the cow-pock, then lately established. I examined the different hospitals and institutions where it was practised, carefully watched the progress of the disease, and attended Dr. Pearson to the villages near Oatlands, where upwards of three hundred people, who never had the small-pox, were inoculated for the cow-pock by the recommendation of the Duke: all of these were again inoculated for the small-pox, and without effect.

effect. Every scruple was therefore removed, and I desired Dr. Pearson to send me, in a letter, some of his genuine matter on a thread, that I might inoculate both my own children, for the satisfaction of all who might wish to have evidence of its effects: and (June 29, 1799) in the presence of Mr. J. Collins, Mr. Braine, and the late apprentice of Mr. Sylvester, I inoculated them both. The boy, who before had had the small-pox, did not take it; but the little girl, who never had either, went well through it, without any previous preparation, without any alteration in her food or manner of living, and with only about two hours illness. She has since been inoculated for the small-pox, and exposed in every manner to its infection, but it is certain cannot have it.

"From her arm I inoculated several children, among whom were two of Mr. Ayrton's; each of which I directed might sleep with one who never had been inoculated for either. The two that were innoculated went well through it, and the two that slept with them did not catch it. By this it appears that it is not infectious, and that any part of a family may have it without communicating it to others.

"An opinion has been delivered about the town, that it is possible for those who have had the cow-pock still to be liable to have the small-pox. This I may safely contradict; as it is an assertion made without proof, or without inquiry after proof: for, notwithstanding every eye has been open to discover whatever might happen, and every attempt made to ascertain it, there is not upon record one single instance.

"Had those who have lately been cut off by the small-pox in Swansea been inoculated for the cow-pock, it is more than probable they would all have been saved: and in consequence of its increasing fatality I was applied to by many, who trusted my assertions, to procure genuine matter from London. I have just received some from Dr. Pearson, and have inoculated the children of Capt. Nichols, on the Burrows, and the two others of Mr. Ayrton, who may be seen by any one desirous of further information. From them I am willing to inoculate such as are fully convinced of its utility, and pledge myself, under Providence, for their safety.

"Obstructions from medical men will sometimes present themselves, through prejudice, or fear, or interest. Prejudice I consider to be a determination to abide by old opinions whether right or wrong: and with men who persevere in detected error, it is useless to reason, and foolish to contend. Fear will operate with those who are apprehensive of of introducing and recommending what they do not clearly understand, and about which they are too idle to make inquiries. And, I am afraid, a few will be found, who regarding their annual harvest from the small-pox as likely to be diminished or totally lost, will honestly endeavour to extinguish the light that would conduct their fellow-beings to safety.

Fisher Street, March 19, 1800.

"POSTSCRIPT.

"After a lapse of three years, the author of these observations cannot but congratulate himself and the public on the unequivocal success which has attended his introducing the cow-pock into this country. Upwards of a thousand persons in the various towns of South-Wales have been inoculated, without the smallest accident or interruption to their health; and the usual ravages from the small-pox are manifestly diminishing every year.

Swansea, June 9, 1802.

Extract of a Letter to Dr. Pearson.

"MY DEAR SIR, Swansea, August 6, 1802.

"You will see by the inclosed, how I from time to time promote the good cause. I have overcome all difficulties, and many thousands have been inoculated without one accident or the least apparent danger. In some towns the whole of the inhabitants, not having previously had the small-pox, have confidently taken the cow-pock. The small-pox has not appeared here for some time, and I hope the day is not far distant when it shall be declared criminal by the legislature to introduce it. Whatever may be the opinion of any individual as to the comparative safety of either, no man can now be justified in contaminating his neighbourhood.

"My eldest daughter, the first Cambrian ever inoculated for the cow-pock, I have lately christened Vaccinia—an unalterable record of its introduction and by whom.

"Ever yours, W. TURTON."

INTERNAL IMPROVEMENTS.

On the 27th of August the magnificent docks at Blackwall, which, in size and accommodation to shipping, exceed every thing that now exists, were opened for the reception of the shipping in the West-India trade.

By eleven o'clock the various avenues and roads leading to the Isle of Dogs were crowded by multitudes, some on horseback, others in gigs and curricles, but the greatest number were pedestrians. The bustle and confusion in repairing to

Blackwall

Blackwall were aſtoniſhing. A little after twelve o'clock, ropes were thrown to the people on ſhore, in order to tow the Henry Addington, a Weſt-Indiaman lately launched, into the dock. The people laid hold of the cords; but the veſſel being large and heavy, it was ſome time before ſhe could be moved, notwithſtanding the Echo, a veſſel from the Weſt Indies deeply laden, had entered the great baſon ſoon after eleven o'clock. By the ſtrenuous exertions of the people on ſhore, aided by a windlaſs on each ſide of the great floodgate, the veſſel was at laſt brought near the entrance of the dock. She was greeted by the populace on each ſide with loud and reiterated huzzas, and by the band of muſic belonging to the firſt regiment of guards, who played "See, the conquering hero comes!"

The veſſel being by this time very near the great floodgate, a conſiderable delay took place before ſhe was introduced to the dock. This, however, having been overcome, the people once more "gave way," and the ſhip came in amidſt the ſhouts of the ſpectators, the band playing "God ſave the King," "Rule Britannia," &c. &c. We never witneſſed any thing more ſtriking, and at the ſame time ſo very pictureſque, as the paſſage of this veſſel into the dock. She was decorated in the moſt ſplendid manner by the flags of all nations diſplayed in various parts of her rigging. Having come to her moorings at the firſt ring-bolt-buoy, ſhe fired a royal ſalute, which was anſwered by the ſhouts and huzzas of the ſpectators.

The Echo, a veſſel, as we have mentioned above, deeply laden from the Weſt Indies, was next towed in. She is a very handſome ſhip, and was received with the loudeſt expreſſions of joy. Upon this veſſel reaching her ſtation, another ſalute was fired from the Henry Addington, which concluded the buſineſs of the docks. In the afternoon the company on board the veſſels, and the various proprietors and commiſſioners of the docks, repaired to the London tavern, where a moſt elegant dinner was provided for their entertainment.

The whole of the ſcene muſt have been highly gratifying to every well-wiſher to the greatneſs of this country. In the ſhort ſpace of two years, by the energy, the ſpirit, the wealth, and the perſeverance of individuals, this imperial work, the proof of paſt and the pledge of future proſperity, has been begun and almoſt finiſhed. New facilities to commerce are thus created from its former acquiſitions, and a freſh activity is given to induſtry and to enterpriſe. While property is thus rendered active by liberty, and maintained ſecure by law (and what other ſource has commerce had in

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this country but liberty and law?) it is impoſſible to ſet bounds to its operations and to its ſucceſſes.

At a public meeting held at Horſham in Suſſex on the 18th of Auguſt, it was reſolved, That acts of parliament having been already obtained for making a canal navigation from the Thames at Rotherhithe to Croydon in Surry, it is deſirable that a canal ſhould be made, to commence at the termination of that canal at Croydon, and to paſs from thence to Portſmouth. A ſubſcription was immediately ſet on foot to carry the deſign into execution.

A very numerous and reſpectable meeting of gentlemen, merchants, bankers, and others, was held at the Crown and Anchor in the Strand, on Thurſday the 5th of Auguſt, to conſider of the expediency of applying to parliament for an act to make a navigable canal from the grand junction canal at Paddington, round the north of London, to communicate with the London Docks at Wapping. Sir Chriſtopher Baynes, bart. was called to the chair, and laid before the meeting a very ſatisfactory ſtatement, not only of the plan propoſed, but of the means by which it may be accompliſhed, together with eſtimates of the expenſe likely to attend its completion; after which a committee of ſubſcribers was appointed to take the neceſſary meaſures for carrying the plan into effect. We forbear, in this early ſtage of ſo important an undertaking, to prognoſticate the various benefits that may ariſe from it, although there ſeems an univerſal opinion in its favour.

We hope alſo to be able, at no very diſtant period, to announce that the iron bridge of one arch over the Thames, projected by Mr. Telford, is to be undertaken. A perſpective view of the bridge has been publiſhed on a very extenſive ſcale. It is an admirable production, eſpecially the engraved part*. It has received the approbation of the moſt eminent mathematicians, as Dr. Maſkelyne, Dr. Hutton, Mr. Robertſon of Oxford, Mr. Atwood of London, Dr. Robiſon and Mr. Playfair of Edinburgh, and Mr. Coupland of Aberdeen; which is a ſufficient juſtification of the principles of the deſign. Among the great, the king, the prince of Wales, the duke of York, and the duke of Kent, have ſtood foremoſt in their approbation. The plate is now dedicated to his majeſty, by his permiſſion, and with the approbation of lord Hawkeſbury, to whom it was at firſt dedicated.

If to the docks in the Iſle of Dogs, and in Wapping, this improvement in the upper part of the river was added, the

* The back ground is in aquatinta.

port of London would be the moſt perfect in the world. The city would be accommodated with wharfs and warehouſes in its centre, and the bridge would be a feature to diſtinguiſh it from other cities. The completing the work of peace, the intended diſſolution of parliament, together with the neceſſary abſence of Mr. Telford in making ſurveys in Scotland, prevented the buſineſs of the bridge from being brought forward during the laſt ſeſſion; but it will probably in the courſe of the next, or at leaſt as ſoon as the ſcheme can be fully matured.

The Scotch ſurveys relate to improving and extending the fiſheries; eſtabliſhing or improving harbours on the eaſt and weſt coaſts for commercial and naval purpoſes; opening an inland navigation from the Murray-frith to the bottom of the Sound of Mull, with a depth of water ſufficient to carry the largeſt Baltic men, Weſt-India men, and frigates; improving the land communications in the north by means of roads and bridges; inquiries into the cauſe of emigrations, and modes to prevent them; and improving the communications between Ireland and the weſt of Scotland and the north of England. The ſurveys are ſtill going on.

Theſe are certainly objects of national importance, and miniſters deſerve credit for beſtowing attention upon them. They embrace a great portion of our internal improvements, on a ſcale which promiſes to promote the proſperity of the Britiſh empire.

The opening the Caledonian canal would admit of the whole of the trade from the weſt of England and Scotland, and the whole of Ireland, paſſing in a direct and eaſy manner to and from the Baltic, inſtead of being expoſed to the ſtormy and dangerous navigation of the Pentland frith, the Orkneys, and northern parts of Scotland, which are particularly expoſed in the time of war: and a naval ſtation at Cromarty, Peterhead, or Aberdeen, would afford ready convoys, and guard the entrance of the Baltic; while the bay of Oban, on the coaſt of Argyle, would afford a ſafe ſhelter on the weſt coaſt. Nature has pointed out this line of country as particularly ſuitable for a canal of this magnitude, the diſtance between ſea and ſea being about 60 miles, in a direct line, out of which upwards of 37 miles are now navigable locks capable of admitting ſhips of the largeſt dimenſions; and the greateſt height above the level of the ſea does not exceed 100 feet. The locks on and above the ſummit-level form reſervoirs of about 20 miles in length; and the waters of a large diſtrict of rainy country fall into the locks which form this reſervoir.

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This inland navigation would alſo open a ready paſſage for the fiſhers of the Eaſt coaſt, to paſs to the fiſhing-grounds on the Weſt coaſt, and of courſe for thoſe who reſide on the Weſt to paſs to the Eaſt ſide of the iſland; ſo that the whole would be as it were under one eſtabliſhment. The executing the works connected with the inland navigation, the harbours, and bridges, would employ the people of the country, give them habits of induſtry, furniſh them with capital for future employment, and be the beſt means of preventing emigration.

LECTURES.

In the ſecond week of October next, will commence at the Elaboratory in Whitcomb Street, Leiceſter Square, a Courſe of Lectures on Phyſic and Chemiſtry at the uſual morning hours, viz:

The Therapeuticks, or Materia Medica, at a quarter before eight.

The Practice of Phyſic, at half after eight.

The Chemiſtry, at a quarter after nine.

By George Pearſon, M. D. F. R. S. ſenior phyſician to St. George's Hoſpital, of the College of Phyſicians, &c.

On the firſt Tueſday evening in October and February, Mr. Blair will begin his Courſe of popular Lectures on Anatomy and the Animal Economy, for the information of ſcientific perſons, amateurs of natural hiſtory, ſtudents in the liberal arts, and profeſſional men in general; and on the firſt Friday in October and February his courſe of lectures on the Clinical Practice of Surgery.

The following Courſes of Lectures will be delivered at the Medical Theatre of St. Bartholomew's Hoſpital, during the enſuing winter:

On the theory and practice of Medicine, by Dr. Roberts, and Dr. Powell.

Clinical lectures on caſes occurring in the Hoſpital will be delivered by Dr. Roberts.

On Anatomy and Phyſiology, by Mr. Abernethy.

On comparative Anatomy and Phyſiology, by Mr. Macartney.

On the theory and practice of Surgery, by Mr. Abernethy.

On Chemiſtry and the Materia Medica, by Dr. Powell.

On Midwifery and the Diſeaſes of Women and Children, by Dr. Thynne.

The Anatomical Lectures will begin on the 1ſt of October at two o'clock, and the other Lectures on the ſucceeding days, which, with all other particulars may be learned by applying to Mr. Nicholſon, at the apothecary's ſhop, St. Bartholomew's Hoſpital.

LII. *On the Virgula Divinatoria, or Divining Rod.* *By* William Phillips, *Esq. Read before the Askesian Society in the Session* 1801.

THE *virgula divinatoria*, or divining rod, is a forked branch, or two shoots or young branches of a fruit-bearing tree, tied together at one end, and held by the other ends one in each hand. When held in a certain position, and under certain circumstances, which I shall endeavour presently to describe, it is said to discover the situation of metals, &c. in the earth, by dipping as it approaches the place beneath which they immediately lie.

It is not known who was the discoverer of it; but Agricola, in his Treatise *De Re Metallica*, supposes that it took its rise from the magicians, who pretended to discover mines by inchantment: others are of opinion that the discovery is of later date, and that the inventor was hanged in Germany as an impostor. Be that as it may, no mention is made of it earlier than the 11th century; and though it has occasionally occupied attention for so long a time, yet the niceties attending its use according to the prescribed directions, and probably, too, the difficulty of accounting for the effects said to be produced by any plausible theory consistent with the admitted laws of natural philosophy, may have retarded its progress; for it is now almost totally neglected.

About the middle of the 18th century it was ably supported in France by De Thouvenel, who published a book upon the subject, in which he endeavoured to substantiate the virtue of the divining rod by the recital of about six hundred instances of its successful employment, principally by himself or within his own knowledge; and soon after by a philosopher of unimpeachable veracity, and a chemist, William Cookworthy, late of Plymouth. The favourable opinion he entertained of it was grounded, according to his own account, as became a chemist, upon actual experiment. It appears that his experiments were frequently repeated, and that the ease which he attained in using the virgula was the means of his satisfying many intelligent men of its virtue, by experiments for the discovery of pieces of metal hid in the earth, as well as by the discovery of a copper mine near Oakhampton, which was worked for several years. Thus it became introduced into Cornwall, where the discovery of several mines is attributed to it; and there are yet a few among

among the most intelligent practical miners in the county who continue to believe in its virtue. The first knowledge he procured of the rod was from a captain Rebeira, who deserted the Spanish service in queen Ann's reign, and became captain commandant of Plymouth garrison; and as Cookworthy's veracity and abilities were unquestionable, and as it undeniably appears that he made many experiments with the rod, it seems as if his account demands some degree of confidence. But the earlier writers who mention it, appear to have supposed that its operation was the effect of magic; and thence the cutting of it was, according to their directions, to be attended by the utterance of certain cabalistic words and the performance of certain ceremonies: they directed it to be cut on a certain day, and at a certain hour, from a tree of a certain description, before sun-rise, about the day of the annunciation of the Virgin Mary, but especially with an increasing moon. It has, however, of later times been agreed, that a forked hazle rod, or two straight rods of one year's growth, being most pliable, cut in the winter and kept till they are dry, answer best; or, if these be not at hand, suckers of the apple or currant-tree, or shoots of the peach-tree, willow, or oak, though green, will do tolerably well, but those of the fruit-bearing trees are preferred. If the rod be made of two separate shoots, they are tied together at their larger ends with some vegetable substance; and these, it is said, answer better than those which grow forked, the shoots of which, being rarely of equal size and length, do not handle so well. The length of the rod is from 2½ to 3 feet.

Upon a nice observation of the mode of holding the rod, prescribed by Cookworthy, much seems to depend. Having, as has been observed, tied the larger ends of the sticks together, the smaller are to be held one in each hand, with that part of it which is grasped by the hand so turned as to be brought parallel to the horizon, and the tied ends pointing upwards at an elevation of about 70 degrees. The more strongly the rod is grasped, the livelier is said to be its action: but it is peculiarly necessary to observe that it be grasped steadily and equally; for if, when the movement or attraction of the rod is commenced, there be the least imaginable opposition to it by a jerk, it will not move any more till the hands have been opened and a fresh grasp taken. It appears that a due observance of this is of much importance, and that the operation of the rod has in many instances been defeated by a jerk or counter-action; and thence, says Pryce, in his *Mineralogia Cornubiensis*, who was "well convinced of its absolute and improveable virtues," ties," it has been concluded that there is no real efficacy in the rod. It muſt, he ſays, be particularly obſerved, that as our animal ſpirits are neceſſary to this proceſs, ſo a man ought to hold the rod with the ſame indifference and inattention to, and reaſoning about it, or its effects, as he holds a fiſhing-rod, or a walking-ſtick; for, if the mind be occupied by doubts, reaſoning, or any other operation that engages the animal ſpirits, it will diveſt their powers from being exerted in the proceſs, in which their inſtrumentality is abſolutely neceſſary: hence, he obſerves, it is that the rod conſtantly anſwers in the hands of peaſants, women, and children, who hold it ſimply, without puzzling their minds with doubts or reaſonings. Whatever, adds he, may be thought of this obſervation, it is a very juſt one, and of great conſequence in the practice of the divining rod.

Equipped as has been deſcribed, and duly obſerving the foregoing directions, the perſon in ſearch of a metallic lode is to walk ſteadily and ſlowly forward; and when he approaches a lode ſo nearly as its ſemi-diameter, the rod, it is ſaid, will feel looſe in his hands, and be ſenſibly repelled towards his face: if it be thrown back ſo far as to touch his hat, it muſt be brought forward to its uſual elevation, when it will continue to be repelled till his foremoſt foot is over the edge of the lode: and when this is the caſe, if the rod be held well, there will be firſt a ſmall repulſion towards the face; but this is momentary, and the rod will be immediately drawn irreſiſtibly down, it is ſaid, and will continue to be ſo during the whole paſſage over the lode: but as ſoon as the foremoſt foot is beyond its limits (Pryce's *Mineralogia Cornubienſis*), the attraction from the hindmoſt foot, which is ſtill on the lode, or elſe the repulſion on the other ſide, or both, throw the rod back towards the face. When the rod has been drawn down, the hands muſt be opened, the rod raiſed by the middle fingers, a freſh graſp muſt be taken, and the rod held again as before; for, if it be raiſed again without opening the hands, it will not work.

Pryce, at p. 123 of his *Mineralogia Cornubienſis*, informs us that many mines have been diſcovered by means of the rod, and quotes ſeveral; but it muſt be obſerved that, by his own account of the adventures, not one of them turned out a profitable concern; and hence he takes occaſion to obſerve, that it is by no means a diſadvantage that the rod dips equally to a poor as to a rich lode, which he allows to be the caſe; otherwiſe the great prizes in the mining lottery would ſoon be drawn, and future adventurers be diſcouraged.

But though the rod is ſaid to dip equally to a poor as to a rich lode, it is not found to dip with the ſame force to all metals; nor, indeed, does it appear to be confined to metals alone, but that it is alſo attracted by coals, bones, limeſtone, and ſprings of water, with different degrees of ſtrength, in the following order:—1. Gold: 2. Copper: 3. Iron: 4. Silver: 5. Tin: 6. Lead: 7. Coals: 8. Limeſtone and ſprings of water. The mode directed by Cookworthy for proving this is the following: With the rod held according to the preſcribed rules, ſtand with one foot advanced, put under it a guinea, and a halfpenny under the other, and the rod will be drawn down forwards: if the pieces of money be ſhifted, it will ſtill be attracted towards the gold, *i. e.* towards the face; which proves that the gold poſſeſſes the ſtronger attraction: and, by thus varying all the forementioned ſubſtances, the ſtrength of their reſpective attractions will be found to correſpond with the order in which they are placed.

According to captain Rebeira, the virtue neceſſarily reſident in the human body for the diſcovery of metals, &c. in the earth by means of the divining rod, is confined to but few perſons; and Agricola very ſhrewdly inſinuates, that where it does not act, it muſt be owing to ſome ſingular occult quality in the perſon. Cookworthy and Pryce, however, aſſert that Rebeira was miſtaken; for that the virtue, as he calls it, reſides in all rods and in all perſons, though not in every rod in the hands of every perſon. Willow and other rods, ſay they, not of fruit-bearing trees, that are not attracted in the hands of thoſe in which the fruit-bearing rods are attracted, will anſwer in the hands of thoſe in which the fruit-bearing rods are not attracted; ſo that all perſons poſſeſs the virtue.

If a piece of the ſame wood as that of which the rod is compoſed be placed under the arm, it will totally deſtroy the operation of it, except in the inſtance of water, for which any rod, they ſay, in any hand will anſwer; or if the leaſt animal thread, as ſilk, or worſted, or hair, be placed on the top of the rod, it will prevent its operation: but if a piece of the ſame animal ſubſtance, or of the ſame wood as that of which the rod is made, provided the rod does not anſwer, be placed under the arm, it will cauſe the rod to operate. If a piece of gold be held in the hand and touching the rod, it will prevent its being attracted by that metal or by copper, for the rod will be repelled towards the face; or if iron, lead, tin, ſilver, limeſtone, bone, or coal, be held in like manner, it will alſo be repelled, and *vice verſa.* If a perſon with whom the rod does not naturally operate hold a piece of gold in his hand, the rod then anſwers to gold and copper; and

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thus with respect to the other metals and substances; and upon these properties of the rod depends its power of distinguishing one metal or substance from another. Another mode however, grounded upon the same principles, is pointed out as being much more ready and certain, viz. by preparing rods that will only answer to some one of the aforementioned substances. The mode of preparing them is by boring a small hole in the top of the rod, and by putting into it a very small quantity of each substance except that after which search is to be made: the hole is then to be stopped up with a piece of the same wood of which the rod is made. These are the directions which Cookworthy has given for the use of the divining rod.

It is now but little if at all practised in this country: the few among the curious, or among practical miners, who continue to assert that it possesses an influence in the discovery of ores, seem so far to have yielded to its opponents as to have given up the use of it. Two with whom I became acquainted in Cornwall still assert their belief in it, and that it has been the means of discovering mines there; and a third assured me that he had himself, by the accidental use of the rod, in a place where he did not expect that it would have been acted upon, viz. in his own shop, discovered a lode which is now working under the town of Redruth: but it must be acknowledged that there are many more among the most intelligent miners who ridicule the rod, than believe in the influence of minerals upon it. Taking it for granted, however, that metals do act upon the rod to the fullest extent of Cookworthy's belief, it still remains a question, notwithstanding the accommodating opinion of Pryce, whether it would prove a benefit to the miner, as it is allowed that it dips equally to the poor as to the rich lode, to a silver penny as to the mines of Potosi; for it is too often experienced in Cornwall that lodes are not wanting, but ore. The advantage to be derived from it, therefore, with regard to metallic veins seems by no means a counterbalance to the niceties and uncertainties attending its use; for the projector, implicitly depending upon the information of the rod, might, at a ruinous expense, ransack the bowels of the earth, in consequence of its dipping to a rich gossan, or a dead lode.

Believing with Boyle, that they who have seen the experiment can much more reasonably believe than they who have not, and being desirous of annexing to this account of the divining rod any little testimonial of my own experience, which a sedulous attention to the preceding directions might afford, I cut, during the last winter, a number of hazle rods,

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and laid them by till they became dry; when, having tied two together with a vegetable ſubſtance, I proceeded to endeavour the diſcovery of ſome pieces of metal: but repeated trials, both by others and myſelf, afforded us no opportunity of becoming convinced by experience that metals poſſeſs any influence upon the rod; and we were obliged, in giving up the trial, to acknowledge that we poſſeſſed thoſe "ſingular occult faculties" which, according to Agricola, in ſome people prevent its action. It would, however, be an abſurd and unwarrantable concluſion, to aſſert that the accounts which have been handed to us have been fabricated merely to excite our wonder, becauſe thoſe effects which have been aſſerted to accompany the uſe of the rod occaſionally have not, in theſe few inſtances, been obſerved. Yet it has ſo long been conſidered the prerogative of human reaſon to deny what cannot be explained, that it is with much difficulty we can admit as fact, however reſpectable the authority, that of which we have no ocular or ſenſible teſtimony, or for which no phyſical cauſe has been aſſigned. Two centuries ago who would have believed in the exiſtence of the electric fluid? or who, if ocular demonſtration were wanting, would not deny the incomprehenſible attraction of the magnet? Philoſophy, like fanaticiſm, has its prejudices, and has often rejected as impoſſibilities what have afterwards been confirmed by experience. But ſo ſtrongly does the reſpectability of its advocates claim a favourable opinion as to the real exiſtence of the virtues aſcribed to the divining rod, that, though it ſeems impoſſible wholly to admit their teſtimony, it ſeems equally ſo wholly to reject it.

The faculty of ſubterraneous diſcovery has been referred to the theory of effluvia, or to the corpuſcular philoſophy, for explanation; but it ſeems only to have been hypothetically referred to an hypotheſis. For, in the firſt place, although the aſſerted effects of the rod have been copiouſly deſcribed, a definition of its *modus agendi*, where it will act, has been wanting, nor have we been told what particular conſtitutional defects have in moſt caſes prevented its acting at all; and ſecondly, the theory of the corpuſcular philoſophy, though perhaps it may be impoſſible wholly to reject it, has never been completely admitted. Rebeira permitted perſons to ſee him uſe the rod, but would diſcover no more; and neither Cookworthy nor Pryce has ſaid whether, as the practiſer in the divining art approaches a ſpot under which ſprings or metals lie hid, he feels any internal ſenſations: but Thouvenel has more completely provoked doubt, by aſſerting that internal ſenſations, nearly approaching to morbid affections, are

are felt, at the ſame time that an external motion is communicated to the rod. Theſe ſingular emotions, none of which were obſerved to take place, when he was above ſtagnant waters were followed by head-ache, fatigue of body, debility of mind, and other ſymptoms of nervous irritation. The dry ſtate of the atmoſphere, alſo favourable to electric experiments, was obſerved to render him more active and lively in his prognoſtics; but a full meal evidently diminiſhed the capacity; and an inflammatory fever, which confined him a fortnight to his bed, deranged or deſtroyed the miraculous power for the ſpace of three months. From theſe circumſtances it ſhould ſeem that its action is dependent on ſome peculiar nervous ſenſibility; that our faith or our imagination ſhould be prepoſſeſſed in its favour, according to Pryce; and that much depends on an harmonious diſtribution of the animal ſpirits, devoid of anxiety or reaſoning reſpecting the event: but that a ſtate of doubt is an obſtruction to its operation. Theſe, perhaps, may be the principal difficulties in uſing the divining rod; but we are aſſured by Cookworthy and Pryce, that, regarding theſe and other eſſentials in its uſe, a rod may be found adapted to the peculiar ſyſtem of every perſon.

Difficult, however, as is the admiſſion of belief in the aſſerted virtue of the divining rod, and little as it has been underſtood by thoſe who have moſt ably eſpouſed its cauſe, it may not be amiſs juſt to trace the outlines of that theory to which it has been by them referred for explanation, that of the corpuſcular philoſophy, which is a mode of accounting for the phænomena of nature by the motion, figure, reſt, poſition, &c. of the corpuſcules or minute particles of matter. Boyle ſums up the chief principles of this hypotheſis in the following particulars:—1ſt, That there is but one catholic or univerſal matter, which is an extended, impenetrable, and diviſible ſubſtance, common to all bodies and capable of all forms. 2d, That this matter, in order to form the vaſt variety of natural bodies, muſt have motion in ſome or all of its aſſignable parts; and that this motion was given to matter by the Creator of all things, and has all manner of directions and tendencies. 3d, Matter muſt alſo be actually divided into parts, and each of theſe primitive particles, fragments, or atoms of matter, muſt have its proper magnitude or ſize, as alſo its peculiar figure or ſhape. 4th, It is ſuppoſed that theſe differently ſized and ſhaped particles may have different orders and poſitions, whereof great variety may ariſe in the compoſition of bodies. (*Encyclopædia Britannica.*) Pryce, in his *Mineralogia Cornubienſis*, gives the following

 account

account of the mode in which these corpuscules or minute *impenetrable* and *divisible* particles of matter act through the medium of the human body or nerves, or by the assistance of the animal spirits, upon the divining rod. "The corpuscules, it is said, that rise from the minerals, entering the rod, determine it to bow down, in order to render it parallel to the vertical lines which the effluvia describe in their rise. In effect, the mineralogical particles seem to be emitted from the earth: now the virgula, being of a light porous wood, gives an easy passage to those particles, which are very fine and subtle: the effluvia, then, driven forwards by those that follow them, and pressed at the same time by the atmosphere incumbent on them, are forced to enter the little interstices between the fibres of the wood, and by that effort they oblige it to incline or dip down perpendicularly, to become parallel to those little columns which the vapours form in their rise." If this jargon, this fabric of unintelligible conclusions, raised upon the slender foundation of *pre-supposition*, be not sufficiently absurd, I beg leave to refer to page 114 of Pryce's work, where he attempts an elucidation of the corpuscular theory.

If an advocate for this theory, as applied for solving the cause of the operation of the divining rod, were to be asked why hazel rods, and branches of other trees said to be attracted by metals, are not attracted by them in their natural growth; and why, consequently, they do not grow with their top declining towards the earth, I feel at a loss to conceive what would be the answer. Would he say that the *vis inertiæ* of matter is not sufficiently powerful to overcome the living principle of the tree? or would he not say that the human body is an excellent conductor of those minute particles or corpuscules, which, according to Hartley, are perpetually flying off from all bodies, for ever seeking new combinations, and of the same catholic matter forming an infinite variety of modifications throughout the universe? Some conclusion, equally satisfactory and philosophical, might be expected from the hypothetical advocates of this theory; and as, in all probability, this theory cannot be established by ocular demonstration, or by any means be made manifest to our senses, it seems as if it were better to acknowledge, if really there be any virtue in the rod, that, as in the instances of the magnetical influence and the electric fluid, it is one of those mysterious effects of the mysterious laws by which nature is governed, inscrutable to human wit, and indefinable by human investigation.

LIII. *Messrs.*

LIII. *Messrs.* COLLARD *and* FRASER'S *Process for preparing the Weld Yellow* *.

THERE is not to be found, either in the vegetable or mineral kingdoms, any other substance which yields so elegant a yellow colour as the *weld*, or, as it is written by some, *would*, or dyer's weed. The weld is of the *resedian* tribe, and is cultivated with care in Kent, Herefordshire, and many other parts of the kingdom. The principal consumers are dyers, calico-printers, and colour-makers. The plants are dried by the growers, tied up in parcels weighing from 30 to 50 pounds each, and are sold, to use the language of the trade, at so much a bundle.

This is a very injudicious practice; for it is the small seeds of the plant only which afford the colouring matter, a great portion of which are shaken out in the package, and even in moving the bundles from one place to another. Besides, the plant altogether occupies so much room, that the carriage of the useless stalks for a hundred miles, by land, amounts to more than five per cent. upon the article; whereas the seeds in a quantity occupying a space of six feet square would by no means fill a half peck measure.

The weld yellow is a water-colour, principally used by paper-hanging manufacturers for elegant work. An oil colour has never been prepared from the weld. A preparation of weld yellow in oil would be a valuable acquisition; for the patent oil colour, made from a very old *recipe*, by fusing the oxide of lead with the muriate of ammonia in the proportion of about one pound of the former to three ounces of the latter, appears as vile as brick dust when compared to the weld yellow.

The weld yellow made in London is sold in hard lumps, and must be ground before it is fit for use. Now it is well known that every colour suffers, in some degree, by that operation. By the following process the most beautiful weld yellow may be prepared, which will fall into a fine powder, and will want no grinding.

Take of pure carbonate of lime (fine washed whiting) any given quantity, *e. g.* let it be four pounds; put it into a copper boiler, and add to it four pounds of soft water: put a fire under the copper and raise it to a boiling heat, and keep stirring with a deal stick till the whiting be completely divided, and forms with the water a consistence quite smooth. Then

* Communicated by Messrs. Collard and Fraser.

add

add for each pound of whiting three ounces of alum previously pulverized tolerably fine. The alum must be added gradually, and the operator should keep stirring with his deal stick during the administration; for a double decomposition is effected, accompanied with effervescence, and carbonic acid is discharged. Thus, if the alum were not administered gradually, the boiler would overflow with the violence of the effervescence; and, if the whiting were not well divided previous to the introduction of the alum, the distribution amongst the whiting would be unequal, and the colour would be injured. When the alum is all introduced, and the effervescence has ceased, the basis is properly prepared. The fire may be then drawn, and it may remain for any length of time without injury, till the other materials are ready. Having thus prepared the basis, take the welds, place them, with their roots uppermost, in another copper boiler, pour in soft water enough to cover every part containing seed, and let them boil not more than fifteen minutes: then take them out, place them, with their roots uppermost, in a tub to catch the liquor which runs from them, and pass the liquor in the copper, with what runs from the welds in the tub, through a flannel filter, to intercept the seeds and fæcula; and thus the colouring matter is prepared.

It is impossible to say what quantity of welds should be employed to any given quantity of whiting, for some bundles will contain three times as much seed as others. It is well, however, to know, that if too much colouring matter be prepared, it may be kept in an earthen or deal vessel for many weeks, without sustaining any injury.

Having filtered a sufficient quantity of the weld liquor, put a fire under the boiler containing the basis, and add the weld liquor till the colour be obtained. When sufficient colouring matter is added to the basis, the fire should be raised to a boiling heat, and the work is finished. In order to be satisfied when the greatest strength of colour is obtained, for there is a *ne plus ultra*, take a little out on chalk, which will absorb the moisture instantly; when it may be laid on paper with a brush, and viewed perfectly dry in a few minutes.

The contents of the furnace should be then put into a deal or earthen vessel to precipitate. The next day the liquor may be poured off, and the colour may be placed on large pieces of chalk, which in a few hours will absorb the moisture, and it will then be fit for use or sale.

The liquor poured off from the colour may, with the addition of water, be used again, and the old welds may be boiled a second time, and taken out previous to the addition of fresh welds, so that no colouring matter will be lost.

In the preceding proceſs, the greateſt care ſhould be taken that no iron be ſuffered to come in contact with the colour; for the gallic acid or aſtringent principle, which eminently abounds in this vegetable, will inſtantly diſſolve iron, and the ſmalleſt particle of that metal is fatal to the delicacy of the weld yellow.

LIV. *Experiments and Obſervations on certain Stony and Metalline Subſtances which at different Times are ſaid to have fallen on the Earth; alſo on various Kinds of Native Iron.* By EDWARD HOWARD, *Eſq. F.R.S.*

[Continued from p. 224.]

Examination of the Stone from Sienna.

THE external coating of this ſtone appeared to have the ſame characters as that of the ſtone from Benares.

The pyrites, although certainly preſent, were not cryſtallized in ſuch groups as in the preceding ſtone; nor could they be ſeparated by mechanical means.

The attractable metal was eaſily ſeparated by the magnet; but 8½ grains only were collected. I treated them with nitric acid and ammonia, as in the preceding caſe. Nearly one grain of earthy matter was inſoluble; the weight was therefore reduced to rather leſs than eight grains. The oxide of iron, precipitated by ammonia, weighed eight grains; and the ſaline liquor gave abundant indications of nickel. As eight grains of this oxide of iron contain nearly ſix of metal, the quantity of nickel in the bare eight grains may be eſtimated between one and two grains. Some globular bodies were extracted, but too few to analyſe.

Since the pyrites could not be ſeparated, I collected 150 grains of the ſtone, freed from iron by the magnet, and as exempt as poſſible from globular bodies. Theſe 150 grains I firſt digeſted with muriatic acid, that the pyrites might be decompoſed, and every thing taken up which could be diſſolved by that menſtruum. A very decided diſengagement of ſulphureted hydrogen gas was occaſioned. When the acid could produce no further action, I collected the undiſſolved matter on a filter, and boiled it with the moſt concentrate nitric acid, in hopes of being able to convert the ſulphur, previouſly liberated, into ſulphuric acid: but my endeavours were fruitleſs; for, upon the addition of nitrate of barytes to the nitric ſolution, rendered previouſly tranſparent, a very inſignificant

insignificant quantity of sulphate of barytes was obtained. The surplus of barytic nitrate was removed by sulphate of potash. I next completely edulcorated the mass which remained insoluble after the action of the muriatic and nitric acids; and, adding the water of edulcoration to the muriatic and nitric liquors, evaporated the whole for silica. I then submitted the mass, undissolved by the acids and the water, to the treatment with potash, muriatic acid, and evaporation, which was, in the first instance, applied to the stone from Benares. The first precipitation was, as in that analysis, also effected with carbonate of potash; but, instead of endeavouring immediately to extract alumina, I ignited the precipitate, that the alumina or silica remaining might be rendered insoluble. After the ignition, I separated the oxide of iron with very concentrate muriatic acid; and the earths, which were left perfectly white, I heated with potash, until they were again capable of being taken up by the same acid. The solution so made was slowly evaporated; and, as very nearly every thing was deposited during the evaporation, I conclude all was silica. The proportions resulting from this single analysis, without the weight of sulphur contained in the pyrites irregularly disseminated through the whole, were,

Silica - - - - - -	70
Magnesia - - - - -	34
Oxide of iron - - - - -	52
Oxide of nickel - - - -	3
	159

Examination of the Stone from Yorkshire.

The mechanical separation of the substances in this stone being as difficult as in the preceding case, I was necessarily satisfied with submitting it to the same treatment. I collected, however, 34 grains of malleable particles; which, by the process already more than once mentioned, left four grains of earthy matter; and, by yielding $37\frac{1}{2}$ of oxide of iron, indicated about four grains of nickel.

150 grains of the earthy part of the stone were, by analysis, resolved into,

Silica - - - - - -	75
Magnesia - - - - -	37
Oxide of iron - - - - -	48
Oxide of nickel - - - -	2
	162

Examination

Examination of the Stone from Bohemia.

The probability of never being able to obtain another specimen of the very remarkable fragment of this substance, did not allow me to trespass more on the liberality of Mr. Greville, than to detach a small portion. I found it of similar composition to that of the three preceding stones; and the count de Bournon has already shown the proportionate quantity of the attractable metal to be very considerable. $16\frac{1}{2}$ grains left $2\frac{1}{2}$ of extraneous earthy matter; and yielded, by the treatment with nitric acid and ammonia, $17\frac{1}{2}$ grains of oxide of iron. This would seem to induce an estimation of $1\frac{1}{2}$ of nickel in 14 grains, or about nine per cent.

55 grains of the earthy part of the stone, by the analytical treatment of the two former, afforded,

Silica - - - - - -	25
Magnesia - - - - -	$9\frac{1}{2}$
Oxide of iron - - -	$23\frac{1}{2}$
Oxide of nickel - - -	$1\frac{1}{2}$
	$59\frac{1}{2}$

The unusual increase of weight in the result of the three last analyses, notwithstanding the entire loss of the sulphur in the pyrites, is obviously owing to the metallic state of the iron combined with the sulphur, as was shown in a former instance.

I have now concluded the chemical examination of these four extraordinary substances. It unfortunately differs from the analysis made by the French academicians, of the stone presented to them by the abbé Bachelay, as well as from that made by professor Barthold of the stone of Ensisheim. It is at variance with that of the academicians, inasmuch as they found neither magnesia nor nickel. It differs from that of Mr. Barthold, as he did not find nickel, but discovered some lime, with 17 per cent. of alumina. With regard to these differences, I have to submit to the chemical world, whether magnesia might not have eluded the action of an acid, when the aggregation of the integrant parts of the stone was not destroyed by treatment with potash. As to the existence of alumina, I do not absolutely deny it; yet I must observe, that the whole of the earth which seemed to have any resemblance, however small, to alumina, was at most 3 per cent., and there seems good reason to consider it as silica. Respecting the existence of lime in the stone of Ensisheim, I must appeal to professor Barthold, whether, supposing lime a constituent part, sulphate of lime should not have been formed, as well as sulphate of magnesia, when sulphuric acid was generated by igniting the earths and pyrites. And, as to the proportion of alumina in the same stone, I would ask, at least, whether it would have been so considerable if the solutions formed by acids, after the treatment with potash, had been evaporated to the requisite dryness: not to observe, that no mention is made of any examination of the properties of the earth called alumina. In the proportion of magnesia I have the satisfaction to find my analysis correspond very nearly with that of professor Barthold; and, if what he considered alumina were supposed silica, the stone presented to the French academy, the stone of Ensisheim, and the four I have examined, would agree very nearly in siliceous proportions. With respect to the nickel, I am confident it would have been found in all, had the metallic particles been separately examined. But, whatever be these variations, the mineralogical description of the French academicians, of Mr. Barthold, and of the count de Bournon, all exhibit a striking conformity of character, common to each of these stones; and I doubt not but the similarity of component parts, especially of the malleable alloy, together with the near approach of the constituent proportions of the earths contained in each of the four stones, the immediate subject of this paper, will establish very strong evidence in favour of the assertion, that they have fallen on our globe. They have been found at places very remote from each other, and at periods also sufficiently distant. The mineralogists who have examined them agree that they have no resemblance to mineral substances properly so called, nor have they been described by mineralogical authors. I would further urge the authenticity of accounts of fallen stones, and the similarity of circumstances attendant on such phænomena; but to the impartial it would be superfluous, and, to those who disbelieve whatever they cannot explain, it would be fruitless. Attempts to reconcile occurrences of this nature with known principles of philosophy, it is true, are already abundant; but (as the earl of Bristol has well expressed) they leave us a choice of difficulties equally perplexing. It is, however, remarkable that doctor Chladni, who seems to have indulged in these speculations with most success, should have connected the descent of fallen stones with meteors; and that, in the narrative of Mr. Williams, the descent of the stones near Benares should have been immediately accompanied with a meteor.

No luminous appearance having been perceived during the day on which the stone fell in Yorkshire, it must be admitted, rather militates against the idea that these stones are the

substances

ſubſtances which produce or convey the light of a meteor, or that a meteor muſt neceſſarily accompany them *. Yet the ſtones from Sienna fell amidſt what was imagined lightning, but what might in reality have been a meteor. Stones were alſo found after the meteor ſeen in Gaſcony, in July 1790. And Mr. Falconet, in the memoir I have already quoted, relates, that the ſtone which was adored as the mother of the gods, was a *bœtilia*; and that it fell at the feet of the poet Pindar, enveloped in a ball of fire. He alſo obſerves, that all the *bœtilia* had the ſame origin.

I ought not, perhaps, to ſuppreſs, that in endeavouring to form an artificial black coating on the interior ſurface of one of the ſtones from Benares, by ſending over it the electrical charge of about 37 ſquare feet of glaſs, it was obſerved to become luminous, in the dark, for nearly a quarter of an hour; and that the track of the electrical fluid was rendered black. I by no means wiſh to lay any ſtreſs upon this circumſtance; for I am well aware that many ſubſtances become luminous by electricity.

But, ſhould it ever be diſcovered that fallen ſtones are actually the bodies of meteors, it would not appear ſo problematical, that ſuch maſſes as theſe ſtones are ſometimes repreſented, do not penetrate further into the earth: for meteors move more in a horizontal than in a perpendicular direction; and we are as abſolutely unacquainted with the force which impels the meteor, as with the origin of the fallen ſtone.

Before I cloſe this ſubject, I may be particularly expected to notice the meteor which, a few months ago, traverſed the county of Suffolk. It was ſaid that part of it fell near Saint Edmundſbury, and even that it ſet fire to a cottage in that vicinity. It appeared, from inquiries made on the ſpot, that ſomething, ſeemingly from the meteor, was, with a degree of reaſon, believed to have fallen in the adjacent meadows; but the time of the combuſtion of the houſe did not correſpond with the moment of the meteor's tranſition. A phænomenon much more worthy of attention has ſince been deſcribed in the Philoſophical Magazine. On the night of the 5th of April 1800, a body wholly luminous was ſeen, in America, to move with prodigious velocity. Its apparent ſize was that of a large houſe, 70 feet long; and its elevation above the ſurface of the earth about 200 yards. The light produced effects little ſhort of ſun-beams; and a conſiderable degree of heat was felt by thoſe who ſaw it, but no electric ſenſation. Immediately after it diſappeared in the north-

* In the account of the ſtone which fell in Portugal, no mention is made either of a meteor or lightning.

west,

west, a violent rushing noise was heard, as if the phænomenon were bearing down the forest before it; and, in a few seconds after, there was a tremendous crash, causing a very sensible earthquake. Search being afterwards made in the place where the burning body fell, every vegetable was found burnt, or greatly scorched, and a considerable portion of the surface of the earth broken up. We have to lament that the authors of this account did not search deeper than the surface of the ground. Such an immense body, though moving in a horizontal direction, could not but be buried to a considerable depth. Should it have been more than the semblance of a body of a peculiar nature, the lapse of ages may perhaps effect what has now been neglected; and its magnitude and solitary situation become the astonishment of future philosophers.

This leads me to speak of the solitary mass of what has been called native iron, which was discovered in South America, and has been described by Don Rubin de Celis. Its weight was about 15 tons. The same author mentions another insulated mass of the same nature. The whole account is exceedingly interesting; but, being already published in the Philosophical Transactions for the year 1788, it needs not be here repeated.

Mr. Proust has shown the mass particularly described, not to be wholly iron, but a mixture of nickel and iron. The trustees of the British Museum, who are in possession of some fragments of this mass, sent to the Royal Society by Don Rubin de Celis, have done me the honour to permit me to examine them; and I have great satisfaction in agreeing with a chemist so justly celebrated as Mr. Proust.

[To be continued.]

LV. *A Dissertation on the Reflection and Refraction of Light from Vapours, Fogs, Mists, &c.; with an Account of some curious Phænomena proceeding from those Causes, seen in Ireland in the Years* 1796, 1797, *and* 1801. *By* WILLIAM BEAUFORD, *A.M.*

To Mr. Tilloch.

SIR, Dublin, Aug. 8, 1802.

IF the following philosophic investigation of some curious phænomena be adapted to your excellent publication, the Philosophical Magazine, it is at your service.

Of all the phænomena exhibited by nature in her various operations, there are none more curious and extraordinary than

than thoſe repreſented by the reflection and refraction of light from fogs and vapours ariſing from the ſea, lakes, and moraſſes, replete with marine and vegetable ſalts. For ſuch vapours, by means of the ſaid ſalts, form various poliſhed ſurfaces, which reflect and refract the light of the ſun, and even the moon, in various directions; thereby not only diſtorting but multiplying the images of objects repreſented to them in a moſt ſurpriſing manner; forming not only images of caſtles, palaces, and other buildings, in various ſtyles of architecture, but the moſt beautiful landſcapes, ſpacious woods, groves, orchards, meadows, with companies of men and women, with herds of cattle, walking, ſtanding, lying, &c., and all painted with ſuch an admirable mixture of light and ſhade that it is impoſſible to form an adequate conception of the picture without ſeeing: not any ſcenery repreſented by the *camera obſcura* can be more beautiful, or more like faithful repreſentations of nature.

Though theſe curious and elegant phænomena are not peculiar to any age or country, they are more frequently ſeen on the ſea-coaſts; and though in ſome reſpects common in ſuch ſituations, they have hitherto been ſo little noticed by the intelligent part of mankind as to be ſcarce known to exiſt. The only ones which ſeem at preſent to have attracted the attention of the curious, are thoſe frequently, during the ſummer ſeaſon, ſeen on the ſouthern coaſts of Italy, near the antient city of Rhegium; and even to this attention they were directed by the fiſhermen and country peaſants, who in their native tongue call them *fata morgana*, or *dama fata morgana* *. They are, however, frequently noticed by the Engliſh, Erſe, and Iriſh peaſants, fiſhermen, and mariners; and denominated in the languages of the two latter *feadhreagh mairethmhe*, or ſea fairies, and *duna feadhreagh*, fairy caſtles. The Erſe fiſhermen among the weſtern iſles of Scotland frequently ſee repreſented on barren heaths and naked rocks beautiful fields, woods, and caſtles, with numerous flocks and herds grazing, and multitudes of people of both ſexes in various attitudes and occupations. Theſe, as they know no ſuch objects really exiſt, they conſtantly attribute to inchantment, or the fairies. They are alſo frequently ſeen on the coaſts of Norway, Ireland, and Greenland †. On the eaſtern and weſtern coaſts of South America, even on the higheſt ſummit of the Andes, the *fata morgana* is met with. Alſo far out at ſea, in the midſt of the Atlantic and Pacific oceans, the adventurous mariner ſometimes obſerves them;

* Swinburne's Travels. † Crantz's Hiſtory of Greenland.

and though well known under the name of *fog banks*, yet has their appearance been so imposing as to illude the nicest scrutiny, and to promise refreshments to the fatigued and sea-worn mariner which he could not obtain. The most antient account of these aërial castles and islands which has been transmitted to us, is the representation of a beautiful island situated nearly in the middle of the Atlantic ocean, between the coasts of Ireland and Newfoundland, first observed by some Danish and Irish fishermen about the year 900, and from that period to the commencement of the 14th century frequently by the Anglo-Saxon, English, and French fishermen and mariners *.

But, as this island could never be approached, it was called the *inchanted island*, and supposed by the maritime inhabitants of Scotland, Ireland, France, and Spain, to be the country of departed spirits, and consequently denominated in Erse *Flath Innis*, or the Noble Island; in Irish *Hy Brasil*, or the Country of Spirits; by the Anglo-Saxons, *Icockane*, or the Country in the Waves; and by the French and Spaniards, who supposed it to consist of two distinct islands, *Brasil* and *Assmanda*, or the Islands of Ghosts. And so much persuaded were geographers of the 16th and 17th centuries of their real existence, that they have place in all or most of the maps of the Atlantic in those periods; and even in the last century De l'Isle, the French geographer, in his maps has placed them as follows: Brasil, lat. 51° north, long. 1° east of Ferror; and Assmunda, lat. 46° 30′ north, long. 356° east of Ferror. Even so late as about the year 1750 an English ship, returning from Newfoundland, near lat. 50° north discovered an island not heretofore known, which not only appeared fertile, but covered with verdant fields and shady woods, among which cattle were seen to graze; and only the appearance of a violent surge hindered the captain and crew from landing, according to their desire †. So well convinced, however, were they of its real existence, that, on arriving at London, ships were ordered out to complete the discovery: but no island could be found, nor has any land been discovered in that track from that time to the present. Commodore Byron, in his Voyage round the World, mentions a fog bank in a high southern latitude, which appeared like an island, with capes and mountains, deceiving the most experienced seamen on board for some time.

From these evidences of the frequent appearance of the *fata morgana*, I shall proceed to describe some seen near the

* Iceland. Ann. Ortelius in Thesauro Geo. Antient Sax. Poem.

† Swinburne's Travels.

the town of Youghal, in the county of Cork, Ireland, in the years 1796, 1797, and 1801, according to the annexed views (see Plate VIII.) drawn on the spot by a young lady, one among numbers of the spectators. The first was seen on the 21st of October 1796, about four o'clock in the afternoon, the sun clear: it appeared on a hill, on the county of Waterford side of the river, and seemed a walled town with a round tower, and a church with a spire; the houses perfect, and the windows distinct. Behind the houses appeared the mast of a ship, and in the front a single tree, near which was a cow grazing; whilst the Waterford hills appeared distinctly behind. In the space of about half an hour the spire and round tower became covered with domes, and the octagonal building, or rather round tower, became a broken turret. Soon after this change, all the houses became ruins, and their fragments seemed scattered in the field near the walls: the whole in about an hour disappeared, and the hill on which it stood sunk to the level of the real field. The hill and trees appeared of a bright green, the houses and towers of a clear brown, with their roofs blue.

On the 9th of March 1797, another similar phænomenon was observed by the same person, in company with several others, about eight o'clock in the morning, on the sea, south-east of the town of Youghal. It had the appearance of a walled town situated on a hill. On one side were houses in ruins, and the ruins of a castle which seemed to fall into the sea. In the middle were two towers broken, on one of which was a flag flying, with houses in ruins between them and the castle. On the south were walls and a round tower with windows, which appeared broken in the middle. The hill on which the whole scene was placed was green and brown, and the buildings purple and brown, clear and brilliant, much resembling a transparent painting. The wall which surrounded the town was of a darker brown, with great holes as if made by cannon shot. The sea was calm and serene, and the whole together formed a charming view; but it is not known how long the scene continued, as the party was obliged to leave the strand before it vanished. What increased the beauty of the scene was the fineness of the morning, and the ships which appeared to pass behind it.

In June 1801, about five o'clock on a fine morning, all the coast opposite the river of Youghal, on the Waterford side, was covered with a dense vapour: that on the right next the sea had the representation of an alpine country; the distant scarpy mountains seemed covered with snow, whilst the foreground, of a brown colour, resembled woods and a cultivated

 country.

country. Soon the ſnow was ſeen to roll down the ſides of the mountains into the valleys beneath, and left the gray rocks of the mountains naked and ſharp. As the ſun increaſed in power, the vapour vaniſhed. On the left, the river and adjacent country were alſo covered with a vapour, but of quite different appearance from the former. The country ſeemed laid out in lawns and improvements, in which were ſituated three gentlemen's ſeats; the houſes well defined, the windows and doors diſtinct; ſome of the windows appeared open, and braſs knockers were ſeen on the doors. From the houſes were beautiful ſhrubberies bordered with white Chineſe paling; behind the ſhrubberies were foreſts of pines; and diſtant mountains, in fine perſpective, cloſed the ſcene. Before the houſes in the lawns were clumps of fine foreſt trees. In about half an hour two of the houſes vaniſhed, and the clumps in front diſappeared, and in their place a fine oak ſprang up, which was the laſt that quitted the ſcene. The ſun becoming powerful, the vapour was rarefied, and the entire magic diſappeared.

The two former of the exhibitions of the *fata morgana* were evidently cauſed by the reflection of ſome of the buildings and other parts of the town of Youghal in a denſe vapour or fog ſtrongly illuminated by the ſun. But in order to have an adequate idea of the nature of the phænomenon, let AG (fig. 1.) be a fog bank or denſe vapour, whoſe ſurface next the ſun is uneven, and formed of a variety of planes capable of reflecting light, as AB, BC, CD, DE, EF, and FG. Let O be a houſe and tree. Now, by the laws of optics, if a ſpectator be ſo ſituated, as at I, that the reflective rays proceeding from the incident ones OG, OF, &c. meet the eye of the ſpectator at I, the image of the houſe and tree at O will be multiplied into the town *vr*, in which, if the ſurface DE is cylindrical and ſomewhat irregular at the top, the image of the houſe will be transformed into a tower, and the roof into a ſpire, with the chimney a flag. Alſo, if any of the other planes be imperfect, the images reflected therefrom will be imperfect, and the houſes appear in ruins. If the ſpectator moves from I to L, and during that time the air ſhould change any of the ſurfaces, the repreſentation will be ſomewhat changed; the image of O, from the plane DE, will become a tower with a dome, and the whole will appear as at *xy*. As the wind changes the form of the fog, or the poſition of the ſun or clouds alters the lights, the entire repreſentation will diſappear, or ſuffer conſiderable changes: on which account none of thoſe aërial exhibitions continue any length of time, and always in calm weather and a clear

 ſky,

ſky, if the picture is brilliant; for, though thoſe fog banks often appear in dark or cloudy weather, the reflection is imperfect, and repreſents only confuſed images of rocks, mountains, and capes. Though diſtant objects are reflected, thoſe immediately under or behind will be refracted. Thus in fig. 2. if a vapour reſts upon an horizontal plane AB, the point B will be refracted to *a*, when the plane will repreſent a hill to a ſpectator at I. The ſcenery may alſo be repreſented by refraction only; for, if the fog or vapour ſhould contain two ſmooth ſurfaces oppoſite to each other, in the manner of a double concave lens, objects will be ſeen refracted, though much diminiſhed in apparent magnitude; and if one or both of the concave ſurfaces ſhould be compoſed of different inclined planes, a ſingle object will be variouſly multiplied and transformed. Thus let AB (fig. 3.) repreſent a vapour, whoſe ſurfaces are concave and tranſparent, but of different faces, as CD, DE, and EF, the object M will be ſeen by a ſpectator at G ſmall and at a great diſtance beyond M, and multiplied as at PQ. And this caſe was exhibited from a bog vapour in the county of Kildare in the year 1787. About eleven o'clock in the morning, the ſun ſhining clear, a hill appeared, about a mile diſtant, covered with trees and houſes, where it was known there was only a plain field; the phænomenon being cauſed by a houſe and garden refracted through a denſe and facetwiſe concave vapour ariſing from the bog.

Theſe phænomena are alſo frequently cauſed by the light refracted through the cryſtalline parts of the vapour, without any of the adjacent objects being either refracted or reflected. For the vapour, being formed into different parts, the light refracted through them cauſes the confuſed appearance of ruins, houſes, woods, lawns, &c. in the ſame manner as a board covered in an irregular manner with black and white ſpots mixed with lines, will at a certain diſtance reſemble a landſcape with woods, ruins, houſes, trees, caſtles, &c., and under ſuch impoſing forms as to appear real repreſentations. Of this ſpecies of the *fata morgana* ſeem to be thoſe ſeen at Youghal in 1801 before ſpoken of: but in whatever manner the repreſentations from vapours and fogs are formed, the weather muſt be calm and ſerene, otherwiſe the vapours will be broken and diſperſed by the wind.

LVI. *An Essay on the Colours obtained from the metallic Oxides, and fixed by Fusion on different vitreous Bodies. By* ALEXANDER BROGNIART, *Director of the National Manufactory of Porcelain at Sevres, Engineer of Mines, &c.**

THE art of employing metallic oxides for colouring by fusion different vitreous matters, is of very great antiquity: every body knows that the antients manufactured coloured glass and enamel, and that this art was practised in particular by the Egyptians, the first people who in this manner imitated precious stones.

The practice of this art in modern times has been carried to a high degree of perfection: but the theory has been neglected; it is almost the only one of the chemical arts in which no attempt has yet been made to apply the new principles of that science.

The very numerous works which treat on the method of preparing and applying vitrifiable metallic colours, either contain no theory, and consequently no general principles, or give only explanations founded on hypotheses, often ridiculous, which formerly composed the theory of chemistry.

One of the best, because it is the work of an enlightened artist, is the *Traité de la Peintre en Email de Montamy*. The archives of the national manufacture of Sevres contain also simple and excellent processes for the fabrication of colours. The authors of them are Messrs. Bailly, Fontelliau, and Montigny; but they are mere descriptions, without any observation which can conduct to general principles.

The other works, such as that of Kunckel, and the manuscripts of Hellot in the possession of the manufactory of Sevres, and the two *Encyclopædias*, present only an undigested assemblage, a compilation without choice and without reasoning, of a multitude of processes collected from all quarters. When some knowledge of the art has been obtained, it is easier to invent a process than to discover among that variety of recipes the one which ought to be preferred.

It has been remarked, that one of the most certain signs of the progress made by a science towards perfection is the possibility it leaves of collecting the facts that compose it into one system, from which general principles might be deduced: it is at this epoch alone that it deserves the name of science; and it is to an exposition of its principles thus generalized that

* From the *Journal des Mines*, No. 67.

that the appellation, more impoſing than correct, of philoſophy of ſcience has been given.

The arts, which are often rather a branch of a ſcience than the mere application of one of its parts, preſent facts equally ſuſceptible of being united in a ſyſtematic form: to carry them ſoon to perfection, it is ſufficient that they are practiſed by men habituated to diſtinguiſh relations, and to deduce conſequences from them.

The learned, who by more elevated ſpeculations are removed from the practice of the arts, perceive the principles of them more readily: they can apply their reſearches in a more direct manner to the advancement of them; and their progreſs, guided by reaſoning, will be more certain, more direct, and more rapid.

I obſerved that the art of preparing and uſing vitrifiable colours was ſuſceptible of the improvement I have pointed out, and that the facts of which it is compoſed begin to be ſufficiently numerous and correct to be exhibited in a general manner. I have thought that an accurate knowledge of theſe facts, and an expoſition of the principles by which they are connected, and which muſt naturally lead to an explanation of a great many of them, might be intereſting to chemiſts, who, employed in more general and more important reſearches, cannot be acquainted with all the details of an art which is exceedingly complex.

I was deſirous alſo to give chemiſts an exact knowledge of the principles of this art, in order that they may be enabled to determine with more certainty what novelty there may really be in the proceſſes ſubmitted to their opinion.

In a word, I have thought it might be of utility to the arts, and that it was the duty of the national manufactory of Sevres to make known the pretended ſecret of the compoſition of thoſe porcelain colours which are unalterable in the fire. It is well known that theſe colours were preſented to he Inſtitute, in the year 6, by a porcelain manufacturer juſtly eſteemed for the beauty of the works which come from his manufactory. I ſhould not have ventured to publiſh this ſecret had it been intruſted to me; but when it is known, I hope I ſhall not be ſuſpected of having in the leaſt abuſed the confidence repoſed in me.

From what has been ſaid it may be readily ſeen that my object is not to give a detailed account of the exact compoſition of all the vitrifiable colours; ſuch a labour cannot be the ſubject of a ſingle memoir.

It is well known that all vitrifiable colours have for their

baſis

basis metallic oxides; but all the metallic oxides are not proper for this purpose: besides, as they are not vitrifiable by themselves, they can scarcely ever be employed alone.

Highly volatile oxides, and those which adhere little to the great quantity of oxygen they contain, either cannot be employed in any manner, as the oxide of mercury and that of arsenic, or are employed only as agents. The colour they present cannot be depended on, since they must lose it in the slightest heat by losing a part of their oxygen: such are the puce-coloured and red oxides of lead, the yellow oxide of gold, &c.

Oxides in which the proportions of oxygen are susceptible of varying with too much facility are rarely employed: the oxide of iron, though black, is never employed for that colour; and the green oxide of copper is, under many circumstances, very uncertain.

I have said that oxides alone are not susceptible of fusion: however, as they are destined to be applied in thin strata on vitrifiable substances, they may be attached to them by a violent heat. But, except the oxides of lead and bismuth, they would give only dull colours. The violent heat, often necessary to fix them, would change or totally destroy the colours. A flux then is added to all metallic oxides.

This flux is glass, lead, and silex; glass of borax, or a mixture of both.

Its general effect is, to give splendour to the colours after their fusion; to fix them on the article which is painted, by promoting more or less the softening of its surface; to envelop the metallic oxides, and to preserve their colour by sheltering them from the contact of the air: in a word, to facilitate the fusion of the colour at a low temperature not capable of destroying it.

The observation which proves the latter use of fluxes is taken from the delicate colours, such as carmine obtained from gold: these colours require much more flux than others. Metallic oxides are employed sometimes directly, and merely mixed with their flux, without being previously fused with it: these colours are those which a strong heat, or heat too often repeated, would alter. It may be readily conceived that a stronger and longer continued heat is necessary to fuse a crucible full of coloured glass, than a stratum of colour not the tenth part of a millimetre in thickness.

I shall return to this subject when I come to speak of the reds obtained from gold.

In many circumstances, oxides are fused previously with their

their flux, and afterwards ground. In ſpeaking of colours in particular, I ſhall point out thoſe which experience this kind of fuſion.

Theſe general principles are ſo ſimple that it is not neceſſary to enlarge on them further.

I ſhall ſpeak here only of the application of metallic colours to vitreous bodies or to vitreous ſurfaces.

Theſe bodies may be divided into three claſſes, very diſtinct by the nature of the ſubſtances which compoſe them, the effects produced on them by the colours, and the changes they experience. Theſe claſſes are:

1ſt, Enamel, ſoft porcelain, and all cruſts, enamels, or glaſs, that contain lead in a notable quantity.

2d, Hard porcelain, or porcelain which has a cruſt of feld-ſpar.

3d, Glaſs in the compoſition of which no lead enters, ſuch as common window-glaſs.

I ſhall here examine in ſucceſſion the principles of the compoſition of theſe colours, and the general phænomena they exhibit on theſe three kinds of bodies.

Colours for painting in enamel are thoſe moſt antiently known: the recipes found in the works I have already mentioned, all relate to theſe colours.

It is well known that enamel is glaſs rendered opake by the oxide of tin, and exceedingly fuſible by the oxide of lead. It is the oxide of lead, in particular, contained in it that gives it properties very different from thoſe of the other excipients of metallic colours. Thus all glaſs and glazing that contain lead will participate in the properties of enamel; and what we ſhall ſay of one may be applied to the reſt with very trifling differences.

Such are the white and tranſparent glazing of ſtone ware, and the glazing of porcelain called *ſoft glazing*.

This porcelain, which was the firſt made in France, and particularly at Sevres, where it was a long time manufactured almoſt excluſively, has for its baſe a vitreous fritt rendered almoſt opake, and ſuſceptible of being worked with clay, and is glazed with an exceedingly diaphanous glaſs, into the compoſition of which there enters a great deal of lead.

The colours employed in it are thoſe which ſerve for painting in enamel: conſequently whatever changes theſe colours experience on enamel they muſt experience on this kind of porcelain, ſince the cauſes of this change, which we ſhall mention hereafter, are the ſame.

Enamel or ſoft porcelain colours require leſs flux than others,

others, because the glass on which they are applied becomes sufficiently soft to be penetrated by them.

This flux may be either glass of lead and pure silex, called *rocaille*, or the same glass mixed with borax.

Montamy asserts that glass of lead ought to be banished from among the enamel fluxes; and he employs only borax. He then dilutes his colours in a volatile oil.

On the other hand, the painters of the manufactory of Sevres employ only colours without borax, because they dilute them in gum; and borax does not dilute well in that substance. I have found that both methods are equally good; and it is certain that Montamy was wrong to exclude fluxes of lead, since they are daily employed without any inconvenience, and as they even render the application of colours easier.

I have said that in the baking of these colours, the crust, softened by the fire, suffers itself to be easily penetrated by them. This is the first cause of the change which they experience. By mixing with the crust they become weaker, and the first heat changes a figure which appeared to be finished into a very light sketch.

The oxide of lead which the crust contains is a second but much more powerful cause of the considerable changes which colours experience. The destructive action which that metal exercises chiefly on iron reds is singularly remarkable. I shall soon give an account of some experiments which prove it in a very evident manner.

It has been already seen, that the two principal causes of the changes which colours on enamel and soft porcelain are susceptible of experiencing do not depend in any manner on the composition of these colours, but on the nature of the glass to which they are applied. When it is said that the colours of porcelain change in a considerable degree, it ought to be added that it is those of soft porcelain; a kind almost neglected.

It follows from what has been said, that painting on soft porcelain has need of being several times retouched, and of several heats, in order that it may be carried to the necessary degree of strength. These paintings have always a certain faintness; but they are constantly more brilliant, and they never are attended with the inconvenience of detaching themselves in scales.

Hard porcelain, according to the division which I have established, is the second sort of excipient of metallic colours. This porcelain, as is well known, has for its base a very white clay called *kaolin*, mixed with a siliceous and calcareous flux, and

and for its covering feld-spar fused without an atom of lead.

This porcelain, which is that of Saxony, is much newer at Sevres than the soft porcelain. The colours applied to it are of two kinds: the first, destined to represent different objects, are baked in a heat very inferior to that necessary for baking porcelain. They are exceedingly numerous and varied.

The others, destined to be fused in the same heat as that which bakes porcelain, lay themselves flat, and are much less numerous.

The colours of painting are made nearly like those destined for soft porcelain; they only contain more flux. Their flux is composed of glass of lead called *rocaille*, and borax. I am not yet acquainted with any work which treats on the composition, use, and effects of these colours; so that it has no where been printed except in one, which might be dispensed with, that these colours scarcely undergo any change in the fire, while it has been often written and said, that the colours for painting in enamel change considerably.

When porcelain is exposed to heat in order to bake the colours, the covering of feld-spar dilates itself and opens its pores, but does not become soft: as the colours do not penetrate it, they experience none of those changes which they undergo on soft porcelain. It must, however, be said that they lose a little of their intensity by acquiring that transparency which is given to them by fusion.

When common articles are manufactured, the retouching may be omitted; but it is necessary to give to a painting all the effect that can be desired: in a word, this retouching does not distinguish painting on porcelain from any other kind of painting.

One of the greatest inconveniences of these colours, especially in the manufactory of Sevres, is the facility with which they scale off when exposed several times in the fire.

This inconvenience is observed more at Sevres than any where else, because it depends on the solidity and infusibility of the porcelain manufactured in that establishment. But these are qualities which make it much longer resist alternations of heat and cold, and which give to its paste a more striking whiteness. Paris porcelain, on the other hand, being more vitreous, more transparent, and bluer, often cracks when boiling liquors are put into it.

To remedy this defect without altering the quality of the paste, I was of opinion that the crust only ought to be softened by introducing into it more siliceous or calcareous flux, according to the nature of the feld-spar. This method has succeeded;

fucceeded; and for about a year paft the colours might be expofed two or three times to the fire without fcaling, if not overcharged with flux, and if not laid on too thick. It has been remarked that foda and potafh introduced into the colours make them fcale; they are therefore never ufed as fluxes. It is found that thefe alkalies, by becoming volatilized, abandon the colour, which when alone cannot form an adhefion with the cruft.

I have faid that colours are alfo prepared, which, being laid on flat, are deftined to be fufed in a furnace for baking porcelain. Thefe colours are not numerous, becaufe few metallic oxides can ftand fuch a heat without being volatilized and difcoloured. Their flux is fand or feld-fpar: as they incorporate with the cruft they are more brilliant, and never become fcaly.

The third fort of excipient of vitrifiable metallic colours is glafs without lead.

The application of thefe colours to glafs conftitutes painting on glafs; an art very much practifed fome centuries ago, and which was fuppofed to be loft becaufe out of fafhion; but it has too direct a dependence on painting in enamel and porcelain to be entirely loft. Befides, a defcription of it may be found in a very great number of works.

[To be continued.]

LVII. *On Painting.* *By Mr.* E. Dayes, *Painter.*

Essay IV.

On Grace.

> From vulgar bounds with brave diforder part,
> And fnatch a grace beyond the reach of art. Pope.

GRACEFULNESS, which may be termed the beauty of motion, is an idea not very different from beauty, and almoft infeparable from it. It is an idea belonging to pofture and motion, and will be found to confift in an eafe unaccompanied with reftraint or difficulty; as at all times the moft eafy will be the moft graceful: it is generally attended with a flight inflection of the body, unbroken, that is, not interrupted with fudden angles; and, in fitting figures, with an eafe approaching to languor.

Propriety of action is a thing of the higheft importance to the figure painter, whether he works in large or fmall.

Expreffion does not merely apply to the face, as many fuppofe, pose, but to the general action and character of each figure, that it be appropriate to the person described; as the state and carriage of public officers, heroes, &c., the clownish and simple attitudes of peasants; and on this being well performed depends the very soul of a good picture.

Much of the merit of Raphael arises from the superior degree of dignity observable in his apostles and other great characters: on the contrary, the excellence of Parmegiano results from the elegant turns he gave his female figures.

As the arts are no longer exotic, we shall find those graces rendered familiar in the works of Reynolds, Mortimer, &c.*

The whole power of man depends on two motions, flection and extension: those may be again subdivided into four; the simple, as in walking, eating, and drinking; the active, as in carrying, pulling, thrusting or pushing, and climbing; the violent, arising from fright, rage, despair, or any other sudden emotion: the fourth sort, which may be considered as a sort of passive action, results from disquiet of mind, as love, hatred, sorrow, joy, &c.: the effect of which is chiefly shown in the extremities, as the face, hands, and feet.

It will be generally found that violent passions of the mind are accompanied with actions more or less angular than the beautiful or passive: as in a man in the act of striking with a club or stick, the upper and fore-arm will form a right angle; again, in a figure frightened, the arms from being thrown up will form an angle with the body; in figures pushing or pulling, the effect will be the same: on the contrary, elegant or graceful figures shake off those violences, and fall into attitudes that show a gentle inflection of line.

We shall find, a standing figure to be graceful must rest on one leg, and the face incline to the hip it rests on, as in the Venus de Medicis, and others remarkable for taste and beauty.

As beauty loves variety, we shall generally observe, if the figure is presented in front, the head will appear rather inclined to the side. (See Plate VI.)

* If I have cautiously forborne to speak of the works of living artists, it is not from thinking light of them, but from a nobler motive. In the limits I have prescribed to myself I could not do justice to the merits of so many and able professors as at present adorn the nation. The prints from the works of British artists are circulated over the civilized part of the world, and copied as soon as they appear on the continent. Such being the fact, whatever the ignorant may assert to the contrary, those who wish to encourage historical painting in this country should aim at cherishing such a spirit as would eventually operate to induce buyers not to give more for works of foreign artists than they would for works of equal merit of the British school.

That beautiful undulating line of grace will alſo be found in the moſt agreeable ſitting figures.

Notwithſtanding what may have been ſaid about "ſmoothneſs, delicacy," &c., yet we ſhall find on inquiry much of the grace and beauty of the painter and ſculptor ariſes from what Hogarth has termed the "line of beauty," and which was not only practiſed but recommended by M. Angelo, as may be ſeen in the book on painting, by Jo. Paul Lomatius, tranſlated by Richard Haydocke in 1598: "ſo that his meaning is (M. Angelo), that it ſhould reſemble the form of the letter S placed right, or elſe turned the wrong way, as ∽; becauſe then it hath his beauty."

The graceful parts of the antique ſtatues poſſeſs that ſweeping line of grace: it may be ſeen too in the figures of Raphael, Parmegiano, &c.; and among the more modern artiſts, as Reynolds, Mortimer, Cipriani, &c.

Three things contribute to the beauty of the Venus de Medicis; its line of grace running unbroken through the whole figure, its form, and the variety and contraſt of the parts, as the head with the cheſt, and the arms and legs with each other.

Thoſe who ſuppoſe this character of line affects the general attitude only, are wrong; it will be found to conſtitute the general form of the muſcle, if taken detached, and viewed from its fleſhy belly to the tendinous part: this, with its interſecting angle, gives much of that variety of character obſervable in human nature. We ſometimes ſee in overcharged figures the convex lines raiſed ſo much beyond the limits of nature, that the power of re-entering them again is loſt, and the whole form appears heavy and incumbered. This fault ſometimes attaches to M. Angelo, but by no means in the extreme aſſerted by Mengs, who, ſpeaking of that artiſt, ſays, "who ſeeking to be always great, was always vulgar." Such language argues great want of either ſenſe or ſincerity: by the way, his favourite Raphael is not entirely free from the charge of heavineſs, in his women in particular.

The Hercules Farneſe of Glicon is a fine example of the well-ordered raiſing and interſecting of the muſcles in a figure poſſeſſing the appearance of great paſſive ſtrength: but few ſimilar examples will occur to the artiſt in the courſe of his practice.

That figure forms the extreme point one way, and the Apollo Belvidere (or Pytheus), the other, for beauty; beyond which it is impoſſible to travel without being abſurd: the mean between thoſe two is the fighting Gladiator (as it is called),

called), and which may be considered as the most natural, the others more pure. Those observations must be considered as applying to the general character of the figures, and not to the parts; the gladiator being in strong action, the appearance of the muscles is altered; those in action being short, and of course rounded more than those in repose.

Grace is of so delicate a nature that it cannot exist in the presence of whatever is rude, vulgar, or excessive: it charms, captivates, and overcomes, by its beneficence: its motions are easy, moderate, and lovely, and it partakes more of the humble than arrogant: it is seen in the Apollo accompanied with dignity, in the Venus of Medicis with modesty, and in the Antinoüs in a more human and less elevated degree.

Parmegiano possessed in a high degree the fascinating power of grace; Corregio felt it in a certain degree; and the females of Albano are distinguished by it. Reynolds's portraits abound with it, and it will be sought for with success in many of the noble monuments of British art.

Raphael understood the grace of motion; but his dry gothic manner of execution did not associate with it: he wanted that sweet mellow pencil necessary to beauty.

If painting were an imitation of nature merely, as many suppose, it would follow of course that it should be inferior to it, as the efficient must always be superior to the effect: but this subsists conditionally: as in the power of light, and its opposite darkness, nature has the advantage: but even light is subjugated to the powers of art, as in our paintings on glass, of which the east window of New College, Oxford, stands a most glorious example, and may be justly entitled the first work of the kind in the world*; but in the article of beauty, and the just power of combination, art has greatly the advantage.

Matter is imperfect, and all that is left us is the will to choose; and happy, thrice happy, is that artist who knows the value of what is good, and in the early pursuit of his studies learns to distinguish what is more or less great and amiable, thereby fixing his desires on things worthy.

By attentively considering the works of the great, from the Greeks to the present time, we shall find they fixed their attention on the most noble part of the art, and pursued the study of it with unremitting ardour: on the contrary, inferior beings became attached to mediocrity, and believed in it

* Many ignorantly suppose the art of painting on glass is lost: the fact is, if we are to judge from the specimens produced in the present age, it never was found till now.

centred

centred all art; while the little grovelling ſpirit became inchanted with whatever was minute and trifling, miſtaking them for principal things.

If the works of renowned artiſts are to be uſed to ſtimulate, we ſhall alſo derive advantage from thoſe who have ſunk from the great to the trifling and uſeleſs, nay, even to the ugly, and from it to the falſe and chimerical, by conſidering them as ſo many rocks and quickſands to ſteer clear of.

A well-ordered picture becomes a leſſon of polite education, by which our manners are amended: on the contrary, dirty ragged ruffians, accompanied with traſh and common-place ſtuff, are not only beneath the dignity of painting, but may corrupt young minds: nay, may not rudeneſs be juſtified by a reference to pictures exhibiting clowniſh and hoggiſh examples, or people the moſt baſe and corrupt of humanity?

It is a poor apology, becauſe a picture is well painted, that it ſhould be hung up in our apartment, when in the arrangement it may violate ſenſe, and in the choice decency; or the people ſuch as one would by no means ſuffer to approach our perſons: and yet nothing is more common. Such efforts may pleaſe the ignorant, but will not call the attention of learned men and philoſophers, with whom ſuch men can only rank as mechanics, and beings without diſcrimination.

What man of taſte ever ſaw a fine picture by Teniers without feeling the heart-ache that ſo much fine colour, *chiaroſcuro*, and execution, ſhould be beſtowed on worthleſs objects? Moſt of the Dutch pictures operate as a libel on their country, by the monſters of humanity introduced in them. In a note to the Life of Hogarth, by lord Orford, (*Vide* Anecdotes of Painters), is the following juſt remark on the Dutch artiſts:—"When they attempt humour, it is by making a drunkard vomit; they take evacuations for jokes; and, when they make us ſick, think they make us laugh. A boor hugging a frightful ſrow, is a frequent incident in the works of Teniers."

We might juſtly conclude that artiſt mad, or ſilly, who, *leaving in his purſuit the grand or beautiful of nature*, ſhould collect for his pictures objects *diſguſting* and *unſightly*: and yet this is frequently the caſe; which ariſes from want of early good inſtruction, and from being led aſtray by people writing on the arts, who are perfectly unqualified for ſo arduous a taſk.

Some have even attempted to ſeparate the pictureſque from the beautiful, as if that which did not poſſeſs beauty could be worthy of painting. By the word pictureſque the artiſt underſtands the irregular, but ever accompanied with a beautiful

tiful choice, and it ſtands in oppoſition to the ſimple or grand; it does not apply to objects "rough and irregular," or ſuch as are deformed, aged, and ugly.

We muſt give up our underſtanding if we call a landſcape fine which repreſents dirty rugged grounds, ſcrubby buſhes, poor ſcraggy and ill-formed trees, ſhapeleſs lumps of antiquity, and muddy pools; peopled with gipſies and vagabonds, dirty beggars clothed with rags, their heads decorated with filthy drapery, ſkins like tanned leather, and their employ diſguſting; and theſe accompanied with poor and old cattle, or naſty ſwine on filthy dunghills. And ſhall thoſe be the objects with which we are to decorate, or rather deform, our apartments? Such a choice argues a taſte as depraved, as if a man were to prefer the horrid ſqueaking of a cart-wheel, to the fineſt ſolo on an organ.

Such objects, if introduced in pictures, can only be ſparingly uſed, to ſet off and give value to beauty, as a foil, but ſhould never appear as principals.

If a man producing ſuch pictures is to be diſtinguiſhed by the noble appellation of a *genius*, we ſhould find ſome other term to beſtow on ſuch artiſts as Raphael, Corregio, Titian, Rubens, Reynolds, &c. &c. &c.; and in landſcape, Pouſſin, Wilſon, Claude, Barret, &c. One thing we are ſure of, that is, that there is no mention of ſuch renowned wrong-heads among the Greeks *.

It muſt not be underſtood that we reject the paſtoral as unworthy; on the contrary, it is highly intereſting, and, when accompanied with ſentiment and a judicious ſelection, (as in ſome of Gainſborough's fine compoſitions,) does honour to the arts. Equally intereſting, though in a leſs degree meritorious, ſtands the ſimple repreſenter of nature; he acquires a new character as a topographer, provided he attach fidelity to his repreſentations.

Under the article *invention* we ſhall again have occaſion to ſpeak of the pictureſque; we ſhall then reſume our ſubject.

Two parts of the body that contribute much to the grace of the figure are an eaſy turned head and neck (ſee Pl. VII.), and a graceful and elegant hand and arm. M. Angelo, Raphael, &c. afford many examples of men; and Parmegiano, Guido, Reynolds, Mortimer, &c. of women. To produce

* The rage for what is termed the *pictureſque*, we ſhould ſay the *deformed*, in the modern and miſunderſtood ſenſe of the word, is carried ſo far, that I ſhould not be ſurpriſed to hear that groups of filthy gipſies were paid to wander about gentlemen's grounds for what ſome might term their *pictureſque effect*. One advantage would reſult from it to their employers, that is, they might indulge their ſmell as well as taſte.

 this

this effect of grace, it is requisite that the head should not present the same view as the chest, and that the hand and arm should not come on a line, but that each should contrast the other by an opposing turn. For examples, see the drawings (Plate VI. and VII.)

Of the feet, our knowledge of beautiful form can only be acquired through the medium of the antique, or fine pictures, being now deformed by the use of shoes. Suffice it to observe, the three foremost toes ought to be the longest; the small ones close, and turning out; and the great one a little separated, more or less in proportion to the action of the foot.

Beauty appears to delight in the irregular or picturesque, while the grand will ever be accompanied with the regular and simple.

LVIII. *Notice respecting the Manners and Habits common to the Shark and Pilot-Fish.* *By* C. Geoffroy, *Professor in the Musæum of Natural History**.

It has been asserted that the sharks have subject to their empire a very small fish of the species of the *gadus*; that the latter precedes his master during his voyages, points out to him those places of the sea most abundant in fish, discovers to him the traces of the prey he is fondest of; and that, out of gratitude for such signal services, the shark, notwithstanding his voracity, lives in good intelligence with a companion so useful to him. Naturalists, always on their guard against the exaggerations of travellers, and not being able to conceive the motives of such an association, have doubted the truth of these facts. It will, however, be seen that they were wrong: the observations even which I have been able to make are accompanied with circumstances which perhaps never occurred with so many details to any one but myself.

In the month of May 1798 I was on board the Alceste frigate between cape Bon and the island of Malta. The sea was tranquil, and the passengers were much fatigued with the long duration of the calm, when their attention was attracted by a shark which they saw advancing towards the vessel. It was preceded by its pilots, which kept at a pretty regular distance from each other, and from the shark. The two pilots directed their course towards the poop of the vessel, inspected it twice from one end to the other, and, after having satisfied themselves that there was nothing which they could turn to

* From the *Bulletin des Sciences*.

their

their advantage, reſumed their former route. During the various movements which they made, the ſhark never loſt ſight of them, or rather followed them as exactly as if he had been dragged by them.

He had no ſooner been deſcried than one of the ſailors got ready a large hook, which he baited with lard; but the ſhark and his companions had already proceeded to the diſtance of 20 or 25 millimetres before the ſailor had made all his preparations: he, however, threw the piece of lard into the ſea at a venture. The noiſe occaſioned by its fall was heard at a conſiderable diſtance. The travellers were aſtoniſhed, and ſtopped. The two pilots then detached themſelves, and went to explore at the poop of the veſſel. The ſhark during their abſence ſported in a thouſand ways at the ſurface of the water; turned himſelf on his back, then on his belly, and dived to a greater depth, but always re-appeared at the ſame place. When the two pilots came to the poop of the Alceſte they paſſed cloſe to the lard, and no ſooner obſerved it than they returned to the ſhark with a greater velocity than they advanced to it. When they reached it, the latter continued his courſe. The pilots then ſwimming one on his right and the other on his left, made every effort to get before him. Scarcely had they done ſo when they ſuddenly returned, and then went back a ſecond time to the poop of the veſſel. They were followed by the ſhark, who was enabled by the ſagacity of his companions to perceive the prey deſtined for him. It has been ſaid that the ſhark is endowed with a very delicate ſenſe of ſmelling. I paid a great deal of attention to what took place on his approaching the lard. It appeared to me that he did not diſcover it till the moment it was pointed out to him by his guides; it was then only that he began to ſwim with greater velocity, or rather made a jump to ſeize it. He detached a portion of it without being hooked; but at the ſecond attempt the hook penetrated the left lip, by which means he was hoiſted on board.

It was not till the end of two hours, during which I was employed in anatomizing the ſhark, that I began to regret I had not obſerved more accurately the ſpecies which had devoted themſelves ſo readily to the ſervice of this voracious fiſh. I was aſſured that ſome of them might be eaſily procured, as it was certain they had not quitted the neighbourhood of the veſſel; and a few moments after I was preſented with an individual, which I found to belong to the pilot or *ſanfre des marins*, and the *gaſteroſteus ductor* of the naturaliſts.

It would be, no doubt, curious to inquire what intereſt can induce animals ſo different in their organization, their ſize,

 and

and habits, to form a ſort of aſſociation. Does the pilot-fiſh feed on the dung of the ſhark? as C. Boſc thinks; and has it impoſed on itſelf the painful duties of domeſticity to find protection and ſafety in the neighbourhood of ſo voracious an animal?

LIX. *Experiments on Charcoal expoſed to high Degrees of Heat in cloſe Veſſels.* *By* DAVID MUSHET, *Eſq. of the Calder Iron Works*.*

IN a former communication I ſhowed that in Stourbridge clay crucibles, made perfectly air-tight, a proportion of charcoal diſappeared much greater than could poſſibly combine with the iron in contact with it. This I attributed to cauſes not yet aſcertained, but worthy of inveſtigation. In many experiments with diamonds, particularly thoſe of D'Arcet and Macquer, it ſeemed that they diſappeared when incloſed in balls of porcelain, and where it was ſuppoſed no air was preſent to promote combuſtion. The facts eſtabliſhed by thoſe eminent chemiſts appeared thus at variance with thoſe principles by which the nature and properties of the diamond and other combuſtible ſubſtances were explained: nor have I yet learned if a ſatisfactory explanation of them has been given.

Having prepared a parcel of ſmall Stourbridge clay crucibles nearly of the ſame ſize, I performed the following experiments with different proportions of charcoal.

Exp. I. In one of the crucibles was incloſed five grains of well dried charcoal: the crucible was yet moiſt. The mouth was afterwards brought together and accurately ſhut. When well dried in a temperature from 70° to 80° of Fahrenheit, it was placed in an annealing fire, and gradually heated till of a bright red colour. It was then placed in the aſſay furnace, and a conſiderable degree of heat excited for the ſpace of 35 minutes. When withdrawn, and cold, it was carefully examined, and found free from cracks. It was then cautiouſly broken, but exhibited no marks of charcoal: one vitrid ſpot only was obſervable upon the bottom, which I ſuppoſed to ariſe from the fuſion of the alkaline reſiduum after the deſtruction of the wood.

Exp. II. In this the crucible contained ten grains of charcoal. It was treated in the ſame manner, only expoſed to a more violent and continued heat. When cold, no cracks ap-

* Communicated by the Author.

peared,

peared, and the interior of the vessel presented a solitary spot of vitrid matter larger than that of No. I. by the additional quantity of charcoal employed.

Exp. III. was performed with 20 grains of charcoal, and a similar result with the former two was obtained.

Exp. IV. contained 30 grains of charcoal. This also disappeared.

Exp. V. was performed with 40 grains, when a few minute flakes of charcoal remained.

Exp. VI. was made with - -	grs. 60
After the usual treatment and exposure, I found that a considerable portion of the charcoal now remained, which I found to weigh - -	35
Not taken up	25

The first inference I was led to make from these experiments was, that the charcoal was consumed by the air included in the crucible when it was introduced. This seemed plausible enough where only five or ten grains were employed, and a considerable space left unoccupied; but in the two last experiments the charcoal was of such bulk as nearly to fill the crucible.

Exp. VII. To determine this, I took a piece of well burnt charcoal wood of 20 grains. This was introduced into a crucible, and shut up in a similar manner with the former. It was placed, after the same train of drying and preparation, in the assay furnace, where for two hours it received the utmost heat that the pot was deemed capable of standing. When cold, I found the crucible very entire, and inclosing the piece of charcoal, apparently of its former dimensions and shape; but, on closer examination, I found the angles completely rounded, and the surface covered with very minute transparent globules of salt. The blackness of the charcoal had deepened into a degree of lustre and richness surpassing any thing of the kind I had ever witnessed. The mass now weighed 17 grains.

From the result of this experiment I inferred that the quantity of included air was not adequate to explain the disappearance of the charcoal powder of the former experiments. I was now led to conceive that it might be materially assisted by the expulsion of a certain quantity of water baked in the clay, which, by a well known affinity, might be decomposed on the charcoal at a high temperature, and carbonic acid gas consequently formed.

Exp. VIII. There were inclosed 20 grains of charcoal in a crucible similar to the former. After ten weeks drying, in a temperature frequently beyond that of boiling water, the crucible was cut acrofs, and found to contain 18 grains. It appeared, therefore, neceffary to the volatilization of the charcoal that a greater heat be urged.

Exp. IX. The fame quantity of charcoal was employed, and fubjected to the fame treatment. The crucible was then placed in the annealing furnace, and broken, as it came from thence, after cooling. The charcoal had difappeared, and, in place of the vitrid matter formerly obtained, a few flakes of alkaline falt were found on the bottom. The heat of the annealing fire did not exceed 30° of Wedgewood. The crucible was weighed before put in and when taken from the annealing fire, and was found to have loft $\frac{1}{9}$th part of its weight, which was fuppofed to be water.

It appears pretty conclufive, from the two laft experiments, that a high heat is neceffary to expel the laft portions of water; and that, as in Exp. VIII., the charcoal nearly remained entire where a temperature confiderably beyond that of boiling water was applied: it was in confequence of the expulfion of this water that the charcoal had difappeared.

This conclufion will eafily explain the evaporation of diamonds in balls of moift clay, wherein the fame circumftances would take place as at prefent. It will particularly explain an experiment of Macquer's, wherein he inclofed charcoal in baked and unbaked crucibles of clay. In the former, where no moifture was prefent, the charcoal remained unchanged; but in the latter it difappeared, and the afhes were found vitrid, as in thefe experiments. This was attributed to certain fhrinkages or cracks, which might take place with green clay, and which afterwards became invifible in cooling.

It is probable, however, that charcoal of wood may furnifh part of the means of its own difappearance by a confiderable deoxidation at a high temperature, and leave its refiduum in a much purer ftate than formerly. The following experiment will prove this.

Exp. X. I took 20 grains of beautiful black charcoal collected from experiments where it had been expofed to heats of 165° Wedgewood. Thefe were inclofed in an unbaked pot, which was fet afide to dry. In three months the crucible was found to weigh - - grs. 8313

It was then placed in the annealing fire, and weighed at a bright red heat - - - 7403

Loft equal to $\frac{1}{9\frac{1}{10}}$th part 910

The

The crucible was then placed in a high heat for two hours, and withdrawn quite entire. When cold, I found a fine impalpable powder of charcoal of a deep velvet black which weighed 12 grains. The treatment in this experiment was every way similar to the former (No. III.), yet only eight grains of charcoal were here missing.

LX. *Observations and Reflections on Storms, and some other Phænomena of the Atmosphere. In a Letter from Professor* WATERHOUSE *to Dr.* MITCHILL, *dated Cambridge, Massachusetts, March* 20, 1802.

"DEAR SIR,

YOUR letter of the 8th instant, requesting information of the precise time the late wide-spreading storm commenced at this place, came to my hands evening before last. I hasten to gratify you as far as I am able.

"Sunday, the 21st of February, the day preceding the storm here, was remarkably calm and pleasant. The smoke ascended from the chimneys in a straight column. The thermometer at noon was 47. Neither hygrometer nor barometer indicated, at that period, any disposition of change in the atmosphere. As late as half past ten at night, the sky was clear and star-light. At about two hours and a half after this, viz. one o'clock in the morning of the 22d, the snow-storm began. My information comes from an intelligent market-man, who set out from his own house for Cambridge at midnight. Excepting for a few hours on Wednesday, 24th, we saw not the sun for nine days. It was the longest if not severest snow-storm I ever knew.

"I here send you an abstract from the official meteorological observations * kept in this university by Mr. Webber,

* *Some Meteorological Observations.*

	Barom.	*Ther.*	*Hygr.*	*Wind.*	*The Sky.*
Feb. 21, 9 P. M.	29 80	27	56	N. W. weak.	Few clouds.
22, 7 A. M.	29 60	25	84	N. very strong.	Wholly cloudy.
2 P. M.	29 30	17	83	Do.	Do.
9 P. M.	29 24	12	83	Do.	Do
23, 7 A. M.	29 61	1	80	N. W. very strong.	Mostly cloudy.

"A severe snow-storm continued through the whole of the 22d. The falling snow was very thick; the wind very strong, and somewhat to the E. of N. but appearing to me, by the college vane, to be nearer to the N. than the N. E. It was noted N.

"The scale of the barometer is French measure, but is here reduced to the English or common scale, and correction made for the effect of variation in temperature. The instruments are placed without a north chamber window."

 professor

profeſſor of natural philoſophy. You will obſerve it commences at 9 o'clock in the evening of the 21ſt. I did not think it neceſſary to add any thing reſpecting the magnetic needle.

" I can readily conceive ſeveral good purpoſes may be anſwered by this inquiry. I have therefore written to Kennebec and to Halifax, and requeſted my correſpondent at the laſt place to extend his inquiries to Newfoundland. I hope you will extend yours to Penſacola, and even to Jamaica. The ſeverity of the ſtorm was from north-north-eaſt; that is, north, two points to the eaſt, being, you know, what the ancients termed *aquilo*. Theſe obſervations will probably ſtrengthen the opinion prevalent in this quarter, that all our ſevere north-eaſt ſtorms begin firſt, in point of time, in the ſouth-weſt. Franklin was firſt led to notice this, on being prevented, by a ſtormy ſky, from obſerving an eclipſe of the moon at Philadelphia, when at Boſton, 400 miles north-eaſt of that city, the hemiſphere was ſufficiently clear for that purpoſe.

" The ancients had ſome ſtrange notions of the local origin of winds. They ſpeak of them as ſomething different from air in motion, and as if the matter of the winds were a hot vapour or exhalation from caverns in the earth, where Æolus kept them in chains, only when his churliſh majeſty choſe to let them looſe, like ſo many bull-dogs, to ſcare Juno, and worry her favourites. This fable, however, is, like almoſt all thoſe of the ancients, pregnant with wiſdom. Lord Bacon himſelf has laboured to teach mankind how to make Æolus ſubſervient to Juno, and ſo did Franklin. The tranſition from winds to rain and ſnow is eaſy and natural.

" It has always impreſſed me with ſomething bordering on wonder, that, during the ſix-and-twenty centuries wherein the memory and learning of mankind have been exerciſed, there has not been found one ſecretary of nature ſufficiently inſtructed to give us a complete hiſtory of the aſcent of vapours from the ocean, their ſuſpenſion in the air, the formation of clouds, of ſnow, and of the deſcent of rain, with an entire and connected chain of cauſes. Des Cartes, Nieuwentyt, Dr. Halley, Hunter, and ſome few others, have amuſed the world with their theories on this ſubject; but which of them is unincumbered with difficulties? What facts we have in this ſublime part of nature, are mere fragments widely ſcattered. The phænomena in theſe lofty regions of the air have been rather terrific objects to purblind ſuperſtition, than inſtructive appearances to calm philoſophy.

" The never ceaſing circulation of water between the ocean and the dry ground has been contemplated, from the earlieſt ages,

ages, with grateful admiration; but, not being an object of sight, has been ranked among the inexplicable works of Deity. The clouds dispensing refreshing showers of rain on the dry and thirsty ground; the flow of rivers, with their long train of beneficial consequences, could hardly escape the notice of any thinking being in every age of the world. We accordingly find the supply of water frequently mentioned in the OLDEST BOOK we have, among the most wonderful as well as valuable of Heaven's blessings.

"Seeing the earth annually covered with a rich and beautiful carpet of vegetables, and these astonishingly variegated, and gradually developing 'from seed-time to harvest-time,' must have led those of ancient days to recognize the proximate causes, the warmth of the sun, and the moisture from the clouds; and these again to an acquaintance with that perpetual circulation subsisting between the ocean and the mountains, through the instrumentality of the atmosphere, and by the medium of rivers to the ocean again. But the philosophy or explanation of this vivifying phænomenon is spoken of as inscrutable and past finding out. They did then, as we do now, carry our investigations as high as we can, as in the case of gravitation, and beyond that principle say, with them, 'it is the hand of God;' an expression denoting the last term of our analytical results. Unable to investigate the essence of light and of fire, the Deity was called by the name of these inexplicable agents.

"In those early days, when the knowledge of nature was confined to narrow limits, they, like our Indians,

'Saw God in clouds, and heard him in the winds.'

Hence they styled the Deity 'the father of the rain,' and represented him as 'calling forth the waters of the sea, and pouring them down according to the *vapour* thereof.' Whence we infer, they believed the water rose in the form of *vapour* from the ocean, and that it became *freshened* in its passage through the air; and it moreover appears that they were sensible that this process was regularly and perpetually performing; for they remarked that 'although all the rivers run into the sea, yet was the sea not full; unto the place whence the rivers come, thither they return again.' They seem also to have known that MOUNTAINS made a part of this GRAND APPARATUS, and to have believed that it was not a fortuitous or random process, but regulated, as we now find it, by weight and measure. May not this be inferred from that sublime question of Isaiah—'Who hath measured the

the *waters* in the hollow of his hand, and weighed the *mountains* in ſcales?'

"Although they diſcerned this magnificent apparatus, and ſaw its effects, yet were they reſtrained by a religious awe from attempting its inveſtigation, becauſe ſtorms, lightning and hail, were conceived to be the precurſors of the chariot of the Deity! 'who maketh the *clouds* his chariot'—'who walketh on the wings of the *wind'*—accompanied with '*hailſtones* and *fire!'* Or, if you chooſe to have the ſpirit of theſe paſſages expreſſed in Engliſh metre—

'On cherubs, and on cherubims,
'Full royally he rode,
'And on the wings of all the winds
'Came flying all abroad.'

For this reaſon, probably, the origin and courſe of the winds, 'whence they come and whither they go,' were deemed myſterious. Hence, inſtead of inveſtigating the cauſe, their pious minds, overwhelmed with awe, ſunk into undiſcerning amazement! Under ſuch impreſſions, I ceaſe to wonder that he who wrote that ancient drama, the book of Job, puts among the moſt difficult of his queſtions that which demands an explanation of the 'balancing of the clouds.' But ſhall not we, who are happily free from the terrors of the Moſaic as well as Pagan ſyſtems, and who enjoy the encouraging *intellectual* ſcheme of Chriſtianity, which, never forgetting Deity, poſtpones every thing *corporeal* to the *primary mental cauſe* *—I ſay, ſhall not we unite our efforts to fill up that dreary blank left in ſcience by the ancients? And 'as man, who is the ſervant and interpreter of nature, can act and underſtand no further than he has, either in operation or in contemplation, obſerved of the method and order of nature †,' let us commence a patient obſervation of the ordinary and extraordinary phænomena that occur in this ſcene of wonders, the atmoſphere; and then collect thoſe fragments of knowledge, widely ſcattered through the world, on the ſame ſubject.

"Although much of the operations going forward in the atmoſphere may have ſome links that have hitherto eſcaped the moſt inquiſitive eye, and others, though ſeen, may not be fully underſtood, ſtill we ought not to be diſcouraged. Theſe detached links will one day be united, and form a part of the great chain of natural cauſes, adding ſtill ſtronger

* Harris.
† Novum Organ. Scient.

proofs

proofs of that *unity of design* which pervades the great Temple of Nature.

"Some men seem destined to observe and record naked facts; others, of a superior genius, follow after and apply them. Some future Franklin may do with these *desiderated* facts what Newton did with those collected by Kepler and Galileo, and therewith form a system which may teach us to bridle the *winds* themselves, and render them further subservient to human uses."

LXI. *An Attempt towards a Theory of the Resistance experienced by two and four-wheeled Carriages on different Kinds of Roads; and to determine the Circumstances under which the one are preferable to the other.* By NICHOLAS FUSS, *Professor of the higher Mathematics at Petersburgh, Member of the Imperial Academy of Sciences, &c.*

[Concluded from p. 266.]

FOURTH DIVISION.

On the Resistance experienced from single Obstacles.

Section 33.

AMONG these obstacles I include, as already mentioned, section 2, single excavations and elevations which here and there occur on roads, such as ridges, stones, channels, cavities, broken pavement, and bridges, &c. When such impediments frequently occur, an examination of the increase of resistance which thence arises cannot be a matter of indifference to the object of the question, and therefore I shall treat of them in particular in the present division.

I. *Roads worn into Sinuosities.*

Section 34.

Let AB, Pl. II. fig. 7. be a road of this kind where the sinuosities are pretty regular. Required the resistance which arises to four as well as two-wheeled carriages at a given point F of the road, the tangent to which, FM, forms with the direction of the road AB an angle $= \gamma$. In this case, when the road is solid, and otherwise free from inequalities, the resistance for the fore-wheels will be found by the same method as that employed section 7 and section 8 to be:

$$\tfrac{1}{2} m \lambda P \cos. \alpha (\alpha + \gamma) + (\tfrac{1}{2} P + p) \sin. (\alpha + \gamma)$$

And for the hind-wheels, when the angle which the tangent F′M′ forms in F with the direction of the road is expressed by δ, the resistance in this point will be:

$$\tfrac{1}{2} n \lambda P \cos. (\alpha + \delta) + (\tfrac{1}{2} P + p' \sin. (\alpha + \delta).$$

For

For the whole resistance, then, of four-wheeled carriages we shall have:

$$R = \begin{cases} \frac{1}{2} m \lambda P \cos. (\alpha + \gamma) + (\frac{1}{2} P + p) \sin. (\alpha + \gamma) \\ + \frac{1}{2} n \lambda P \cos. (\alpha + \delta) + (\frac{1}{2} P + p') \sin. (\alpha + \delta) \end{cases}$$

But for two-wheeled carriages the resistance in the same point will be found by section 10 and section 11 to be:

$$R' = m \lambda P \cos. (\alpha + \gamma) + (P + \varepsilon P + \pi) \sin. (\alpha + \gamma)$$

But the moving power here is $V = M \left(1 - \frac{g}{G}\right)^2 \cos. \gamma.$

II. *Single Excavations.*

Section 35.

For single excavations or hollows, the distance of which from each other is greater than that between the fore and hind axles, the angle will be $\delta = 0$; consequently we shall have for the resistance to four-wheeled carriages,

$$R = \begin{cases} \frac{1}{2} m \lambda P \cos. (\alpha + \gamma) + (\frac{1}{2} P + p) \sin. (\alpha + \gamma) \\ + \frac{1}{2} n \lambda P \cos. \alpha + (\frac{1}{2} P + p') \sin. \alpha \end{cases}$$

Section 36.

If such excavations occur on roads of the second and third class, fig. 8, the resistance for two and four-wheeled carriages in the above point F on the former kind of roads will be,

$$R = \begin{cases} \frac{1}{2} m \lambda P \cos. (\alpha + \gamma) + (\frac{1}{2} P + p) \sin. (\alpha + \gamma) \\ + \frac{1}{2} n \lambda P \cos. \alpha + (\frac{1}{2} P + p') \sin. \alpha \\ + (\frac{1}{2} P + p) \cos. (\alpha + \gamma) \text{ tang. } \varphi + (\frac{1}{2} P + p') \cos. \alpha \text{ t. } \psi \end{cases}$$

$$R' = \begin{cases} \mu \lambda P \cos. (\alpha + \gamma) + (P + \varepsilon P + \pi) \sin. (\alpha + \gamma) \\ + (P + \pi) \cos. (\alpha + \gamma) \text{ tang. } \omega \end{cases}$$

And for the latter kind of roads the resistance will be:

$$R = \begin{cases} \frac{1}{2} m \lambda P \cos. (\alpha + \gamma) + (\frac{1}{2} P + p) \sin. (\alpha + \gamma) \\ + \frac{1}{2} n \lambda P \cos. \alpha + (\frac{1}{2} P + p') \sin. \alpha \\ + (\frac{1}{2} P + p) \cos. (\alpha + \gamma) \sin. \beta \text{ tang. } \xi \\ + (\frac{1}{2} P + p') \cos. \alpha, \sin. \beta, \text{ tang. } \eta \end{cases}$$

$$R' = \begin{cases} \mu \lambda P \cos. (\alpha + \gamma) + (P + \varepsilon P + \pi) \sin. (\alpha + \gamma) \\ + (P + \pi) \cos. (\alpha + \gamma) \sin. \beta \text{ tang. } \vartheta \end{cases}$$

In regard to $\varepsilon = \frac{OH}{OI}$; in all these cases $OH = OS$ tang. $(\alpha + \varkappa)$, where $\varkappa$ denotes the angle which the pole IH makes with the inclined plane AB when the wheel is in F. If IW be drawn perpendicular and OM parallel to AB, the angle $MOI = K$ and sin. $K = \frac{MI}{OI}$.

Example.

Section 37.

Let every thing be the same as in the example given section

tion 30. That is, let there be a ſingle excavation in a road conſiſting of ſuch dry ſand; let the carriage be in F; and let the angle $\gamma = 19°$, MI = 9 inches, OI = 12 feet; in this caſe, ſin. $\varkappa = 0{\cdot}06250$, and $\varkappa = 3° 35'$; conſequently OH = 0·38038, and $\varepsilon = 0{\cdot}03170$. From theſe data we ſhall have,

For four-wheeled Carriages.

$\frac{1}{2}\,\mu\,\lambda$ P cos. $(\alpha + \gamma)$	=	12·273
$\frac{1}{2}\,n\,\lambda$ P cos. α	=	9·976
$(\frac{1}{2}$ P + $p)$ ſin. $(\alpha + \gamma)$	=	267·260
$(\frac{1}{2}$ P + $p')$ ſin. α	=	49·527
$(\frac{1}{2}$ P + $p)$ cos. $(\alpha + \gamma)$ ſin. β, tang. ξ	=	115·624
$(\frac{1}{2}$ P + $p')$ cos. α, ſin. β, tang. η	=	107·112
	R =	561·772

For two-wheeled Carriages.

$\mu\,\lambda$ P cos. $(\alpha + \gamma)$	=	15·780
(P + ε P + ϖ) ſin. $(\alpha + \gamma)$	=	535·317
(P + ϖ) cos. $(\alpha + \gamma)$ ſin. β, tang. ϑ	=	208·035
	R′ =	759·132

We have here $M\left(1 - \frac{g}{G}\right)$ cos. $\gamma = 561{\cdot}772$, and $M \left(1 - \frac{g'}{G}\right)^2$ cos. $\gamma = 759{\cdot}132$; conſequently $g = +\ 1{\cdot}318$ and $g' = -\ 0{\cdot}0187$, if we make M = 800 and G = 11, as in ſection 30. Theſe two horſes, therefore, would not be able to draw a two-wheeled carriage over the point F of this excavation; whereas they could draw without much exertion, and with a velocity of more than 18 inches per ſecond, a four-wheeled carriage over the ſame point. On the other hand, they would be obliged to employ nearly as great an exertion for the hind-wheels; but this double exertion will be leſs fatiguing than the ſingle exertion in the caſe of two wheels provided they do not ſtick faſt, as the calculation ſuppoſes.

III. *Single Elevations.*

Section 38.

Fig. 9. The caſe is the ſame when the obſtacles which occur are ſingle elevations, ſuch as ridges, ſtones, broken pavement, and bridges, &c. Let G be an obſtacle of this kind, the height of which is FR = b; let the ſemidiameter of the wheel

wheel be OG $= a$, so that cos. GOR $= \frac{a - b}{a}$. Let this angle GOR be for the fore-wheels $= \rho$, for the hind-wheels $= \sigma$, and for the two-wheeled carriages $= \tau$. The increase of resistance arising from this obstacle in the case of the fore-wheels will be $= (\frac{1}{2} P + p)$ cos. α tang. ρ; in that of the hind-wheels $= (\frac{1}{2} P + p')$ cos. α tang. σ; and of the two-wheeled carriages $(P + \pi)$ cos. α tang. μ. But of the first two, as one only acts at a time, the whole resistance on each kind of way where such obstacles occur will be much easier overcome by the four-wheeled than by the two-wheeled carriages.

Fifth Division.

General Considerations and Results.

Section 39.

I have already shown, in regard to all the three classes of roads in general, the conditions under which the one kind of carriage is to be preferred to the other. But as the multitude of elements which occur in all these formulæ render a general view of them difficult, it may not be superfluous to collect here a few of the principal results as deduced from a closer comparison of the general conditions.

Section 40.

On roads of the first class, when the axles and wheels are in the common ratio, the difference between R and R′ can never be very considerable. But as the wheels of the two-wheeled carriages are generally made as high or higher than the hind-wheels of the four-wheeled carriages, we shall always have $R > R'$ as long as P, ε and α are not very great. But if the road be exceedingly steep, and the load very high and heavy, we shall have $R < R'$; consequently the four-wheeled carriages will be preferable.

Section 41.

In the commencement of this essay, section 2, among roads of this class, I included those with solid broad ruts, to which every thing observed, in general, in regard to solid and smooth roads is applicable. But if the solid ruts are narrow and deep, a friction is produced on the sides of the fellies which increases the resistance; but I cannot determine accurately this increase, as we are unacquainted with the laws according to which this friction acts: all that we know of it, and it is sufficient for our purpose, is, that the increase of resistance thence arising is for four-wheeled carriages nearly double that for two-wheeled carriages;

carriages; and consequently on such roads the former deserve the preference, and the more so the narrower and deeper the ruts.

Section 42.

When the dimensions of the wheels and axles are in the common ratio, the difference on roads of the second class between R and R′ will be considerably greater than for the carriages examined section 40, and to the prejudice of the four-wheeled carriages; and the more rugged the road the steeper it must be, and the higher and heavier must be the load to make $R < R'$. On the whole, two-wheeled carriages on roads of the second class are always preferable in regard to resistance.

Section 43.

But on roads of the third class, the advantage inclines strongly to the side of the four-wheeled carriages; and it is decidedly so when the surface of the road consists of soft sand, moist tender earth, tough dirt, &c. so that the hind-wheels run in the ruts formed by the fore-wheels. For here we have unconditionally $R < R'$. But even in the case of dry soft sand or earth, or fluid dirt, where the ruts made by the fore-wheels immediately close up again, we shall have also $R < R'$ when the sum of the semidiameter of the fore- and hind-wheels is not much smaller than the diameter of the wheels of the two-wheeled carriages without regard to P, α and ε. In the last place, if the road be steep and the load heavy and voluminous, the two-wheeled carriages, to the prejudice of the necessary strength, must have very large wheels to make $R < R'$. On the whole, therefore, on such roads four-wheeled carriages are better.

Section 44.

On the roads with sinuosities of section 34 we have $R < R'$ when the angle $\delta = 0$, or vanishes; that is, when the distance between the excavations is greater than that between the fore and hind-wheels, or when they are placed so near each other that the hind-wheel sinks while the fore one ascends, as seen, figure 7, at F'' and F. In both cases, particularly the last, four-wheeled carriages are to be preferred to two-wheeled, not only because $R < R'$, but because the moving power remains greater in the former case than in the latter, where the continued alteration in the direction of the pole, and the vibrating of the centre of gravity which thence arises, tend greatly to fatigue the cattle.

Section

Section 45.

In the case also of single excavations and elevations, such as those considered section 35 and section 38, we shall have, as already mentioned, R < R′ when such occur on any road whatever. When these obstacles are numerous, but not so near each other that the fore- and hind-wheels both experience a resistance at the same time, four-wheeled carriages are for the most part to be preferred to two-wheeled, without taking into consideration the nature of the road in other respects.

Sixth Division.

More accurate Determination of the Resistance in regard to the Direction of the Pole or Shafts.

Section 46.

In the preceding researches it has been supposed that the direction of the pole of the carriage is parallel to that of the road. In general, however, it deviates more or less from this direction according as the breast leather or the collar of the team horse is higher or lower than the axles of the wheels. This deviation depends also, besides the length of the pole, on the kind of harness, on the height of the cattle and the method of yoking them, and on the size of the wheels; and when this is taken into consideration the resistance R and R′ will certainly be somewhat different from that found in the preceding divisions. But though the difference is very small, to render the examination of this question as complete as the nature of the subject will admit, I shall take into consideration in this division the direction of the pole, and again determine the values of R and R′ for each of the supposed three classes of roads.

I. *Roads of the first Class.*

Section 47.

Let the pole OI, fig. 10. make with the direction of the road AB or OM an angle MOI = K, the moving power OI $= V = M\left(1 - \frac{g}{G}\right)^2$ is in this case not entirely employed, but only the part OM = V cos. $\varkappa$; while the other part, ON = V, sin. $\varkappa$, lessens the pressure on the fore axle, which is only $\frac{1}{2}$ P cos. α, — V, sin. $\varkappa$. Therefore the resistance from friction on the axle $= \frac{1}{2} m \lambda$ P cos. α, $- m \lambda$ V, sin. $\varkappa$; and the whole resistance acting in the direction OP against the power OM = V cos. $\varkappa$ is,

$$\left\{\begin{array}{l}\frac{1}{2}(m+n)\lambda P \cos.\alpha + (P+p+p')\sin.\alpha \\ - m\lambda V \sin.\varkappa = V\cos.\varkappa\end{array}\right\}$$

If

If we therefore put for this clafs of roads $V = M\left(1 - \frac{g}{G}\right)^2 = R$, the required refiftance for four-wheeled carriages will be,

$$R = \frac{\frac{1}{2}(m+n)\lambda P \cos.\alpha + (P + p + p')\,\text{fin.}\,\alpha}{\cos.\varkappa + m\lambda\,\text{fin.}\,\varkappa}$$

If we make for two-wheeled carriages the angle MOI = $\varkappa'$ and $V = M\left(1 - \frac{g'}{G}\right)^2 = R'$, we fhall find in the fame manner,

$$R' = \frac{\mu\lambda P\cos.\alpha + (P + \varepsilon P + \pi)\,\text{fin.}\,\alpha}{\cos.\varkappa' + \mu\lambda\,\text{fin.}\,\varkappa'}$$

Where it is however to be remarked, that though $\varepsilon = \frac{OH}{OI}$ we have here OH = OS tang. $(\alpha + \varkappa')$. If $\varkappa = 0$, and $\varkappa' = 0$, then will R = R (fection 9), and R′ = R′ (fection 12).

EXAMPLE.

Section 48.

Let every thing be as in the example fection 18, and, befides, let IW = 42 inches. For R let OI = 10 feet, and for R let OI = 12 feet, fo that $\varkappa = 13° 30'$ and $\varkappa' = 7° 11'$; confequently OH = 2 tang. 13° 11′ = 0·46848, and ε = 0·03904. Hence we fhall have R = 199·557 and R′ = 189·943. In fection 18 we had R — R′ = 9·510, and here R — R′ = 9·614. Therefore the difference is nearly equal.

II. *Roads of the fecond Clafs.*

Section 49.

On roads of this kind in the fore-wheels of four-wheeled carriages the momentum of the part K of the moving power, which is employed in order to raife it above the obftacle G, is K.GU = OR.GR; that is, K.GO cos. $(\varphi - \varkappa) = (\frac{1}{2}P + p)$ cos. α.GO fin. φ. Hence the power K acting in the direction OH = $(\frac{1}{2}P + p)$ cos. α fin. φ, fec. $(\varphi - \varkappa)$; confequently that in the direction OP = OH cos. α = $(\frac{1}{2}P + p)$ cos. α, cos. $\varkappa$, fin. φ, fec. $(\varphi - \varkappa)$. The fum of all the powers acting in the direction of OP therefore is,

$$\left\{\begin{array}{l}\frac{1}{2}(m+n)\lambda P\cos.\alpha + (P + p + p')\,\text{fin.}\,\alpha \\ - m\lambda V\,\text{fin.}\,\varkappa + (\frac{1}{2}P + p)\cos.\alpha,\cos.\varkappa,\,\text{fin.}\,\varphi \\ \text{fec.}\,(\varphi - \varkappa) + (\frac{1}{2}P + p')\cos.\alpha\,\text{tang.}\,\psi\end{array}\right\} = \cos.\varkappa$$

Hence we obtain $V = M\left(1 - \frac{g}{G}\right)^2$; or,

$$R = \left\{\begin{array}{l}R + \dfrac{(\frac{1}{2}P + p)\cos.\alpha\cos.\varkappa\,\text{fin.}\,\varphi,\,\text{fec.}\,(\varphi - \varkappa)}{\cos.\varkappa + m\lambda\,\text{fin.}\,\varkappa} \\ + \dfrac{(\frac{1}{2}P + p')\cos.\alpha\,\text{tang.}\,\psi}{\cos.\varkappa + m\lambda\,\text{fin.}\,\varkappa}\end{array}\right\}$$

 And

And in the ſame manner we find for two-wheeled carriages,

$$R' = R' + \frac{(P + \pi) \text{ cos. } \alpha \text{ cos. } \varkappa' \text{ ſin. } \omega, \text{ ſec. } (\omega - \varkappa')}{\text{cos } \varkappa' + \mu \lambda \text{ ſin. } \varkappa}$$

If therefore $\varkappa = 0$ and $\varkappa' = 0$, we obtain for R and R′ the values found in the ſecond diviſion, ſection 19 and ſection 20.

Example.

Section 50.

Let every thing be as in the caſe calculated ſection 23; alſo let IW = 42 inches, for R let OI = 9 feet, and for R′ let OI = 12 feet: hence $\varkappa = 14° 29'$, and $\varkappa' = 7° 47'$. Now as OH = 2 tang. 21° 47′ = 0·799268 feet, therefore $\varepsilon = 0·06660$. Hence we obtain,

$$R = \frac{(\text{'} m + n) \lambda P \text{ cos. } \alpha + (P + p + p') \text{ ſin. } \alpha}{\text{cos. } \varkappa + m \lambda \text{ ſin. } \varkappa} = 529·268$$

$$\frac{(\frac{1}{2} P + p) \text{ cos. } \alpha \text{ cos. } \varkappa \text{ ſin. } \varphi, \text{ ſec. } (\varphi - \varkappa)}{\text{cos. } \varkappa + m \lambda \text{ ſin. } \varkappa} = 95·836$$

$$\frac{(\frac{1}{2} P + p') \text{ cos. } \alpha \text{ tang. } \psi}{\text{cos. } \varkappa + m \lambda \text{ ſin. } \varkappa} = 72·139$$

$$R = 697·243$$

$$R' = \frac{\mu \lambda P \text{ cos. } \alpha + (P + \varepsilon P + \pi) \text{ ſin. } \alpha}{\text{cos. } \varkappa' + \mu \lambda \text{ ſin. } \varkappa'} = 526·260$$

$$\frac{(P + \pi) \text{ cos. } \alpha \text{ cos. } \varkappa' \text{ ſin. } \omega, \text{ ſec. } (\omega - \varkappa)}{\text{cos. } \varkappa' + \mu \lambda \text{ ſin. } \varkappa'} = 124·021$$

$$R' = 650·281$$

In the example ſection 23 we had R — R′ = 45·357, but here R — R′ = 46·962; conſequently in this caſe the differences are nearly equal.

III. *Roads of the third Claſs.*

After what has been ſaid, ſection 49, it is needleſs to repeat ſtep by ſtep the proceſs for roads of this claſs. It may be eaſily ſeen that here,

$$R = \left\{ R + \frac{(\frac{1}{2} P + p) \text{ cos. } \alpha \text{ ſin. } \beta \text{ cos. } \varkappa \text{ ſin. } \xi}{\text{cos. } \varkappa + m \lambda \text{ ſin. } \varkappa} \frac{\text{ſec. } (\xi - \varkappa') + (\frac{1}{2} P + p') \text{ cos. } \alpha \text{ ſin. } \beta \text{ tang. } \eta}{\text{cos. } \varkappa + m \lambda \text{ ſin. } \varkappa} \right\}$$

$$R' = R' + \frac{(P + \pi) \text{ cos. } \alpha \text{ ſin. } \beta \text{ cos. } \varkappa' \text{ ſin. } \vartheta, \text{ ſec. } (\vartheta - \varkappa')}{\text{cos. } \varkappa' + \mu \lambda \text{ ſin. } \varkappa'}$$

So that when $\varkappa = 0$, and $\varkappa' = c$, we obtain for R and R′ the ſame values as thoſe found ſection 26 and ſection 27.

Example.

EXAMPLE.

Section 52.

Let every thing be as before section 30; also IW = 48 inches, for R let OI = 9 feet, and for R′ let OI = 12 feet; therefore $\kappa = 17^\circ\ 22'$, and $\kappa' = 9^\circ\ 24'$. Now as OH = $2\frac{6}{7}$ tang. $13^\circ\ 24' = 0{\cdot}68067$, then is $\varepsilon = 0{\cdot}05672$. From these and the preceding data we obtain,

$$R = \frac{\frac{1}{2}(m+n)\,\lambda\,P\cos.\alpha + (P+p+p')\sin.\alpha}{\cos.\kappa + m\lambda\sin.\kappa} = 125{\cdot}403$$

$$\frac{(\frac{1}{2}P+p)\cos.\alpha\sin.\beta\cos.\kappa\sin.\xi,\ \sec.(\xi-\kappa)}{\cos.\kappa + m\lambda\sin.\kappa} = 117{\cdot}198$$

$$\frac{(\frac{1}{2}P+p')\cos.\alpha\sin.\beta\ \text{tang.}\ \eta}{\cos.\kappa + m\lambda\sin.\kappa} = 111{\cdot}453$$

$$R = 354{\cdot}054$$

$$R' = \frac{\mu\lambda P\cos.\alpha + (P+\varepsilon P+\pi)\sin.\alpha}{\cos.\kappa' + \mu\lambda\sin.\kappa} = 116{\cdot}055$$

$$\frac{(P+\pi)\cos.\alpha\sin.\beta\cos.\kappa'\sin.\vartheta,\ \sec.(\vartheta-\kappa)}{\cos.\kappa' + \mu\lambda\sin.\kappa'} = 216{\cdot}092$$

$$R' = 332{\cdot}147$$

In the example section 30, we had R — R′ = 16·071, but here R — R′ = 21·907.

LXII. *Reflections on the Zodiacs found by the French in Upper Egypt.* By Mr. DELUC *.

THE principal arguments opposed to the authenticity of what Moses relates in regard to the history of the deluge, and the period when it took place, are drawn from the supposed antiquity of our continents, which is carried back, without bounds, beyond that epoch. This opinion has its source in idea rather than in observation; for facts which have been carefully observed show, on the contrary, that the continents we inhabit have no older date than that fixed by the chronology of Moses since the flood. For the proofs of this truth I refer to *Lettres Physiques et Morales sur l'Histoire de la Terre et de l'Homme*, and to those *sur l'Histoire Physique de la Terre*, or *Lettres Geologiques*, where are collected a great number of facts the evidence of which cannot be contested.

But the project, long ago formed, of destroying the credit due to the revelation announced by the sacred historian, pre-

* From the *Bibliothèque Britannique*, No. 154.

vails, with fome, over evidence. No attention is paid by infidels to the proofs which confirm it; and, without having been able to deftroy them, and even without having tried it, they return to the charge as foon as an opportunity offers.

The *Moniteur* or French *Gazette Nationale* of the 25th of Pluviofe laft (February 14, 1802,) contains a long article, in which are announced difcoveries made in Upper Egypt, and among thefe is that of two zodiacs; from which it is "certain," fays the writer, "that the prefent divifion of the zodiac fuch as we are acquainted with was eftablifhed among the Egyptians fifteen thoufand years before the Chriftian æra, and that it has been preferved without alteration and tranfmitted to all other nations."

This conclufion, given with a tone of affurance, may eafily impofe, and make it be believed that it is well founded, though it can reft only on conjectures or miftakes in the application of aftronomical calculations: but in fuch fpeculations, as they are retained by no religious perfuafions, they follow their own ideas, without ever inquiring whether they can be reconciled with what is pointed out to us by nature.

The Memoirs of the Academy of Sciences for 1708 contain an engraving of a large fragment of an Egyptian planifphere or zodiac which was fent from Rome to the academy. This zodiac, engraven on antique marble, was preferved in the Vatican. It reprefents concentric bands or circles divided into twelve equal portions by lines drawn from the circumference to the centre. The circle in the centre, which is not divided, contains three conftellations, the Dragon and two Bears. The next circle, which is divided, contains the figures of animals, reptiles, and others. The two following circles contain each in the fame order the twelve figns of the zodiac, fome of which are in good prefervation. The fifth circle, feparated by a band on which are traced out letters or characters, contains in each divifion, correfponding to a fign, three human figures, fome of which have the head of an animal. And the laft circle, which inclofes the whole, reprefents the planets repeated under the figure of human heads correfponding to certain divifions of the figns, according as the imagination, inclined to the chimeras of aftrology, fuggefted.

The learned in 1708 were far from affigning to this zodiac a high antiquity: it was even confidered, and with juftice, as being rather aftrological than aftronomical; and therefore it was left in the hiftorical part of that year as a mere object of curiofity, not worthy of engaging the time of the academy.

But Voltaire and his fchool had not yet appeared *feated in* *the ſcorner's chair,* thowing out their ſophiſms and their ſarcaſms againſt the account given by Moſes. Theſe arms made their uſual impreſſion on inattentive men. They reject as fabulous the chronology of the ſacred hiſtorian; and, by a very remarkable but not novel inconſiſtency, they give more faith to the uncertain interpretations of theſe combined arrangements of the Egyptian ſigns and hieroglyphics, the date of which as well as the meaning is unknown, than to a chronology eſtabliſhed on an uninterrupted ſeries of generations.

Fortunately, without going far from the place where theſe zodiacs were found, a very remarkable fact of the philoſophy of the earth bears teſtimony againſt the antiquity aſcribed to them.

We know, from the accounts of enlightened travellers, that the coaſt of Arabia on the Red Sea is incumbered with banks or reefs of coral, which render acceſs to them difficult and dangerous.

Theſe reefs are the work and habitation of polypes, which in proportion as they labour abandon their firſt habitations, on which they continue to build. This ſucceſſion of labour is ſeen very diſtinctly in thoſe marine productions which ſerve to ornament our cabinets of natural hiſtory under the names of coral, madrepores, millepores, ſea organs, &c.

In warm climates theſe polypes are always in activity; they never ceaſe to multiply and to labour; the reſult of which is, that in a ſhort time they augment in a ſenſible manner the maſs of their habitations, which are not deſtroyed by age, as they are of the ſame ſubſtance as ſhells, and have the ſame hardneſs.

Niebuhr, in his Deſcription of Arabia, p. 199, mentions a ſtriking inſtance of the rapid increaſe of theſe coral banks obſerved at the diſtance of ſome leagues to the north of Mokha. "Ghaleſka, a town formerly celebrated," ſays he, "is at preſent a wretched village, the inhabitants of which, few in number, live on their dates and by fiſhing. The coaſt is at preſent ſo filled with coral banks, that the port is impracticable even to ſmall veſſels."

If only a few centuries then were required to render a port and the neighbouring coaſts impracticable, this rigorous conſequence reſults, that all theſe ſhores muſt many ages ago have been inacceſſible to ſhips, had the Red Sea, and the coaſts by which it is bordered, exiſted fifteen thouſand years before the Chriſtian æra, as is ſaid of the zodiacs of Upper Egypt, which would ſtill ſuppoſe many thouſands of years anterior to that period.

And when we reflect that, as we are no longer ftopped in regard to the antiquity of our continents by any known chronology, the refult is, that they may have exifted millions as well as thoufands of years: there are no more bounds, then, affignable to their antiquity, and confequently to the progrefs of the labour of thefe infects; and the Red Sea, narrow and deep, ought to have been totally choked up by it.

But the Red Sea is not the only one which exhibits thefe coral reefs, and their continual increafe: a great number of ifles fituated between the tropics are furrounded by them in fuch a manner as renders accefs to them as difficult as on the coafts of Arabia.

Mr. Labillardiere, the author of *Voyage à la Recherche de la Peroufe,* makes on this fubject the following reflection, in confequence of the veffels having been expofed to great danger among fuch reefs, which extend around New Caledonia:—"Thefe polypiers," fays he, "the continual increafe of which blocks up more and more the bafon of the feas, are very capable of frightening navigators; and many fhoals which ftill afford a paffage will foon form reefs exceedingly dangerous."

If the prefent ftate of the feas and continents had exifted for thoufands of ages, as pretended by thofe geologues who reject the chronology of Mofes, is it not evident that thefe reefs, which continually increafe, would have long ago furrounded thefe iflands with fo great a number of thefe walls of coral, that it would have been impoffible for the firft navigators to approach even within a confiderable diftance of them? Nature, then, agrees here with the chronology of the facred fcriptures. The labour of thefe little animals rifes up from the bottom of the fea, in teftimony of the truth of its relation.

Thefe coral rocks appear to be a production peculiar to the prefent fea; for we find nothing fimilar in calcareous mountains, nor in hills confifting of fhells. Coral and madrepores are, no doubt, found in them; but they are infulated in the ftrata like all other marine bodies. This example fhows how deceitful the calculations of geometry may be, when applied to facts in the philofophy of the earth without confulting nature.

The celebrated geometrician Delaplace, calculating the depth of the fea from the Newtonian theory of the tides, has determined that this depth cannot be lefs than four leagues*.

The attentive obferver of nature has means more certain

* *Renouvellement périodique des Continens terreftres,* p. 288.

for

for founding this depth than the refult of fuch calculations. Thefe are, the numerous volcanic ifles fcattered in all latitudes throughout the bofom of the moft extenfive feas. Thefe iflands atteft, that the bafis on which the fubterranean fires have elevated them cannot be at the depth of even a thoufand toifes; and if we add to thefe volcanic ifles all the natural ifles which are at a great diftance from continents, what will become of the depth of *four leagues*, affigned to the fea from thefe calculations?

Another fact, which oppofes this hypothefis, refults from currents. If the flux and reflux depended on the depth of the fea, it ought to experience the fame libration throughout its whole mafs; which is not the cafe. The currents are not fenfible but at a fmall diftance from the furface of the water.

This fact, which is well known to navigators, fupplies them with the means of determining whether their veffel be in a current. They hoift out a boat, which proceeds to fome diftance from the veffel, and then let down a weight attached to a rope to the depth of 200 fathoms. This weight being thus at a great depth in calm water, obfervation and experience having fhown that currents are not fenfible beyond the depth of ten fathoms, it produces the effect of an anchor which retains the boat: they then throw into the water a very thin board, that the wind may have no hold of it, and according to the motion of this board, if it has any, they difcover whether there be a current, and determine its direction and velocity. It refults then from thefe facts, that the libration of the fea, occafioned by the moon, which produces the tides, is owing to its extent, and in no manner to its depth.

What then ought we to conclude from all thefe facts? That in regard to the philofophy of the earth we ought to confult them, and direct our obfervations in particular by the firft of all motives, that of attaining, as far as poffible, to the knowledge of truth.

I fhall take this opportunity of making a remark connected with fome obfervations contained in my letter of the 10th of November laft. Since the currents of the fea are experienced only at a fmall depth, and as the fea beneath them is calm, the geological fyftems founded on the formation of new continents by currents at the bottom of the fea have not this fuppofed fact in their favour, fince it is proved that they do not exift.

Geneva,
May 10, 1802.

 LXIII. *Ob-*

LXIII. *Obfervations refpecting the Aya-Pana. Read in the Clafs of the Phyfical Sciences of the French National Inftitute on the 14th of Fructidor, Year* 10. *By* C. VENTENAT.

SEVERAL of the journals have lately made mention of the *aya-pana*. They have faid that this plant was originally a native of Brazil; that it is cultivated with fuccefs in the Ifle de France; that it poffeffes great virtues, and may be confidered as an univerfal panacea. I hope, therefore, that the clafs, and particularly phyficians, will be gratified with a more complete account of this vegetable, the difcovery of which is a valuable acquifition to natural hiftory, it the virtues afcribed to it are not exaggerated.

About eight months ago one of my nephews, being about to leave the Ifle of France, begged citizen Michaud to point out to him fuch plants cultivated in the garden of the ftate as he thought likely to be an acceptable prefent to me. Our friend mentioned to him the rareft articles: he even was fo kind as to procure them, and did not forget the famous plant of Brazil. The information which my nephew obtained refpecting this plant, being perfectly agreeable to that which has been fince tranfmitted to madame Bonaparte as well as to C. Juffieu, I flatter myfelf that I am able to give the clafs an accurate account in regard to every thing that concerns the native country of the *aya-pana*; the properties afcribed to it; and, in particular, its botanical characters.

The *aya-pana* grows in South America on the right bank of the river of the Amazons. The inhabitants of that country have long confidered it as an excellent fudorific, and a powerful alexipharmic or antidote againft the bite of ferpents and the wounds made by poifoned arrows. Its virtues are equally extolled throughout all Brazil, where it is carefully cultivated, and where it is diftinguifhed by the name of the *miraculous plant*.

In the 7th year of the French republic captain Auguftine Baudin, brother of captain Baudin fo well known to naturalifts who is now on a voyage to the South Seas, being at Brazil, and having heard of the *aya-pana*, confidered at firft as fabulous, or at leaft exaggerated, every thing told him refpecting the virtues of this plant. But the relation of feveral cures performed by it during his ftay in that country, confirmed by the teftimony of perfons worthy of credit, and particularly by that of Dr. Camara, a celebrated botanift and able phyfician, who was formerly a pupil of Juffieu, entirely removed his doubts.

Convinced that he should render an important service to the French colonies by introducing the *aya-pana*, captain Baudin made every effort to obtain it. With great difficulty he procured some roots, which he caused to be conveyed on board his vessel, giving orders that the greatest care should be taken of them. When about to leave Brazil, being desirous to see in what state his slips of the *aya-pana* were, he found that, unfortunately, they no longer existed: they had been entirely destroyed by some fowls which had escaped from the hen-coop.

Captain Baudin was much afflicted at this loss; and though his departure had been fixed for the next day, he resolved to procure the *aya-pana* again, whatever it might cost: but his demands were not complied with, and his offers were even rejected. A love of science, and the desire of being useful to his country, induced him then to pass over certain considerations which, under other circumstances, might have checked him. He remembered that there was a root of *aya pana* in the window of an individual, which had been constantly refused to him: he formed the project of carrying it off in the night-time. Accompanied therefore by some sailors he repaired to the place, and by means of long poles they threw down the pot which contained the plant. Captain Baudin immediately seized it, returned speedily on board, and at day break proceeded on his voyage to the Isle of France.

Scarcely had captain Baudin landed in that French colony when he informed the director of the garden of the state, that he had procured this valuable plant, with which he proposed to enrich the colony. As the *aya-pana* is easily propagated by slips, the plant was soon multiplied; and at present there is scarcely a plantation where it is not cultivated.

The properties of the *aya-pana*, if the information communicated to me, and that since transmitted to madame Bonaparte and C. Jussieu by captain Augustine Baudin himself, can be credited, are not belied at the Isle of France, where this plant enjoys as great celebrity as in its native country. The garden of government is continually beset by diseased persons, who come to solicit a few leaves of the *aya-pana* to cure their maladies. The colonial gazette daily contains some new proofs of its virtues; and it is employed with success not only against the bite of serpents, but also for curing the dropsy, syphilis in its most inveterate stages, and all sorts of wounds.

Among the great number of cures effected at the Isle of France by means of the *aya-pana*, and announced in the gazette already mentioned, I shall select three or four, which will

will show the manner of administering this plant, and the different doses employed, according to the purposes for which it is applied.

A planter of the Isle of France, C. Cotte, was stung in the right hand by a scorpion: a violent inflammation, accompanied with acute pain, immediately took place. Captain Baudin advised him to make use of the *aya-pana*. Several leaves were pounded, and applied to the wound; the pain immediately ceased: at the end of two hours there was no more inflammation, and the hand soon returned to its natural state.

C. Ponset, an officer of artillery, brought to captain Baudin a negro, who while fishing had been pricked by a fish known under the name of the *last*. The prick of this fish is so venomous that, before the *aya-pana* was known, amputation of the wounded limb was the only remedy. The hand of the negro was very much swelled. Captain Baudin recommended the application of the *aya pana* pounded; and as he supposed that a great deal would be required to effect a cure, he induced C. Poncet to send some person to the garden of the state to procure a considerable quantity of the leaves, in order that the hand of the patient might be wrapped up in them. But as the garden was at the distance of three leagues, and as the patient suffered a great deal from the pain of the wound, captain Baudin resolved to take seven or eight leaves from a young shoot which he had at his house. These he caused to be pounded, and then applied to the part affected. Next day the hand of the black was completely cured.

A black whose belly was much swelled, and exhibited symptoms of a dropsy, having applied to a surgeon, the latter resolved to tap him: he, however, deferred the operation because he had other patients to visit. Being urged by the master of the black to prescribe for him, he said, by way of derision, "Give him an infusion of *aya-pana* till I return." The surgeon's orders, happily for the patient, were literally complied with. The dropsy made no further progress; the symptoms gradually disappeared; and at the end of a few days the black was in a condition to resume his labours.

Captain Baudin, in going on board his vessel, happened to fall and hurt his left leg very much. It was necessary, on his being carried home, to cut off his stocking in order that the wound might be dressed. Captain Baudin ordered some leaves of the *aya-pana* to be boiled; and when the decoction was tepid the wounds were washed with it, and the leaves used for making the decoction were applied to them. The leg was then wrapped up in several folds of a bandage dipped

 in

in the same liquor, besprinkling it anew every ten minutes. About two hours after the first dressing the inflammation had so much abated that the patient was able to walk with the help of a stick, and at the end of thirteen days he was perfectly cured.

I could mention a great many more cures effected by means of the famous plant of Brazil; but, as it is not prudent to certify any facts of which one has not been a witness, we ought, in my opinion, to wait till the virtues of the *aya-pana* have been confirmed by the continued observations of able physicians. The testimony, however, of captain Baudin, and that of several persons lately arrived from the Isle of France, are entitled to some confidence, and give us reason to hope that the *aya-pana* may increase the number of our vegetable productions employed for relieving or curing the evils incident to the human race.

It is to be presumed that this plant will be soon multiplied in the gardens of the capital. C. Michaux, who has rendered so great services to botany and agriculture, has sent seeds of it to C. Cels, and madame Bonaparte has received some from the director of the garden of the state: but, as the seeds do not always produce plants, it is to be wished that some living shoots of it could be obtained: they might easily be multiplied from slips, and it might then be possible to form some decisive opinion in regard to the virtues ascribed to this plant.

Though we are allowed to doubt the virtues of the *aya-pana*, the botanical characters of this plant are so simple and easy to be known, that there cannot be the least uncertainty in respect to the genus to which it ought to be referred. The examination I have made of several complete plants has proved to me that it belongs to the family of the *corymbiferæ*, and that it belongs to the genus *eupatorium* of Linnæus.

The stem of this plant, which I have called *eupatorium aya-pana*, is straight, full of branches, of a dark brown colour, about three feet in height, and of the size of a goose-quill. Its leaves are alternate, almost sessile, lance-formed, and very entire; the flowers are of a bright purple colour, and disposed in corymbi at the summit of the stem and branches.

The *eupatorium aya-pana* may be distinguished from other species of this genus by the following character: *Eupatorium foliis lanceolatis, integerrimis, inferioribus oppositis, superioribus alternis; calicibus subsimplicibus, multifloris* *.

* A description of a plant possessing similar properties to the *aya-pana*, and agreeing with it in several of its characters, may be seen in our last volume, p. 36.—Edit.

A figure

A figure and a more extensive description of the botanical characters of the *aya-pana* will be found in the first number of the *Plantes du Jardin de la Malmaison*, which will appear in a few months.

P. S. I have received from madame Bonaparte a quantity of the dried leaves of the *aya-pana*, which I have delivered to citizen Alibert, physician to the hospital of St. Louis, professor of the materia medica, to determine, by experiments, its medical properties.

LXIV. *General Considerations on Vegetable Extracts.* By C. Parmentier *.

Modern chemists have denoted under the name of *extract*, or rather that of *extractive matter*, and placed among the number of the immediate materials of vegetables, a substance the distinguishing characters of which, when in its state of purity, are: it is soluble in water; after a proper evaporation of the juices, or of the decoction which held it in solution, it becomes a solid transparent body, and, when the evaporation has been too rapid, an opake mass, more or less insoluble; in both cases it is coloured, and has a savour always acid, and more or less bitter, acrid, or harsh.

They have found also in extractive matter the property of combining with alkalies; of strongly attracting oxygen; of being precipitated by acids, alum, metallic solutions, and oxides; and of being able, with the help of mordants, to adhere to stuffs like the colouring part of vegetables.

The medicines known in pharmacy under the name of extracts do not exhibit this extractive matter pure and unmixed, as it ought to be in order to be chemically examined.

Extracts are productions obtained by the evaporation of juices or infusions, or the decoctions of plants under different degrees of consistence, from that of honey to the dry or pulverulent state.

They are often very compound mixtures, which contain,

1st, All the immediate materials of vegetables which the water can carry with it, whether naturally soluble, or whether they acquired that property both by the help of caloric and the reciprocal action which they exercise on each other.

2d, All the combinations which these immediate materials can form with each other during the evaporation.

3d, All the soluble results of the decompositions they have experienced.

* From the *Annales de Chimie*, No. 127.

We

We may give an idea of the variety of the ſubſtances which are, or may in general be contained in pharmaeeutic extracts, by preſenting thoſe which have been found in the ſap, juices, infuſions, and decoctions of vegetables.

Before the intereſting analyſis of ſeveral kinds of ſap by Deyeux and Vauquelin, chemiſts were far from imagining that liquors ſo limpid, and in appearance ſo ſimple, were ſo much compounded as they really are.

The above celebrated chemiſts found in them the carbonic and acetous acid; acetites and carbonates of potaſh and lime; muriate, ſulphate, nitrate of potaſh, &c.

The ſap of the vine and horn-beam tree furniſhed a vegeto-animal matter.

That of the oak and beech-tree preſented gallic acid, tanning principle, and two ſorts of extracts.

That of the birch and maple gave a very abundant ſaccharine matter.

Of theſe different ſubſtances diſcovered in ſap, and of thoſe which exiſt in the expreſſed juices of freſh herbaceous plants, in thoſe of fruits, in the infuſions and decoctions of dried plants, and of all the ſolid parts of vegetables, we may, with ſufficient foundation, form the following liſt:

1ſt, Mucous matter or mucilage: it is obtained from ſeeds infuſed in water; there are ſome plants which contain it in great abundance, for example the mallows:

It oozes from the bark of ſeveral trees under the name of *gum*.

2d, The acid mucous matter: it exiſts in lemons, oranges, granadillos, &c.

3d, The acid and ſaccharine mucous matter: it is contained in apples, pears, grapes, &c.

4th, Sugar: it is found in ſeveral roots, in the ſap of certain trees; it iſſues under a fluid form from the bark of ſome of them, and becomes condenſed; it bears the name of *manna*: it exiſts in the gramineous ſtems, very little in the leaves, almoſt always in the ſtate of nectar, of honey, or mucoſo-ſaccharine matter. It abounds in fruits, and is not perceptible in the ſeeds until they have experienced germination, and particularly in berries. The ſugar-cane and maple give it pure and cryſtallized.

It is difficult to obtain it in the dry ſtate from other vegetables either, becauſe it is much more embarraſſed by the mucilage, acid, and extractive matter, &c. whether it exiſts in them under a different modification or in a ſtate of imperfection.

5th, Mucous matter combined with a reſin; it may be diſtinguiſhed diftinguifhed in plants which, like the *tithymalli*, give milky juices: nature prefents us with fuch a combination in refinous gums, fuch as gum ammonia, affa-fœtida, &c.

6th, Extractive matter: it is always united with other immediate materials of vegetables, and is found in greater quantity in plants which have come to maturity, in ligneous roots, wood, bark, and dried leaves, than in vegetables or thofe parts of vegetables where mucous matter prevails.

7th, Colouring principle: there are two kinds of it.

1ft, That which, combined with mucous or extractive matter, is foluble in water; it is feen in flowers under the fkins of fruit, in Indian wood, the root of madder, &c.

2d, That which, when fixed on any refinous fubftance united with extractive matter, is rather carried away than diffolved by boiling water, and may form part of extracts. It exifts in the root of the walnut-tree, in fandal wood, in the bark of the alder-tree, in the hufk of walnuts, &c.

8th, The tanning principle. This fubftance has an aftringent favour, which particularly diftinguifhes the oak, the gall nut, &c. The maceration of thefe fubftances has the property of precipitating and rendering infoluble the animal gelatin, of hardening it in leather, which by thefe means can be preferved for a long time without alteration.

The tanning principle is often accompanied with gallic acid, which may be diftinguifhed by the property it has of precipitating iron black, and which was thought to belong to that principle called aftringent, and which bears the name of *tannin.*

9th, The aroma. This is the volatile and odorous principle, which, being differently modified in many plants, gives to each of them an odour by which it is characterized.

It refides, in particular, in volatile oils. Perhaps it is nothing elfe than thefe oils themfelves, more or lefs combined with other vegetable principles, which facilitate its folution in water, and which, in feveral cafes, give it a certain fixity: but fome chemifts have entertained doubts refpecting the exiftence of aroma diftinct from the other materials of vegetables.

Extract of opium, indeed, retains the virous odour of the poppy, notwithftanding the continued heat which the juice of that plant experiences during its evaporation.

Extracts of rue, favine, and wormwood, retain the odour of thefe plants; and the fugar, carried to a very high temperature in the preparation of rofe and orange flower tablets, ftill exhales a very fenfible odour of the flowers which have been employed.

And

And in dragees called *orangeat*, the bark of the orange-tree, baked in a great deal of water till it lofes its odour and tafte, refumes enough of both to be agreeable when it is confectioned in fugar.

10th, Amylaceous fecula. This is a white, dry, pulverulent fubftance, without favour and fmell, infoluble in cold but foluble in warm water, with which it affumes the gelatinous ftate of glue.

It is extracted from gramineous feeds, tuberous roots, and feveral fruits.

11th, Gluten. This is a gray fubftance, of an infipid tafte, with the odour of horn flightly heated, of a foft, gluey, tenacious and elaftic confiftence, which is obtained in a ftate of purity only from the farina of wheat.

It is dry and pulverulent in the farina; but during the operation it is faturated with the quantity of water neceffary to affume the ftate of foftnefs, elafticity, and ductility, under which it appears.

It is this matter which in the fermentation of bread gives to the farina of wheat the moft decided pre-eminence over that of all the other gramineous plants, which contain none of it, or which, like barley, rye, and oats, contain only the materials of it.

Some chemifts have imagined that they could difcover the exiftence of it in feveral vegetables.

12th, Sulphur: a fimple, yellow, dry, cryftallizable, inflammable, and well known fubftance, which was thought to exift only in minerals, and which is found in feveral vegetables, thofe plants called antifcorbutic, the root of the patience, dock, &c. and even in animals.

13th, Vegetable acids. Thefe are very much multiplied, though they may be confidered as modifications of one and the fame acid.

Their diftinguifhing characters are: that they become decompofed in the fire, emitting an empyreumatic odour, and leaving a carbonaceous refiduum; that they even poffefs the property of being volatile, a property which may be employed with great advantage for obtaining them in a greater degree of purity.

Thofe beft known are:

1ft, The gallic acid: it exifts in the gall nut, the bark of the oak, &c.

2d, The benzoic acid: it is found in benjamin and other balms and refins.

3d, The citric acid: it abounds in lemons, goofeberries, &c.

4th,

4th, The malic acid: it is contained in apples, ſtrawberries, raſpberries, &c.

5th, The oxalic acid: it exudes from the hair of vetches.

6th, The acetous acid. According to ſome chemiſts, it is not always the product of the fermentation known under that name; it is obtained ſometimes by the action of the ſulphuric and muriatic acids on vegetable ſubſtances. C. Vauquelin found it in the ſap of trees.

7th, The oxalic acidulum. This is a non-ſaturated combination of the oxalic acid with potaſh: it is furniſhed by ſorrel.

8th, The tartarous acid. It is found cryſtallized in large quantity on the ſides of caſks in which wine has remained; but it exiſts alſo in tamarinds, the barberry buſh, &c.

Theſe acids are either inſulated in vegetables or combined with earths, either calcareous or aluminous, and alkalies.

To theſe ſaline combinations, which with the two acidula may be conſidered as the real eſſential ſalts of vegetables, we might add other ſalts which are often found in them: of this kind are the ſulphates of potaſh and ſoda, the muriates of potaſh and ſoda, the nitrate of potaſh.

Theſe laſt ſalts, according to the obſervations of chemiſts, are products in vegetables merely by the power which reſides in them, and which have the faculty of compoſing them perfect, of uniting and combining the principles which can conſtitute them, but in different proportions, ſince it may depend on a pre-exiſting ſaline atom.

Certain plants in which nitrate of potaſh is found are fonder of earth which contains it: pellitory, in particular, ſeems to chooſe, that it may grow there at its eaſe, the bottom of a wall well furniſhed with ſaltpetre.

When the ſea, impelled by an impetuous wind, enters through the mouth of a river at a time when it is leſs abundant in water; when it penetrates very far into the country through the ſmall canals by which it is watered, and drenches with brine the plants that uſually grow on their banks; theſe plants ceaſe to have a deſire for inhabiting them; they die; and their place is ſoon ſupplied by other vegetables to which this moiſture is ſuited, neceſſary, and indiſpenſable.

This is exactly what has taken place at the mouths of the Nile. One branch in particular of this river, that of Damietta, oppoſed for ſome time, by a peculiar circumſtance, leſs reſiſtance to the waters of the ſea: it received and ſtill receives them during that part of the year when it is loweſt; and ſince that period ſeveral of the plants which grew in the canals

canals in the neighbourhood of Damietta, and which could not bear to have their roots immerfed in earth moiftened by water lefs frefh than before, have difappeared; fo that the papyrus, which was very abundant in that diftrict, is now exceedingly rare. The papyrus has abandoned its native country.

Inftead of this lift, it would be more advantageous to be able to prefent an exact analyfis of each pharmaceutic extract in particular. This would be the means of enlightening the apothecary in regard to their preparation, and the phyfician in regard to their virtue; but the labours of modern chemifts on this point are ftill very deficient, and the antient pharmacopolifts never thought of undertaking this object, which they would not have been able to accomplifh with the neceffary chemical knowledge. For want of better materials, they collected very juft obfervations; fo that, guided by them, and authorized by the example of nature, which in refinous gums, fap, and refins, prefented them with products very fimilar to the different extracts, they arranged the latter into four claffes:

1ft, Gummy extracts. They refemble glue and jelly, and are furnifhed by the feeds of the flag, mallows, &c.

2d, Gummy refinous extracts. Thefe are thofe which contain gum and refin united together. They are obtained from jalap, aloes, &c.

3d, Saponaceous extracts. Thefe are thofe in which the gummy and refinous principles are fo well combined that they do not feparate. Of this kind are extracts of the carduus benedictus, fumitory, &c.

4th, Refinous extracts. Thefe are the refins properly called, obtained either by means of alcohol, which gives them more or lefs pure, or by means of ether, which furnifhes them abfolutely freed from gummy principle.

The different extracts have received different names.

Robe, fapa, defrutum, jelly, extract.

Robe is the juice of any fruit infpiffated to the confiftence of honey.

Sapa is the juice of grapes evaporated to the fame degree.

Defrutum is the fame juice deprived of two-thirds of its humidity, and which being left to ferment in this ftate gives baked wine.

Jelly is the infufion or decoction of the mucilaginous fubftances of vegetables, or the gelatinous parts of animals concentrated to the proper degree.

Extract is the product of the evaporation of vegetable juices, infufions, or decoctions.

As the object which pharmacopolifts propofed by preparing thefe different extracts was to concentrate and preferve in a fmall volume the virtues and properties of vegetables, it is neceffary that we fhould give a view of the means they employed to accomplifh this object, fuch as the extraction of the juices of green plants; maceration, infufion, or the decoction of dried plants; and evaporation.

[To be continued.]

LXV. *Biographical Memoirs of Dr.* ROBISON, *of Edinburgh.*

SOME time ago we gave a head of Dr. Robifon, with a very brief account of his life collected from fuch imperfect materials as we could at that time obtain. As we have fince learnt that this fketch was incorrect in feveral particulars, and as it always gives us pleafure to rectify any errors into which we may inadvertently fall, we are happy to have it in our power to lay before our readers a more correct life, written by a gentleman of diftinguifhed literary abilities, and who, from his intimacy with the profeffor, muft be perfectly acquainted with the fubject. Dr. Gleig, the gentleman alluded to, in a letter to the editor of the Anti-jacobin Review, to whom this life was firft communicated, expreffes himfelf in the following candid manner:

In the tenth volume of the Philofophical Magazine are Memoirs of the Life of John Robifon, LL.D. &c., Profeffor of Natural Philofophy in the Univerfity of Edinburgh; the author of which has, indeed, done juftice to the profeffor's general character as a man of fcience and of virtue, whilft he has ftated inaccurately almoft every incident of his life. To point out the numerous miftakes into which he has fallen, and correct them in a table of *errata*, would ferve no purpofe, becaufe to fuch tables attention is feldom paid; and being an abfolute ftranger to the conductor of that publication, I cannot requeft him to fill, with a fecond life of my friend, pages profeffedly devoted to the improvement of ufeful arts and phyfical fcience. Perhaps it may gratify curiofity to inform the public, that the engraved portrait of Dr. Robifon, which accompanied the Memoirs in queftion, appears to me a ftrong, though perhaps not flattering, likenefs.

I am, Sir, your moft refpectful humble fervant,

GEORGE GLEIG.

Stirling,
Dec. 24, 1801.

JOHN

John Robison, LL.D. is a younger ſon of the late John Robiſon, eſq. of Boghall, in the county of Stirling.

Mr. Robiſon, the father, engaged, at an early period of life, in commerce, and carried on, for many years, a lucrative trade as a merchant in Glaſgow; but before the birth of the ſubject of this memoir he had retired from buſineſs, and lived on his eſtate. He is remembered both in Glaſgow and in the country with much reſpect, as a man of great piety, honourable in his commercial dealings, kind to the poor, and a good landlord.

Dr. Robiſon was in 1739 born at Boghall, where he paſſed the early years of childhood; but there being no ſchool of any note in the pariſh of Baldernock, where Boghall is ſituated, he received the whole of his education in Glaſgow. His progreſs through ſchool muſt have been rapid; for before he was nineteen years of age he had completed the uſual courſe of ſtudy in the univerſity.

I have indeed often heard him regret that he was but a careleſs ſcholar: but his apprehenſion is ſo quick, and his memory ſo retentive, that he muſt have acquired a competent knowledge of the Greek and Latin languages with very little labour. His knowledge of theſe languages now is ſuch as few men poſſeſs whoſe lives have been devoted to the purſuits of ſcience; and this, in all probability, it would not have been; had not a ſolid foundation been laid at ſchool. Senſible, however, that by greater exertion he might have done more than he did, he regrets, at preſent, what moſt men, who were clever boys, have cauſe to regret, that, at ſchool, he contented himſelf with barely ſurpaſſing his duller claſs-fellows.

In the univerſity he had the happineſs of ſtudying under the profeſſors Moore, Simſon, Smith, Dick, and Leechman, whoſe eminence as teachers of the Greek language, of mathematics, moral philoſophy, natural philoſophy and theology, will be long remembered in Glaſgow. To mathematics he had no particular predilection till he perceived the uſe of that ſcience when ſtudying natural philoſophy under Dr. Dick; and to algebra he has at no period of his life been partial. Dr. Simſon's lectures were not, indeed, calculated to make any of his pupils partial to that branch of ſcience; and I have heard Dr. Robiſon ſay, that he firſt attracted the regard of that admirer of antient geometry by owning his diſlike of algebra, and by returning a neat geometrical ſolution of a problem which had been given out to the claſs in an algebraic form. With this mode of ſolution the profeſſor was delighted, though the pupil candidly acknowledged that it had been adopted only becaufe he could not folve the problem in the manner required of the clafs.

Of the knowledge which Dr. Robifon now poffeffes of mathematical fcience in all its branches I need fay nothing, fince I have been the inftrument of communicating fome valuable fpecimens of it to the public; but I know that, even yet, he delights much more in geometry than in any of the modes of algebra, affigning, as the reafon of his preference, that in the longeft demonftration the geometrician has always clear and adequate ideas, which the moft expert algebraift can very feldom have.

Dr. Dick, who had been conjoined with his father in the profefforfhip of natural philofophy, dying in the year 1757, Mr. Robifon offered himfelf to the old gentleman as an interim affiftant; and, though then not nineteen years of age, he had the honour to be recommended as fit for the office by Dr. Adam Smith, afterwards fo well known by his celebrated work on the Wealth of Nations. Profeffor Dick, however, thought him too young; but, acknowledging his merit, he joined with Dr. Simfon in recommending him to Dr. Blair, prebendary of Weftminfter, whom they underftood to be in queft of a young man to go to fea with Edward duke of York, and read mathematics with his royal highnefs and a young officer who was to attend him as a companion. Though this employment had been declined by another gentleman, Mr. Robifon embraced with eagernefs fo favourable an opportunity of efcaping from the clerical profeffion, from which, though defigned for it by his father, whom he revered, and could not difobey, he had acquired an infuperable averfion. That averfion arofe not, however, from any determination formed by him to devote his life to the advancement of mathematical fcience, and ftill lefs from any diflike which he had conceived to the ftudy of theology; but from circumftances which, though they did credit to his head and heart, were fuch as would not intereft the public. No man, I believe, has jufter notions of the importance of theological knowledge, or a more fincere regard for the faithful minifters of religion, than profeffor Robifon; and certainly no man has a more rooted abhorrence of hypocrify in all its forms.

Without any very diftinct notion how he was to be employed, or what were to be the emoluments of his office, Mr. Robifon went to London in 1758. There he foon difcovered that the hopes with which he had been flattered, of reading mathematics with the duke of York, were built upon no other foundation than fome vague fcheme of Dr. Blair's, in cafe his royal highnefs fhould go to fea the enfuing fummer;

mer; and it is not to be doubted but that he felt the disappointment. He acknowledges, indeed, that he felt it severely; but, as he could not think of returning to Glasgow, he embraced the opportunity of still going to sea as mathematical tutor to Mr. Knowles, eldest son of admiral Knowles, and the intended companion of the duke of York.

With that gentleman he went, in 1759, on board the Neptune, of 90 guns, bound to Quebec; and Mr. Knowles being on the voyage appointed lieutenant on board the Royal William, Mr. Robison accompanied him, and, at his own request, was rated midshipman. I have often heard him say that in the Royal William he spent the three happiest years of his life. When he gave me the article Seamanship, which is published in the *Encyclopædia Britannica*, he said it was the superior seamanship of captain Hugh Pigot which so forcibly turned his attention to that noble art, and gave him such a love for the profession that it is still a favourite subject of his thoughts. Indeed, I believe that, if he ever formed a determination to devote his life to the improvement of any art or science, it was at this time to the improvement of the art of seamanship. When captain Pigot took the charge of the ship, which during very stormy weather he generally did, the address with which he made her do whatever he pleased, after she had baffled the efforts of the officers of the watch, filled the mind of Mr. Robison with delight and wonder. It excited in him an ambition to rival such skill, whilst he confesses that he despaired of ever surpassing it.

It was on board the Royal William, in the river St. Lawrence, that Mr. Robison first noticed a connection between the *aurora borealis* and the direction of the magnetic needle. Pointing out the circumstance to the gentlemen on the quarter deck, he got the remark inserted in the St. James's Evening Chronicle, and afterwards in the London Chronicle, with an invitation to navigators to pay attention to the subject, and communicate their observations to the Royal Society.

A reinforcement of men being wanted for the ships lying before Quebec, lieutenant Knowles and a hundred seamen, with petty officers, were received from the Royal William on board the Stirling Castle, where sir Charles Saunders had his flag. There Mr. Robison saw much service both on board and ashore, and was sometimes employed in taking surveys of different parts of the river. Returning to the Royal William when Quebec was taken, he spent the whole of next year and part of the following in the bay of Biscay, and on the coasts of Spain and Portugal.

Lieutenant Knowles being appointed to the command of

 the

the Peregrine ſloop of war, Mr. Robiſon accompanied him; but thoſe friends ſoon after parted, never to meet more. In 1762 the ſubject of this memoir was ſent, by the admiralty board, to Jamaica, to make trial of Harriſon's time-keeper; and, on his return, he learned, with grief, that the Peregrine had foundered at ſea, and that his beloved friend and pupil, with the whole crew, had periſhed.

His proſpects were now not flattering. Admiral Knowles had retired to the country in deep affliction for his ſon; lord Anſon, on whoſe promiſe of future preferment Mr. Robiſon had gone to Jamaica, was dead; in the friendſhip of Dr. Blair he had little confidence; peace ſeemed to be at no great diſtance; and his hopes of advancement in the navy were very ſmall.

He determined therefore to return to college, being aſſured by admiral (then ſir Charles) Knowles, that he would ſend his remaining ſon as ſoon as he ſhould have paſſed through the forms of Eton ſchool, to complete his education under his inſpection. Next year Mr. Mac Dowell jun. of Caſtle Semple (now of Garthland, and M. P.) was placed under his care; and ſoon afterwards he carried from London to Glaſgow Mr. Knowles, now ſir Charles Knowles, and a rear admiral.

It was when he returned to college from the navy, as I have heard Dr. Robiſon ſay, that he ſeriouſly began to ſtudy; but his helps were gone. Dr. Simſon was dead, Dr. Smith ſoon left Glaſgow to travel with the duke of Buccleugh, and Dr. Moore was greatly changed. He attended, however, the lectures of Mr. Miller, the late celebrated profeſſor of civil law in the univerſity of Glaſgow, and thoſe of the ſtill more celebrated Dr. Black, on chemiſtry; and finding in Dr. Reid, who ſucceeded Dr. Smith, and in Dr. Alexander Wilſon, profeſſor of aſtronomy, minds congenial with his own, he ſoon formed with theſe two men a very cloſe intimacy. He ſpeaks likewiſe with great affection of Dr. Wight, profeſſor of hiſtory, and of Dr. Stevenſon, profeſſor of medicine, and in terms of high reſpect, indeed, of all the members of that learned body. That the reſpect between them and him was mutual is apparent from many circumſtances.

When Dr. Black was called, in 1767, to Edinburgh, the ſenate of the univerſity of Glaſgow, on his recommendation, appointed Mr. Robiſon to ſucceed him as lecturer on chemiſtry. He read lectures on that ſcience for three years with great applauſe, and had among his pupils men who have ſince diſtinguiſhed themſelves among the moſt eminent chemiſts of the age.

In 1770 ſir Charles Knowles, being invited to St. Peterſburgh by the empreſs Catharine II. to aſſiſt her in reforming her

her marine, requeſted Mr. Robiſon to accompany him in the capacity of his official ſecretary, with a ſalary of 250l. a-year. Mr. Robiſon's attachment to the navy, and to his affectionate friend and patron, being as ſtrong as ever, and a lecturer not having the ſame rank in the univerſity of Glaſgow with a profeſſor, the requeſt was cheerfully complied with.

It would appear that his conduct at St. Peterſburgh, and the knowledge which he had occaſion to exhibit in the view of the admiralty college, had powerfully recommended him to that board; for in 1772 he was appointed inſpector-general of the corps of marine cadets,—an academy conſiſting of upwards of four hundred young gentlemen and ſcholars, under the tuition of about forty teachers. As the perſon who fills this office has the rank of lieutenant-colonel, it became neceſſary, by the cuſtoms of Ruſſia, that Mr. Robiſon ſhould prove himſelf a gentleman, or what is there called a *dvoranin*; and the proof required was entered on record.

As inſpector-general he had nothing to teach, nor did he ever teach mathematics in any ſchool during his reſidence in that vaſt empire. His duty was to viſit daily every claſs of the academy; to receive weekly reports from each maſter, ſtating the diligence and progreſs of every perſon in his claſs; and twice a-year to advance the young gentlemen into the higher claſſes, according to their reſpective merits. Of theſe he was conſtituted the ſole judge, and from his ſentence there lay no appeal.

In juſtice to a ſtranger and foreigner, it is proper to add, that, when ſpeaking of this part of his duty, Dr. Robiſon always mentions in terms of high reſpect the enlightened and honourable conduct of general Kutuzoff, who was military head of the academy, and held the third place in the admiralty college. He repreſents the behaviour of that general to himſelf as more like the behaviour of a parent than of a ſuperior; for he approved of all his deciſions, adopted all his meaſures, ſupported his authority againſt intrigue and oppoſition, and introduced him to the grand duke as an admirer of the Ruſſian language, of which his imperial highneſs was the declared patron. This was a very powerful recommendation; for, however abſurdly Paul ſeems to have conducted himſelf on the throne, he had taſte enough, when grand duke, to feel the beauties of that language, and to befriend foreigners, who, like the ſubject of this memoir, had ſtudied it with ſucceſs.

Dr. Robiſon had not the honour of being at all known to the empreſs; nor did I ever hear him ſpeak of being concerned in any plan for supplying her palace with water; though I recollect a conversation between him and me, occasioned by the description of a ball-cock * in one of our newspapers, which could not have failed to lead to the mention of such a plan had he known any thing of it. I have, however, heard him say, that he presented to the admiralty college a plan for rendering the magnificent docks at Cronstadt of some use by means of a steam-engine; and that the plan was adopted, and executed with success after he left Russia.—*Tulit alter honores.*

He quitted that empire not because the emoluments of his appointments were comparatively small, for they were much greater than those of his appointment in Edinburgh, but because, the academy being at Cronstadt, a dismal solitude, he found his situation extremely irksome. Had it been at Saint Petersburgh, the society of Euler and Æpinus, to whom he was known, as well as of many Russian gentlemen whom he speaks of as possessing British hearts, might have reconciled him to that capital; but to get away from Cronstadt he accepted with pleasure the invitation of the magistrates and town council of Edinburgh to be professor of natural philosophy in their university. The grand duke parted with him reluctantly, and requesting him, when he left the academy, to take with him some young men of talents from the corps of cadets; he promised him a pension of 400 rubles (80 l.) a-year. That pension was regularly paid only during the three years that the gentlemen whom he selected resided in Edinburgh: it was then discontinued, as I think he told me, because he did not continue a correspondence with the academy, and communicate all the British improvements in marine education,

Much has been said of professor Robison's lectures on natural philosophy; much that is true, and something that is unquestionably false. It is universally admitted that he gives a comprehensive and scientific view of his subject, and that he skilfully applies its principles to the acts of life; but complaints have been made of the abstruseness of his demonstrations. Are the complainers certain that the demonstrations are abstruse to such as are qualified by a preparatory know-

* The ball-cock thus described was, in fact, the same with that of Desaguliers, noticed in the article Water Works in the *Encyclopædia*. Dr. Robison, after expressing some surprise that the writer in the newspaper should have said that it is not noticed in that article, gave me an account of his having been frequently employed to disengage air from water pipes both in England and in Scotland; but said nothing of his being so employed at St. Petersburgh.

ledge

ledge of mathematics to enter upon the ſtudy of natural philoſophy? It becomes not me, perhaps, to anſwer this queſtion; but I may ſurely ſay that, in converſation, no man communicates knowledge more clearly than Dr. Robiſon, and that a more perſpicuous account of what philoſophy can attain, and how it ſhould be cultivated, will not readily be found than what he has given in the *Encyclopædia Britannica* under the titles Philoſophy and Phyſics. To underſtand the demonſtrations which he gives in the claſs, no higher knowledge is requiſite than that of the moſt elementary properties of the conic ſections; and, for my part, I cannot conceive how he, or any man, could demonſtrate that the moon, for inſtance, is retained in her orbit round the earth by a gravitation, ſuch as Newton diſcovered, to him who knows not the nature of the ellipſe which ſhe deſcribes.

Of the eſtimation in which his talents and his virtues have been held, not only by his colleagues in the univerſity of Edinburgh, but by various other literary ſocieties, the following unſolicited honours conferred upon him by thoſe ſocieties, afford ample evidence.

In 1783, when the Royal Society of Edinburgh was incorporated by charter, he was unanimouſly choſen general ſecretary; and diſcharged the duties of the office to the ſatisfaction of the preſident, vice-preſidents, and council, till a few years ago, that bad health obliged him to reſign it. In 1798 he was complimented with the diploma of LL.D. by the academy of New Jerſey. In 1799 he was created LL.D. by the univerſity of Glaſgow, which ſent to him a diploma conceived in terms the moſt honourable, as well to the ſenate that decreed it, as to him in whoſe favour the decree was paſſed. And in 1800 he was unanimouſly elected foreign member of the Imperial Academy of Sciences of St. Peterſburgh, in the room of Dr. Black. To the ſcientific public it may not be unacceptable to add, that, at the particular requeſt of the friends of that eminent chemiſt, he is now preparing his lectures for the preſs.

Though this detail muſt not be conſidered as a ſpecimen of biography, but merely as correct annals of Dr. Robiſon's life, it would be unpardonable to conclude it without noticing his connection with the fraternity of Free-maſons, and his attack on their higher myſteries.

As I was privy to the compoſition of his Proofs of a Conſpiracy, &c. I have his own authority to ſay that he never was in a maſon lodge in Great Britain. Once, indeed, when a lad at college, he was carried into a barn by two or three of his companions, who, being themſelves free-maſons, ſhowed him,

him, in a frolic, some mummeries, exacted his oath of secrecy, and told him that he was now a free-mason! The whole appeared so silly that he believed they were playing a trick upon him. This was, indeed, the case; but the scene gave him such an idea of masonry that he never bestowed a thought upon it till he was at Liege in his way to St. Petersburgh. Dining one day with sir Charles Knowles at the table of the prince bishop, he was surprised to observe that all present, masters and servants, had about them some badge or other of free-masonry; and learning that the chapter constituted a lodge, of which the bishop was the *très-vénérable*, he was easily persuaded by such masons to become a brother. He was accordingly received apprentice a few days after, and has himself published an account of his progress through the other degrees till he attained the rank of Scotch master. In all the conversations which I have had with Dr. Robison on this subject, justice requires me to say that I never heard him once insinuate that there is any thing immoral in the simple system of British masonry; and he certainly has not accused that system of immorality in his book. Yet I have heard British masons apply to themselves all that he hath said of the French degrees, and even of the order of the *Illuminati*, and represent his Proofs of a Conspiracy as a collection of calumnies! Surely such men are not aware that, by holding this language, they accuse themselves of crimes of which the author of the Proofs has declared them innocent. I can, however, assure them that he considers their mysteries as extremely frivolous, though not criminal; and that, on account of the superstructure which elsewhere has been raised on them, he never advises a young man to become a free-mason.

Dr. Robison retains an affectionate attachment to the place of his nativity, and passes a part of every summer amid the scenes of his youthful pleasures. What he possesses is but a remnant of the estate which was the property of his father; but he is a man of too much virtue to diminish it otherwise than as it was diminished before—in making provision for his children; and too much addicted to science and literature to set his heart anxiously on increasing it.

Nam sapiens virtuti honorem, præmium, haud prædam petit.

LXVI. *Extracts from Foreign Journals respecting the History and Antiquity of the Cow-Pock, and the Progress of the Vaccine Inoculation.*

IF the most glaring instance were required of the very long oversight of men to a simple fact, of obvious application

tion to a practice of infinite moment to the comfort of the whole human race, one might name with truth the inoculation of the vaccine disease. When we read, in the work noticed in our last Number, the accounts of the fact of the cow-pock being known among the country people, not only in England, but in Ireland and Germany; and even some instances of intentional inoculation, we felt humiliation from the notion of the human intellect excited on this occasion. Although, with partiality to our own countrymen, we may even rejoice to find, in the extracts before us, instances of equally glaring oversight in other nations; yet these further instances, we must allow, afford confirmation of the humiliating notion just mentioned.

I. *On the Antiquity of the Cow-Pock, and of its Inoculation Time immemorial in Germany. (From Annalen der Kuhpocken-Impfung.)*

(No. 2, page 135.) Buckburg, Feb. 25, 1802.

"The following highly important document, and hitherto the oldest known in regard to the history of the cow-pock, will, no doubt, be welcome to our readers, and particularly to the friends of vaccination.

" A weekly journal, entitled *Allgemeine Unterhaltungen*, for the year 1769, printed at Gottingen by F. A. Rosenbusch, with plates, contains a learned dissertation, by a writer who calls himself 'An old housekeeper,' without mentioning the place of his abode, 'on the disease among the horned cattle; of quotations from Livy;' the most remarkable passage in which is to the following purport: 'On this subject, however, I will not venture to decide; but what chiefly excites my attention, is the circumstance that such a plague was very *common among men and these animals*, which is not the case at present. I conceived that there might be many diseases of this kind, and that perhaps it was only some inflammatory fever, accompanied with eruption, which was often common to men and animals; and Livy, in one place, calls it expressly *scabies*. But it afterwards occurred to me that it might be the well-known cow-pock, not unknown in this country, (Gottingen, no doubt, where the journal was printed,) and which is still infectious to the girls who milk cows, and to other persons who have the care of these animals. It is true, indeed, that few men or animals die of this disease; but those attacked by it may be exceedingly sick, and perhaps it is owing to the coldness of our climate that the poison is not more violent. I must, however, remark, that in this country (Gottingen) those

those who have had the cow-pock are fully convinced that *they are secured from the infection of the common small-pox, as I myself, on carefully inquiring into this circumstance, have often heard.*'

"This remarkable document was discovered and again made known by Mr. C. G. Steinbeck, who, as I learn by a letter from a friend, inserted it in his monthly journal, called The German Patriot, for January 1802. When the person who transmitted this notice, counsellor Faust, found it among his books, he exclaimed, Ευρηκα! I have found it! Hanover or Germany, therefore, enjoys the honour of having first discovered and publicly described the cow-pock, and the virtue it possesses, as far as is yet known, of being a preventive of the small pox*."

(No. 1. page 86.) "In the month of July, 1800, the cow-pock was discovered among the cows in the neighbourhood of Plön, and a physician of Eutin made experiments with the matter, an account of which may be seen in Henning's *Genius der Zeit*, for the month of October, 1800. 'Just when I was about to send the copy of these annals to the press,' says the author, 'I read in the *Reichs Anzeiger*, 1801, No. 182, a piece of very important intelligence, by counsellor Hellwag of Eutin, that in Holstein and Jutland there are several men who have had the cow-pock, which is indigenous in that country, both by infection and by being purposely inoculated, 13, 29, 36, and even 46 years ago, and who have been hitherto preserved from the infection of the small-pox, though attempts have been made to communicate the latter disease to them by inoculation."

(No. 2, p. 110.) "A malignant species of the small-pox, which, about the time when the first experiments were made in Germany, prevailed for fifteen months in the neighbourhood of Hanover, and swept off a great many children, contributed not a little to favour the introduction and propagation of the vaccine inoculation.

"Matter was immediately procured from Dr. Jenner in Gloucestershire, and it was observed that it produced more local effect on the place of inoculation, while that obtained from Dr. Pearson of London often produced a mild eruption. The same thing was afterwards observed in regard to the cow-pock matter produced in Hanover. At first it was supposed that this difference in effect arose from a difference in the inoculating matter. But Dr. Pearson, who was consulted

* Is it not very singular that no physician of Gottingen, or of Germany in general, had it been only in consequence of this Essay of the year 1769, thought this circumstance worthy of further examination?

sulted on this occasion, informed Stromeyer *, in a letter, that he considered the difference which had been observed as merely accidental, and not as depending on the difference of the matter. Even experience shows, that in regard to the principal object, the property of preventing the small-pox infection, the vaccine matter of doctors Jenner and Pearson, and that produced in Hanover, are entirely the same."

(No. 2. p. 126.) "That the cow-pock does not infect, but by the immediate contact of wounded places, has been confirmed by experience in Hanover; as has also been the assertion of Dr. Pearson, that those who have once had the common small-pox, or the genuine cow-pock, cannot be affected a second time by either of these diseases, even though the vaccination be several times repeated. In the last case, however, suppurating pustules, surrounded with a little redness, arise sometimes from the puncture; but they are not only unattended with the characteristic form of the real cow-pock pustules, but the general re-action on the system connected with it."

II. *Cow-pock introduced into Portugal.* (From the Lisbon Gazette of 31st July, 1802.)

"Doctor Francis Manuel da Paula, approved physician, &c. having applied himself successfully to the vaccine inoculation, makes known to the public, that he is provided with matter of the best quality for inoculation from England, by means of Dr. Domeir †, who first propagated the disorder before he left this country. The above physician Da Paula has continued the inoculation from children of three months old and upwards, among which number were his own children."

III. *Discovery of Vaccine-Pox among the American Cows.* (From the American Medical Repository, vol. v. p. 93. 1801.)

"We are happy to find that our suggestion to physicians in the United States, to inquire for the vaccine disease among the cows of this country (see our vol. iv. p. 322), has produced the desired effect. The coincidence of the following articles of information, derived from different respect-

* Neues Hannovr. Magazin 1800, and Hufeland's Journal der Prakt Heilk, v. 10. part 3.

† Dr. Domeir is the attending and travelling physician of his royal highness the duke of Sussex; and after great difficulties were overcome, and bestowing much pains, he introduced the cow-pock inoculation with matter furnished from the Vaccine Institution of London.

able

able sources, and, so far we know, without communication with one another, seems to place the fact beyond the reach of doubt. We state them as they severally came to our hands.

"1. Dr. William Buet, of Sheffield, in the state of Massachusetts, in a letter to Dr. Miller, dated 20th May, 1801, describes the case of a lad, in his neighbourhood, affected with an eruption on his face and hands, greatly resembling vaccine pustules, to whom he was called on the 10th of the preceding month. With matter taken from these pustules he inoculated several persons, and observed the disease to pursue a similar course, and to exhibit similar phænomena, to a case of actual vaccine-pox then under his care. And after the termination of this new disease, he tested it, as usual, by variolous inoculation, with the same happy result as in other cases of the vaccine-pox. Upon inquiry, he found the lad had sometimes milked cows, that these cows had been observed to have sore teats, and that the hands and face of the lad had been prepared for the reception of the disease, by having been previously scratched in play by his companions.

"2. Dr. Elisha North, of Goshen, in the state of Connecticut, who has bestowed much attention on the vaccine disease, has found it among the cows of that neighbourhood, and inoculated it with success. In a letter of the 25th of May last to Dr. Miller, he announces the discovery, and that the inoculation of the disease had been tried in a number of instances with complete effect.

"3. Dr. Joseph Trowbridge, of Danbury, in the state of Connecticut, in a letter to Dr. Mitchill, dated 6th of July, 1801, communicates a similar discovery which he has made among the cows of that place. At that time he had inoculated three persons of his own family, and the disease produced by the inoculation exhibited all the appearances of the genuine vaccine-pox.

"Since our last Number, the vaccine disease, apparently genuine, has been introduced and propagated in this city (New-York). The present season of the year, which, according to popular prejudice, is deemed unfavourable to inoculation, has hitherto prevented the disease from being employed frequently or generally: and the usual banishment of the small-pox at this time renders it more difficult to apply as a test of the genuineness of the few cases of vaccine-pox which have yet occurred. We hope to be able to offer a more satisfactory account of the progress of the disease in our next Number."

The

The above account affords another proof of the little dependence to be placed upon physicians in the application of facts to practice; and the more glaring they are, it seems, the more heedless, or even stupid, they have been in some instances, as in the present case. It now appears that the cow-pox prevails not only in the western counties of England, where the farmers discovered that their servants or themselves were exempted from the small-pox by having had the cow-pox; but the same disease and the same fact of exemption were also known in other English counties; in Ireland, in Holstein, in Denmark, in many parts of Germany, and even near Gottingen, in Switzerland, and in the Milanese. Nay, as long ago as 1769, the German journalists announced these facts, and the advantages over the small-pox.

LXVII. *Some curious Observations respecting the Crocodile. By* C. Frank, *Physician to the French Army of the East.*

When Egypt and the Nile become the subject of conversation in Europe, the danger to which people are exposed of being devoured by the crocodile is commonly mentioned. It is, however, not generally known that this amphibious animal is never seen in that part of the Nile which traverses Lower Egypt, and that to obtain a sight of this monster it is necessary to go up the river a considerable way into the Thebaide. I never found any crocodiles till I had got a good way beyond Gyrge. This animal quits its retreats at the bottom of the water during the warm days, and when the Nile is low, and places itself on the sand-banks, which are then frequently met with. It was in the months of April and May that I travelled in the Said. The crocodile seldom appears on the banks of the river, except when little frequented, or when access to them is difficult. It appears that the crocodile is aware of the danger to which it would be exposed without that precaution. In general, it never goes to a greater distance from the water than about six paces. The least noise awakens it. I never was able to get within musket shot of it. Besides, as the animal is covered with very hard scales, it is almost impossible to kill it, unless it be wounded exactly under one of the shoulders. I found at Dendera a *kachef* who took a singular delight in hunting the crocodile; he had killed, in succession, seven of them, which I saw placed on the terrace of his house in such a manner, that at some distance they resembled so many cannon. If the natives shoot any of them, or catch them in snares, they are as proud as those who, in Europe, kill a wolf. Of all the crocodiles which I had an opportunity of seeing, either in going up or down the Nile, I never observed any more than eight or ten feet in length. Prosper Alpinus speaks of a crocodile thirty ells in length: but it is proper to remark that this author never was in Upper Egypt, and that he was probably deceived by false reports. The celebrated Norden says he saw some fifty feet in length. I am, however, of opinion that he was deceived also; for I never found any person in the country who saw any so large.

In regard to the danger of being devoured by this animal, it is much less than is commonly believed. The crocodile, in general, seems to dread man, for it is not fond of inhabited places: the nearer, then, that one approaches to the cataracts, the more frequently they are met with. The indifference with which the inhabitants and their children amuse themselves in the water and walk on the banks, proves to me that they are in no dread of the crocodile.

If a favourable opportunity, however, occurs, this cunning animal will seize a sheep, a goat, or an ass, and sometimes a child, which it drags with it to the middle of the river, and plunges to the bottom. In one place, where the women are accustomed to fill their vessels with water, I saw a semi-circular palisade, made of reeds, destined to prevent the crocodile from doing mischief. In that place, one of them seized and tore off a woman's breast at the time she was stooping down to fill her pitcher with water.

It is a very singular observation, that this animal when it remains out of the water is almost always surrounded by various large birds, among which I could always distinguish the pelican. What strange relation exists between these animals so different? It is a well-known fact, that the white heron has a singular sympathy for the buffaloes, oxen, and cows. Does there exist a sympathy of the same kind between these birds, but particularly the pelican and the crocodile?

LXVIII. *Proceedings of Learned Societies.*

FRENCH NATIONAL INSTITUTE.

ACCOUNT of the labours of the Class of the Mathematical and Physical Sciences during the third quarter of the year 10.—Continued from p. 300.

C. Denieuport, associate, has sent to the class a memoir concerning the equilibrium of a body which balances freely on on a flexible wire or fluid. He determines, in a special manner, the conditions of this equilibrium from this principle, that the centre of gravity of the system must descend as low as possible; and details various situations of equilibrium, either fixed or transitive, which the proposed bodies may assume.

EXPERIMENTAL PHILOSOPHY.—*Determination of the Intensity of the Action which Magnetic Bars exercise on different Metals purified by the ordinary Processes.*

In pursuing his researches on the action which magnetic bars exercise on all bodies, C. Coulomb has been able to measure the intensity of this action for the different metals brought to that state of purity which results from the common operations of refining.

He formed small cylinders of wax, into which he introduced different quantities of iron-filings uniformly dispersed over the whole mass, and, by measuring the action which they experienced from magnetic bars, has deduced the law according to which the magnetic force decreases in proportion as the quantitity of the iron mixed is lessened. With these two data he determined the very small quantity of iron that remained in an ingot of silver fused with an equal portion of iron by C. Guyton, and which in the operation had appeared to separate itself very exactly from the second metal.

This silver, dissolved in nitric acid and precipitated by prussiate of soda, gave no indication of the presence of iron; it however experienced, in a sensible manner, the influence of the magnetic bar, and in such a manner as to show that it still contained iron. By comparing this action with that of the same bar on the cylinders above mentioned, C. Coulomb has found that there remained in the piece of silver $\frac{1}{312}$ of iron. He found by the same method, that if the action of the magnetic bar on a plate of silver purified by cupellation, or extracted from the muriate, ought to be ascribed to the presence of iron, the quantity of the latter metal present will amount only to $\frac{1}{130000}$ part. This quantity, which may be considered as infinitely small, would, however, be in such a state of division that there would be no molecule of silver which did not contain a portion of iron.

On the 11th of Pluviose C. Guay Lussac presented to the Institute a memoir on the dilatation of various elastic fluids by the agency of heat. In examining the experiments of different philosophers on this subject, he states that the great discordancy in their results is chiefly owing to the presence of water in the apparatus employed, which being dissolved by

 the

the gas employed, or converted into vapour in it, in different proportions at different temperatures, causes it to undergo irregular expansions. By the methods that he employed, the vessels and instruments made use of were rendered completely dry; and under these circumstances he found that the volumes of all the permanent elastic fluids, whether soluble or insoluble in water, underwent an uniform and equal change of volume with every change of their temperature; and that they suffered an expansion of $\frac{80}{213}$ of their bulk in passing from the temperature of 32° Fahrenheit to 212°. The vapour of ether obtained by heat followed the same law of equable dilatation; and calculating upon it, it appears, that with every increment of a degree of Fahrenheit there is an increment of volume of nearly $\frac{1}{483}$, probably, for all aëriform fluids. This is not very different from the estimation given in his *Traité Elémentaire de Chimie*, by Mr. Lavoisier, who, from the experiments of Mr. de Luc, considers the expansion of atmospherical air as $\frac{1}{474\frac{1}{3}}$ for each degree of Fahrenheit *.

LXIX. *Intelligence and Miscellaneous Articles.*

VACCINE INOCULATION.

THE printed report of the house of commons professing merely to have published extracts from the minutes of the evidences, but a partial account only having been given to the public of Dr. Pearson's evidence from those minutes, we propose to give it wholly. It is not our intention to make any remarks; the fairest way for the parties interested, and most proper conduct for us, being considered to be the giving the account from the minutes, especially as Dr. Pearson's "Examination of the Claims†," &c. just published, is most likely to afford the requisite explanations.

In our next Number we shall give the second and only other evidence of Dr. Pearson on the 15th of April.

Dr. Pearson's first Examination (the honourable admiral Berkeley in the chair), agreeably to the Summons dated Lunæ, 5to Die Aprilis 1802. [From a Transcript by the Committee Clerk, taken from the Minutes of the House of Commons.]

Are you conversant with the vaccine inoculation?

* On this article the editors of the *Journal des Mines* remark that, according to the experiments of Mr. Saussure, air, in all its different states of saturation with moisture, experiences uniform increments of temperature; and that of some experiments from Amontons it is proved that the principle is the same with regard to pressure.—Editor.

† See our last Number, page 283, for the account of this publication.

A. Yes: I have been acquainted with the practice since January 1799. I also think it is but justice to Dr. Jenner to state, that I am acquainted with the practice of inoculation of persons for the small-pox, who on good evidence were said to have gone through the cow-pox since June 1798: the result of which was, that they could not receive the small-pox infection.

Was it from the communications of Dr. Jenner, or any other source, that you derived your knowledge of the vaccine inoculation?

A. In the first instance from Dr. Jenner: afterwards I got information from other sources.—[Letters delivered in.]

Do you imagine that the information contained in these letters arose from Dr. Jenner's publication of his discovery, or from a previous knowledge of vaccine inoculation?

A. I imagine they were independent of each other.

Did you ever hear that Dr. Jenner had communicated his discovery to Mr. John Hunter many years previous to this correspondence? And is it not known that in his lectures some years before his death he mentioned it publicly?

A. Not *the practice of inoculation*; but that Dr. Jenner had acquainted him that persons who had the cow-pox could not take the small pox, and that nobody had been known to die of the cow-pox.

Had you any other communications with the Rev. Herman Drew, besides the letters delivered in, upon the subject of vaccine inoculation?

A. None that I think relate to the question.

Does Mr. H. Drew lay claim to the discovery of inoculating with the vaccine matter from one human being to another?

A. No; that is exclusively* Dr. Jenner's.

Do you know when the facts stated in the correspondeenc which you delivered to the committee actually took place†?

A. Only that they took place, in all probability, earlier than the year 1798.

On what do you ground that opinion?

A. Because, immediately upon the publication of Dr. Jenner's work in 1798, I wrote to the gentlemen who furnished that information, namely, the Rev. Mr. H. Drew, Dr. Pulteney,

* Dr. Pearson, in his book lately published, finds that this is not strictly correct; for vaccine inoculation from the human subject had been previously instituted.

† The dates were subsequently obtained, and are printed in Dr. Pearson's work just published.

Mr. Dolling, and Mr. Down, of Bridport. They *immediately communicated their cases of vaccine inoculation, without appearing to be acquainted with Dr. Jenner's works.*

Have you reason to think that Dr. Jenner, previous to the publication of his first work on vaccine inoculation, was at all acquainted with the facts contained in the correspondence delivered in?

A. I have said, I apprehend the parties all performed their inoculations independent of each other.—Withdrew.

THE LONGITUDE.

The following letter from a gentleman in Greenock relates to a matter of so much moment, that our readers will regret the death of the person who contrived and executed the instrument alluded to. It is fortunate however that the apparatus is still in existence, as further experiments, and a more minute examination of its structure, may perhaps lead to a discovery of its principles.

All that can be inferred at present is, that possibly a well poised magnetic ball, though it may remain stationary (excepting the change occasioned by the magnetic variation), while kept in the same place, may possess a property which, on carrying it eastward or westward from that spot, may occasion a revolution on its axis proportioned to the distance. Should any thing like this turn out to be the fact, we may yet see that accomplished which has hitherto baffled every human effort.

But be that as it may, ingenious men will endeavour to profit by the hint which the following letter presents:

"Greenock, Aug. 2.

"An affair of so much consequence to mankind as the following it were criminal in me to conceal; I therefore request of you to make it as public as possible among your seafaring and philosophical friends.

"Our mutual friend, before his departure last fall for Philadelphia, constructed a machine, apparently simple, but which is infinitely more valuable to navigation than the compass. It was brought to me, together with his log-book, by a fellow passenger homewards, who unluckily had paid no attention to the use of the apparatus; which was the more unfortunate, as our friend died within three leagues of land.

"It is a magnetic ball, floating in a bason of quicksilver. The ball is painted all over, to keep the quicksilver from penetrating the pores, which might embarrass the evolutions, which

which coating I dare not deſtroy to examine the materials of the ball; but from its weight it muſt be metallic, yet it floats high in the fluid. Since he took it from this place, I perceive he has marked it with lines of longitude and latitude, like a geographical ſphere. This, I preſume, he has done on his voyage outward, the journal of which is likely left in America. But this which I poſſeſs begins with the exact point of latitude and longitude of Philadelphia, and records the zenith of every day as accurately as if he had been all along on terra firma. In bed he told the captain his diſtance from the coaſt of Ireland to a minute, by looking at his machine.

"The properties of magnetiſm are not yet ſufficiently known, and they have heretofore been applied to uſe only in the form of the needle. But it appears to poſſeſs, beſides its well known polarity, a propenſity to retain its native relative poſition on the earth; that is to ſay, it turns upon an axis, like the earth, one point always pointing at the pole ſtar. Beyond the line, this point upon the ball is below the horizon; and on the ſhores of America the longitudinal line, which now is its meridian, was far down the ſide: ſo that, if he had ſailed round the earth, his little ball would have made a complete revolution upon its axis."

ARTS.

We mentioned ſome time ago that a French artiſt had diſcovered a method of ſoldering glaſs when broken. This art we now underſtand has been carried ſo far towards perfection, that two plates of the ſize of eighteen inches may be joined together.

Another artiſt of the ſame country has found out the means of rolling plates of glaſs in ſuch a manner as to extend them ſome inches each time they are paſſed through the rollers, as would be the caſe with metal. The proceſs has not yet been made public; but we apprehend that a part of it muſt conſiſt in ſubjecting the plates, after the firſt caſting, to ſuch a heat as may make them ſufficiently plaſtic to go through the operation once, and ſo again for a ſecond and ſubſequent rollings, till the required extenſion be given to them.

The alloys of gold with platina have hitherto been ſuppoſed to depreciate the colour and malleability of the precious metal in ſuch a manner as to prohibit their uſe. It appears, however, from ſome late experiments made by an ingenious jeweller, Mr. Francillon, that a mixture, conſiſting of ſix parts of gold and one of malleable platina, gives a metal of

 a beautiful

a beautiful colour, great malleability, and capable of receiving an exceeding fine poliſh, more unalterable than that of gold when expoſed to the action of ſulphurized hydrogen or ſimilar agents.

A NEW COMET.

About ten at night, on the 28th of Auguſt, C. Mechain, member of the National Inſtitute and of the Board of Longitude, diſcovered a new comet in the conſtellation of Serpentarius: it was ſome degrees below two nebulous ſtars which are on the left ſide of that figure, and near the equator. He determined its poſition, and found that it was riſing with great rapidity towards the north. He continued to obſerve the following days. The light of this body did not appear to him to increaſe in a ſenſible manner; its nucleus did not become more brilliant; and the nebuloſity which ſurrounded it did not extend.

On the 1ſt of September he made a report to the National Inſtitute of his firſt and laſt obſervations.

Auguſt 28. Mean time, 9 hours 24′ 6″; right aſcenſion, 249° 18′; declination ſouth, 6° 11′ 31″.

Auguſt 31. Mean time, 9 hours 35′ 19″; right aſcenſion, 250° 16′; declination ſouth, 0° 29¾′. It is to be remarked, that, according to the preſent poſition of this comet, its diſtance from the ſun is neceſſarily greater than that of the ſun from the earth. It riſes towards the north pole, following the left ſide of Serpentarius and the oppoſite ſide of Hercules. Though it is viſible only with the help of teleſcopes, it may ſtill be obſerved a long time if its light be not weakened.

We learn by a letter from Bremen, that on the 2d of September, at nine in the evening, Dr. Olbers diſcovered a ſmall comet, which cannot be ſeen but with good teleſcopes. From its obſerved poſition it ſeems to be the ſame that C. Mechain ſaw ſix days before. Dr. Olbers' obſervations are ſtated as follows:

September 2, at one minute paſt eleven, its right aſcenſion was 251° 28′; declination north, 4° 32′.

On the 4th, Mean time, 9 hours 7 min.; right aſcenſion, 251° 28′; declination north, 7° 57′.

There is, however, probably, a miſtake in the letter reſpecting the laſt-mentioned right aſcenſion.

CHEMISTRY.

Mr. Arthur Aikin has ſucceeded in producing an amalgam of iron and mercury, by uniting an amalgam of zinc and mercury with iron filings, and then adding muriate of iron.

iron. A decompofition takes place, and there is produced a muriate of zinc and the amalgam of iron and mercury, which by kneading and the aid of heat affumes the metallic luftre.

The fame gentleman along with Mr. Allen has obtained a regulus of tungften, from the ammoniate of that metal, the fpecific gravity of which is above 17·22. It is of an iron colour and of great brilliancy, but not malleable.

MR. PEPYS'S GAS-HOLDER.

We find by a line from Mr. Pepys, that a note has been omitted in printing his article in No. 50. It related to the regifter tube, and mentioned, that "it was added to the gas-holder on the fuggeftion of Dr. Marcet."

NATURAL HISTORY.

One of the French journals contains the following article:—"Snakes have increafed this year fo much in number in the large commons, that the proprietors of fheep have fuftained great lofs by them. Thefe reptiles, particularly in the fpring, fuck the milk of the fheep; and when the wound which they inflict is deep, the two teats dry up; fo that the fheep, which continue to be fruitful, can no longer fuckle their young. But, when the wound is flight, the wounded teat only dries up. In feveral of the communes of the department of Landes, there are flocks, the fheep of which have been fucked by thefe fnakes in the proportion of four to one."

NATURAL PHILOSOPHY.

Vaffalli-Eandi, profeffor of natural philofophy in the Athenæum at Turin, has invented and caufed to be conftructed a pneumatic apparatus, with which all experiments in regard to the rarefaction and condenfation of air, and all kinds of aërial mixtures in given proportions, can be performed in an eafy and fimple manner by means of piftons and cocks. This machine has been depofited in the phyfical cabinet of Turin.

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Colours,

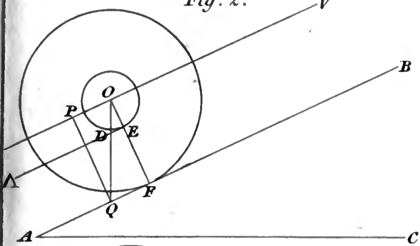
Geoffroy

Stockholm

END OF THE THIRTEENTH VOLUME.

Printed by Wilks and Taylor, Chancery-Lane.

Fig. 2.



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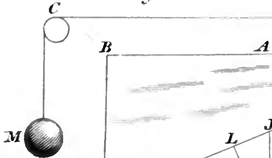

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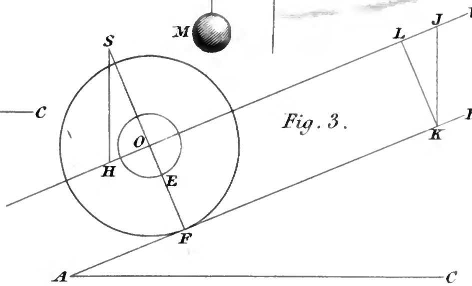

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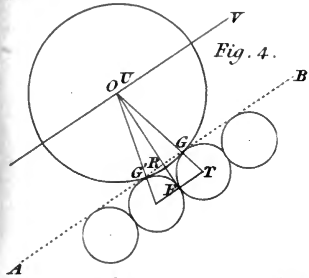

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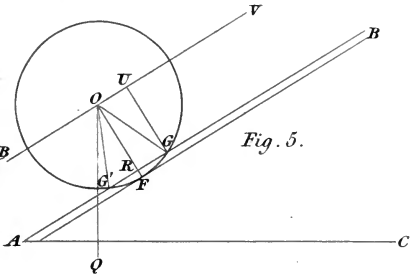

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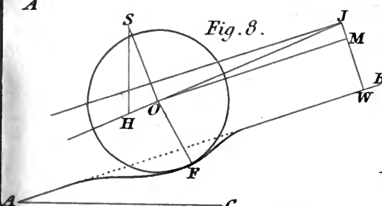

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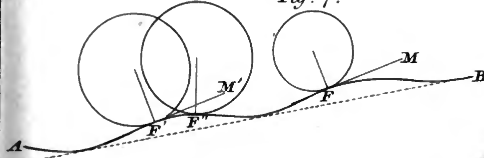

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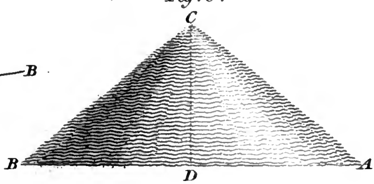

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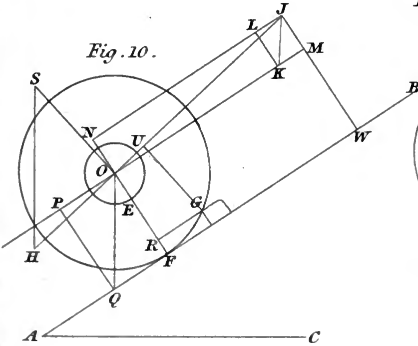

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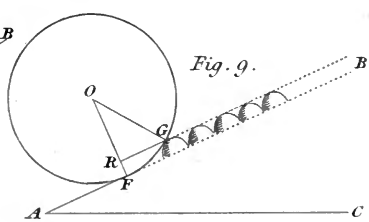

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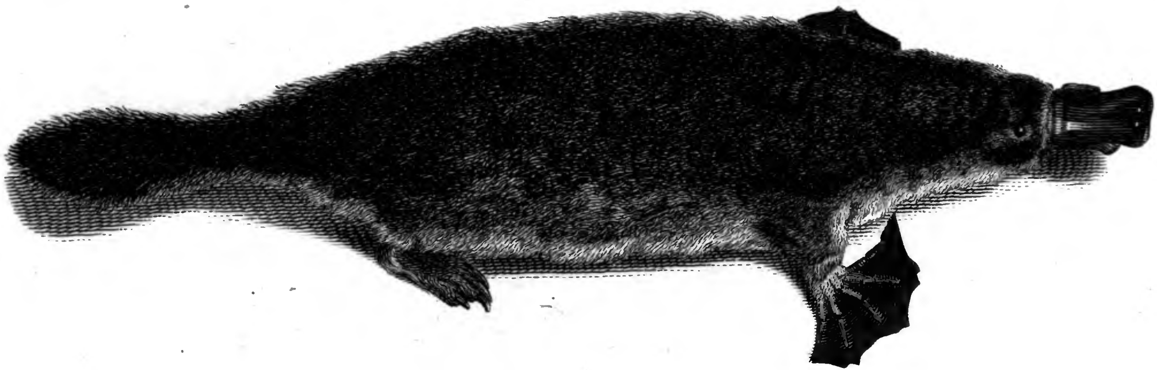

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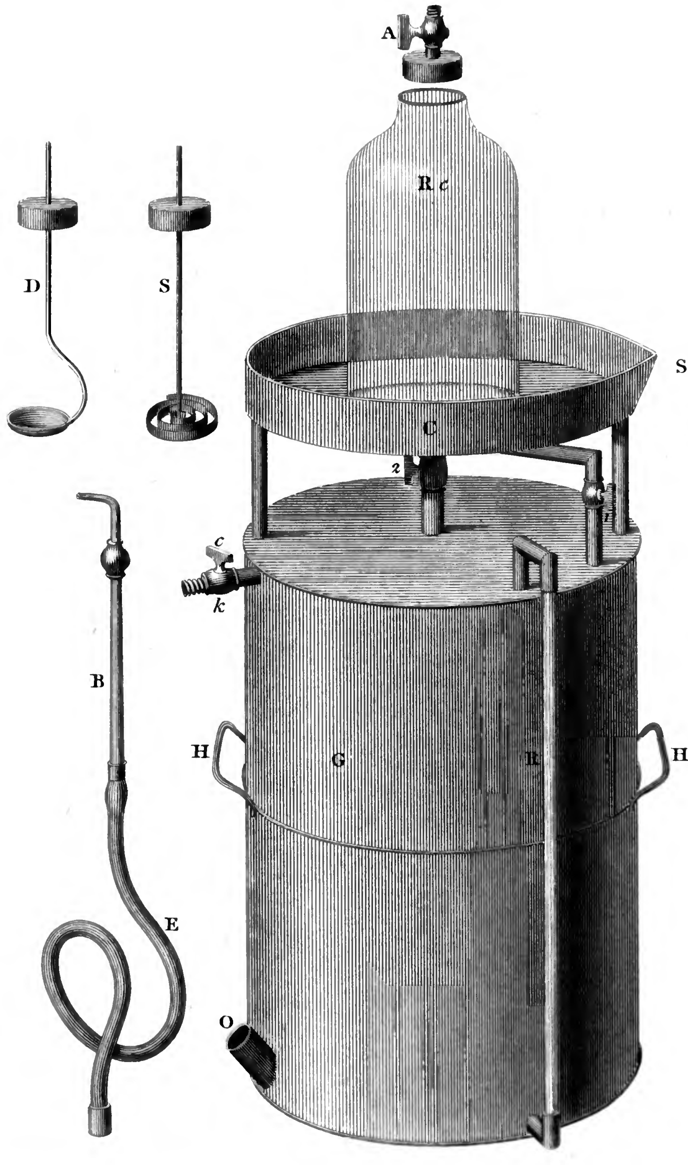

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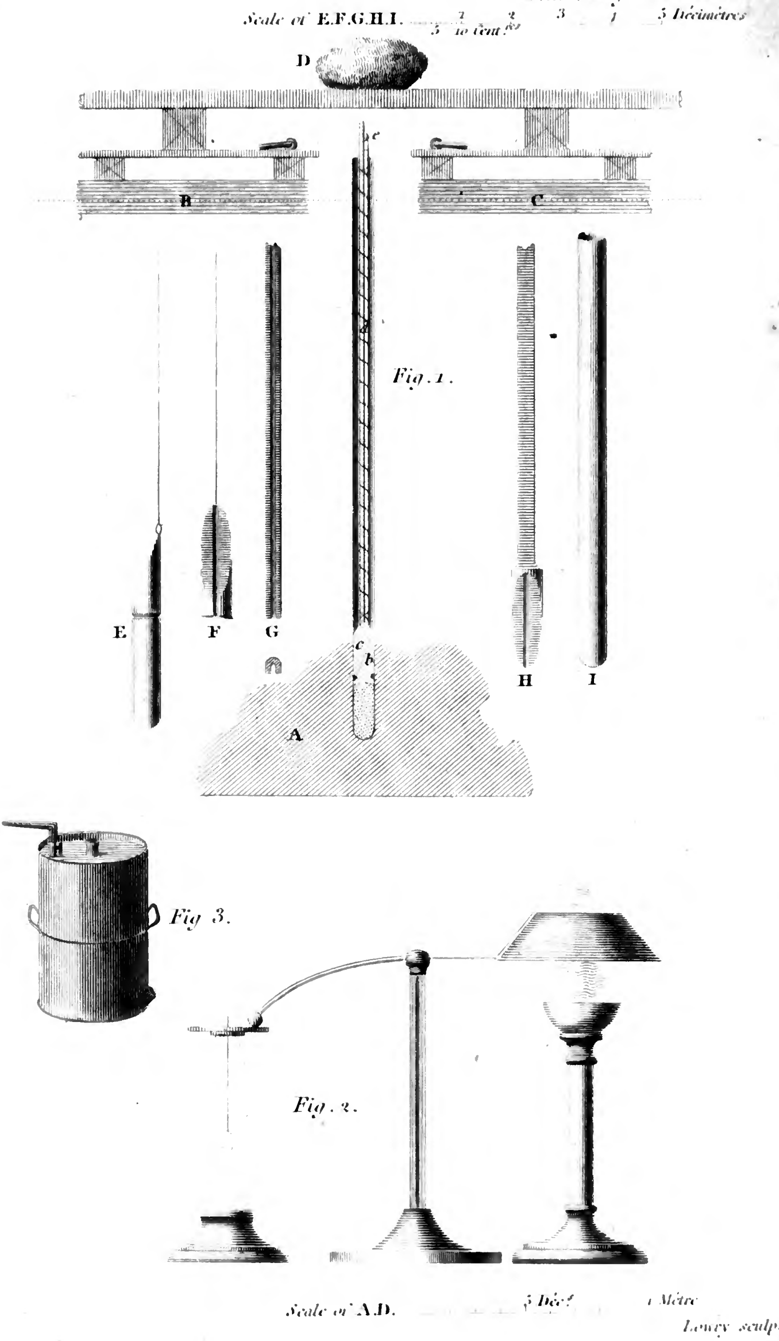
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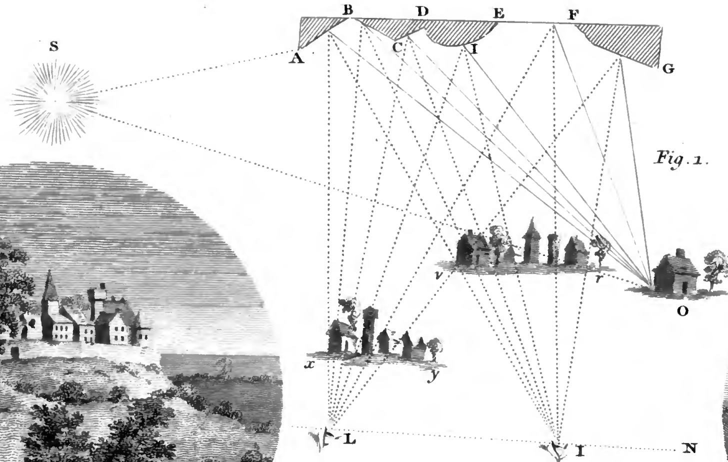
Lowry sculp.

Seen Oct. 21st 1796.



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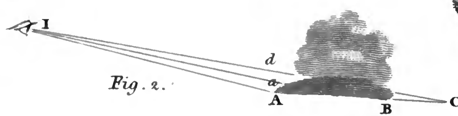

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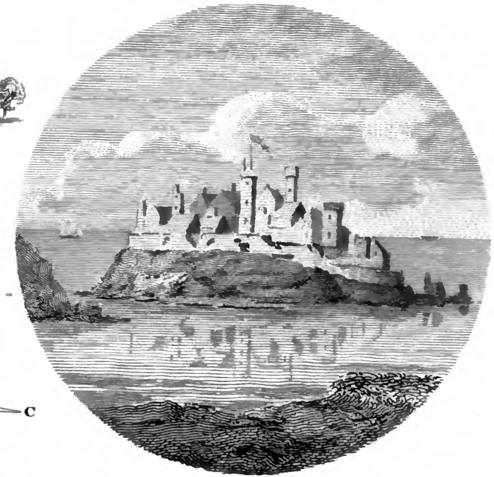

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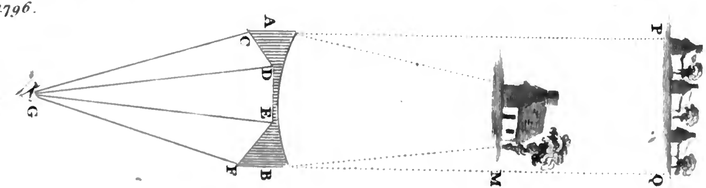

Fig. 3.