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Page 26, l. 14 fr. bot. for *survey, or,* read *surveyor;* p. 27, l. 3 fr. bot. omit *always;* p. 237, l. 2 fr. top, erase *and*, and insert a , after abandoned; p. 246, l. 2 fr. top, for 1831, read 1832; p. 258, l. 8 from top, for *ornamental*, read *ornamented*.

The Nos. of the Arts. X and XI, in the first No., are repeated both in the contents and text, and all the Nos. that follow are, therefore, wrong.

Vol. xxiii, p. 404, l. 7 fr. bot. for *Morriss river*, read *Moosup river*.

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JOURNAL OF SCIENCE, &c.

Art. I.—*Essay on the Georgia Gold Mines*; by William Phillips, Engineer.

INTRODUCTION.

In attempting an essay on this subject, in which it is intended to convey an accurate idea of the gold mines, the author is fully aware of the difficulties he has to encounter, and approaches the subject with great diffidence, under a conviction of his inability to do it the justice it merits. If apology, under such circumstances, be necessary, it will be found in the necessity of inviting the attention of the scientific and experienced, to the development of this important branch of our domestic industry. The simple fact that all the mines of the state, have their business conducted without the aid of the experience of older mining countries, would induce a belief that an association which would promote an interchange of ideas, and a diffusion of such useful knowledge as could be obtained by sending a competent person to examine the mining business of other countries, would have a most salutary effect. Should the following remarks result in the desired improvement or induce more competent persons to take up the enquiry and aid in improving the mining industry of Georgia, the author will be amply rewarded, for the time devoted to this essay.

In accordance with recent approved geological arrangements, the deposit or branch mines will be first considered, and then the vein or ridge mines. The process of separating the gold from the ore, will also be attended to. A description of the Shelton mine is added with a drawing of the lot.

Deposit or Branch Mines.

That the deposits of which we are to write, owe their origin to the mechanical agency of water, there can be no doubt; but there are persons who believe that the agent producing them, has acted suddenly and that these immense beds of gravel have been collected together at one and the same time. If they reflect, however, they will discover reasons to modify their opinions, and adopt a more plausible and perhaps correct theory. The geological character of this part of the country, is denominated *primitive* according to Eaton, *primary* by Bakewell, and *inferior stratified* or *non-fosilliferous* by De la Beche. I have generally applied the word *original*, to distinguish these rocks from the others. They are gneiss, mica and talcose slate, hornblende and granite; the predominating rock being the first named and alternating, in strata of various thickness, from three inches to thirty feet. The gneiss occurs, indurated, more frequently, however, in a state of decomposition, but still accupying its original position. When indurated, it formes the skeletons or bases of the ridges, while the decomposed portion, yielding readily to the action of water, is washed away leaving vallies. On this irregular surface, rest the deposits, consisting of rounded or "rolled" and angular fragments of quartz, gneiss, hornblende, &c. with smaller fragments of cyanite, garnets, catseye, jasper, pyrites, and brown oxide of iron, which often cements them all together, and causes them to appear as if burned without heat. Owing chiefly to the extensive range of the garnets, it is only in the river deposit, that they occur in abundance. The gravel of the branches, had evidently resulted from the disintegration of the rock in their neighborhood. In this gravel, as it is called, which varies from one foot to four feet in depth, the gold is found, and generally at the bottom of the bed. Above the gravel there is a bed of sand, with scales of mica, varying from three to twenty feet deep, on a bed of clay with angular fragments of quartz, from 0 to five feet deep. The fragments of rock forming this gravel, have the "*rolled*" appearance, according generally, with the size of the stream of water adjacent to the deposit. This shews, at once, that the agent producing these deposits, has acted slowly, and when we remember that caloric, electricity, air, water, &c. have been at work chemically and mechanically, for at least six thousand years, we cannot be surprised that the hardest of the rocks, have in the course of ages, yielded to the incessant action to which they have been subjected. Over this irregular surface the rivers, when urged by a freshet, rush with inconceivable fury, and they then have a transporting power, sufficient to carry large blocks over rocky shoals, and to deposit them (where an eddy is caused by a sudden bend in the river) in places far below their former location. These eddies, having but a small transporting power, soon permit an accumulation of rocks, sand, &c.

and by protecting the strata beneath, they frequently produce other phenomena in the directions and levels of the stream.

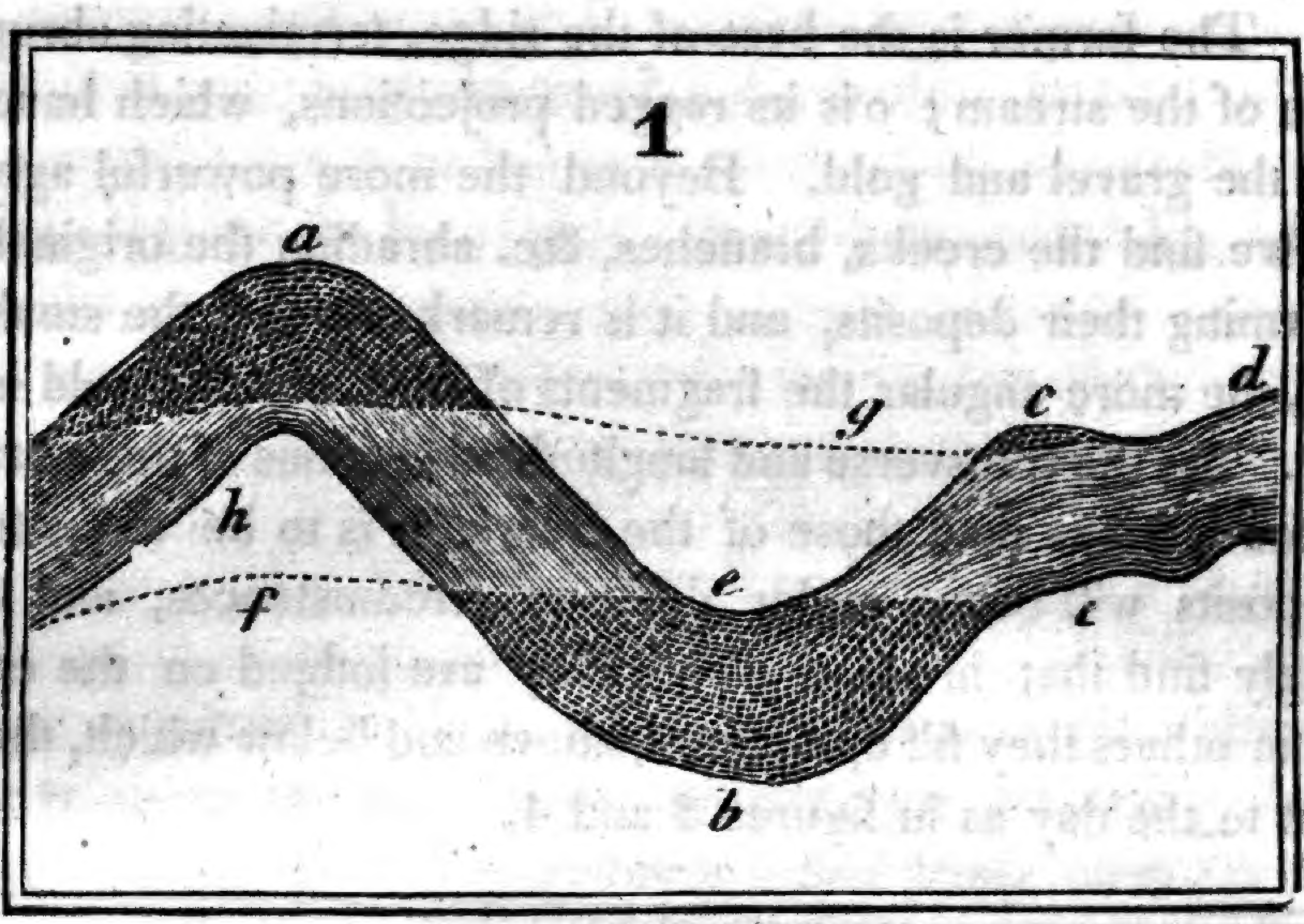
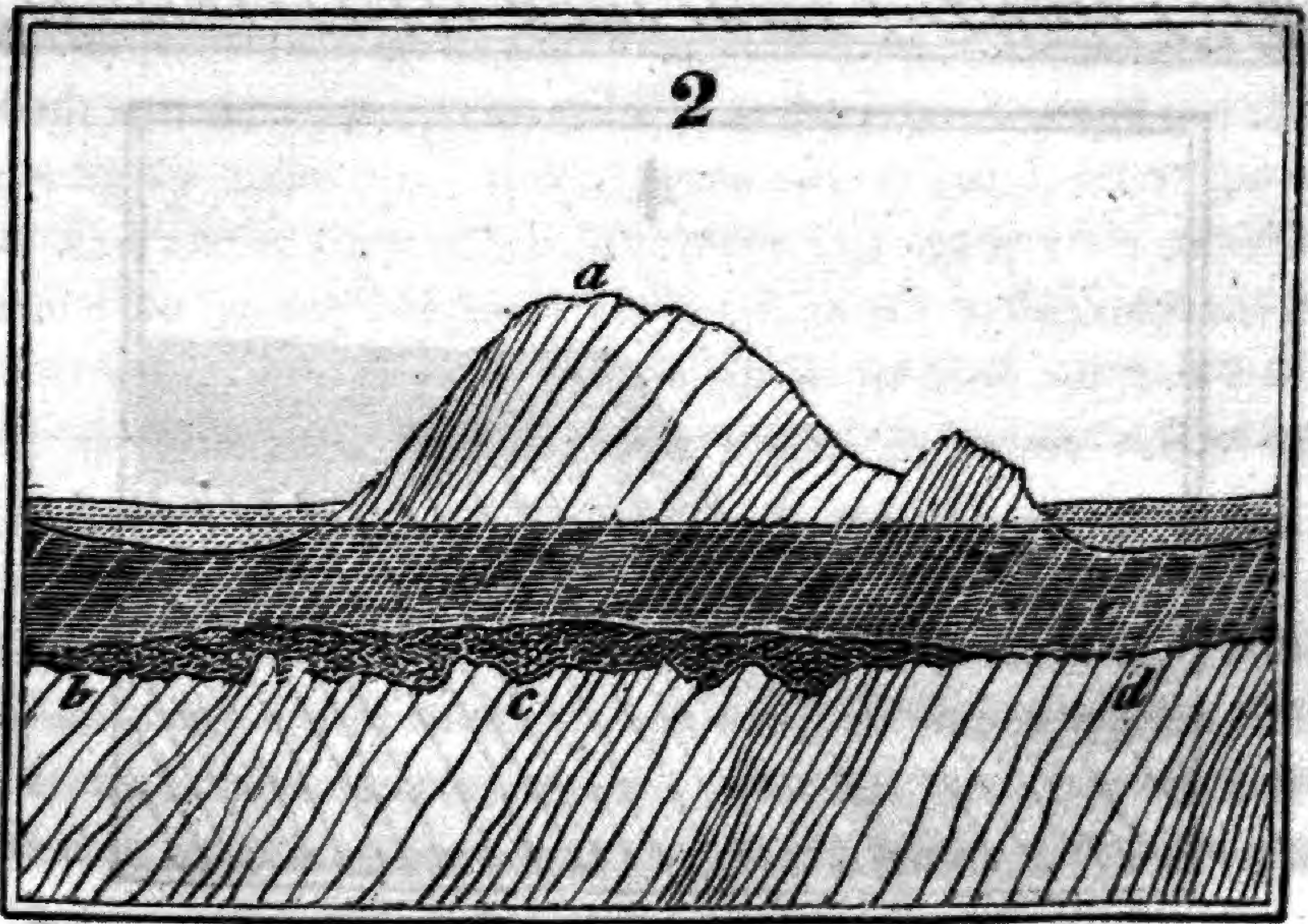


Fig. 1, represents a portion of a river, or (on a horizontal plane) *a*, *b*, *c*, *d* and *e* are deposits, resulting from the transporting power of the currents, caused by eddies which arrest the gravel in its descent. It is observed that all water courses, have a disposition to make their channel straight by cutting off points and filling up the bends or "bights," which latter is an indisputable consequence to the former, for if the points *f* and *g* are ever worn off to *h i*, the deposits *a b*, will be formed and soon become covered by sand, &c. deposited, when the waters were subsiding from a freshet. Vegetation will encroach as the water will require only a certain width of channel, for its ordinary descent.



In Fig. 2, the manner in which shoal deposits are formed is exhibited; *a* is a stratum of indurated gneiss, and *b*, *b*, are decomposed strata. The former is the base of the ridge, terminating abruptly on the side of the stream; *c* is its ragged projections, which have intercepted the gravel and gold. Beyond the more powerful agency of rivers, we find the creeks, branches, &c. abrading the original strata and forming their deposits, and it is remarkable that the smaller the stream, the more angular the fragments of rock, and the gold is more ragged. As the transverse and longitudinal sections of these branches are more various than those of the rivers, it is to be expected that the deposits will occur under different circumstances, and we accordingly find that in sôme places they are lodged on the edges of strata, in others they fill up hollows, above and below which, the strata run out to the day as in figures 3 and 4.

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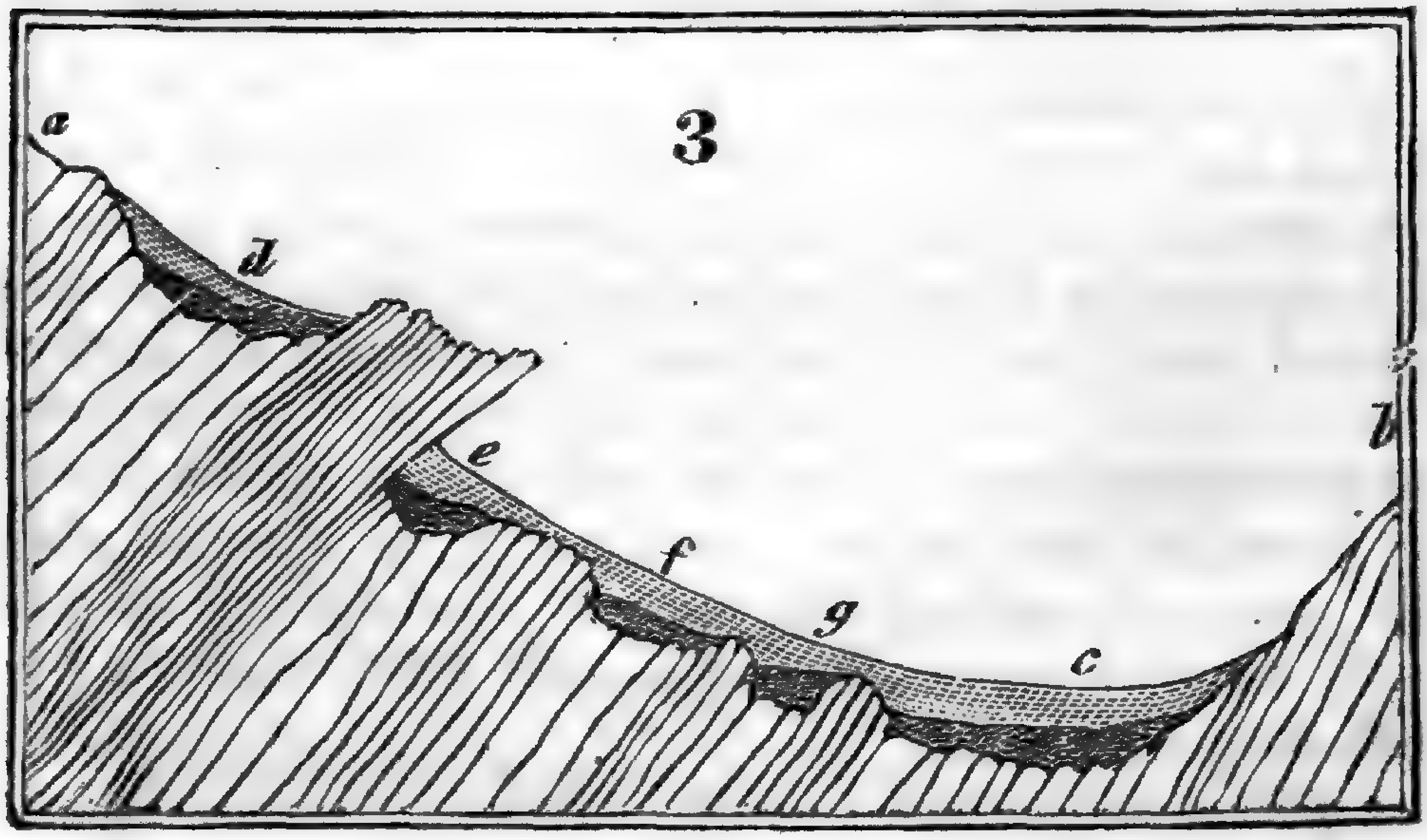

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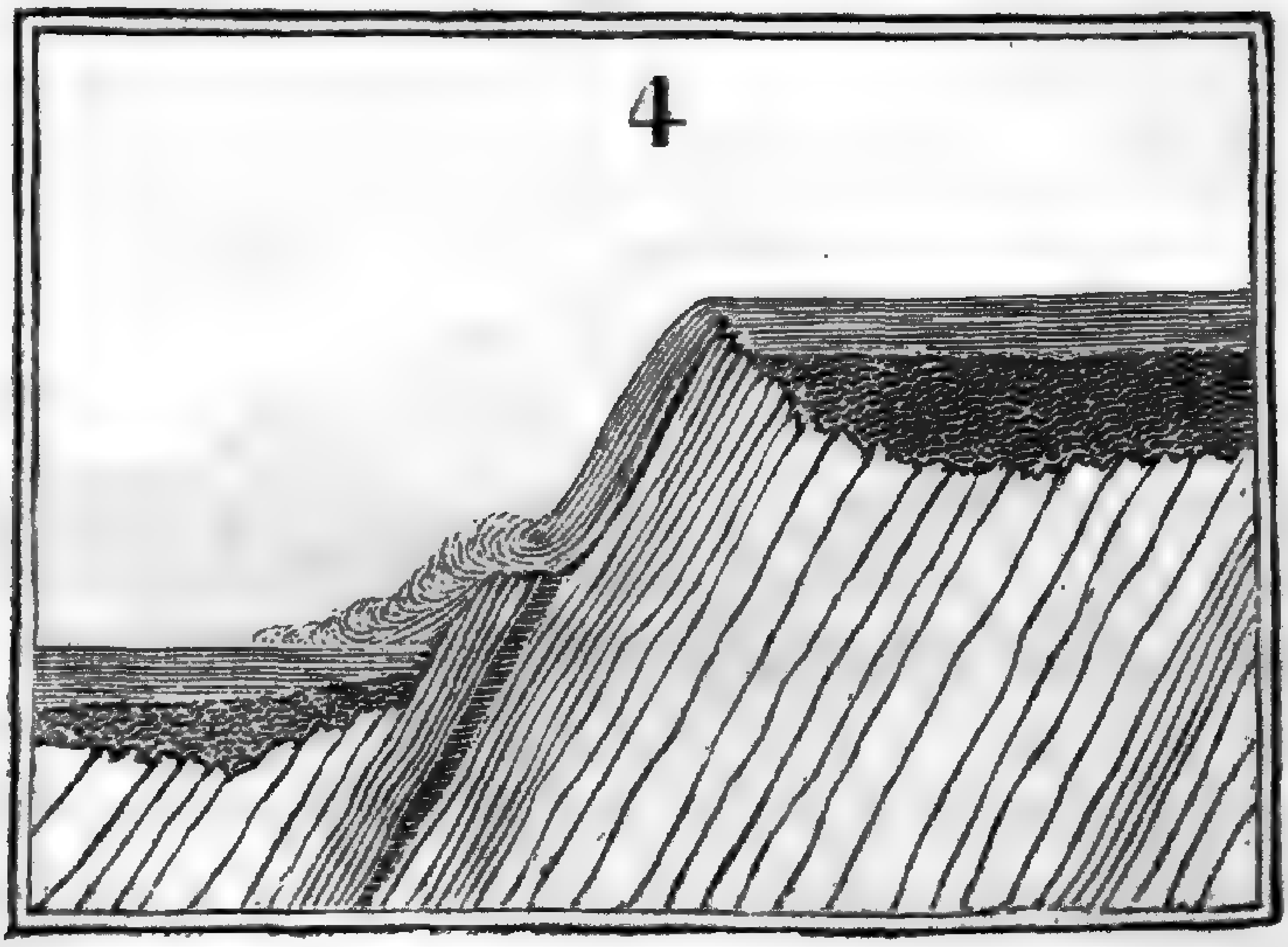
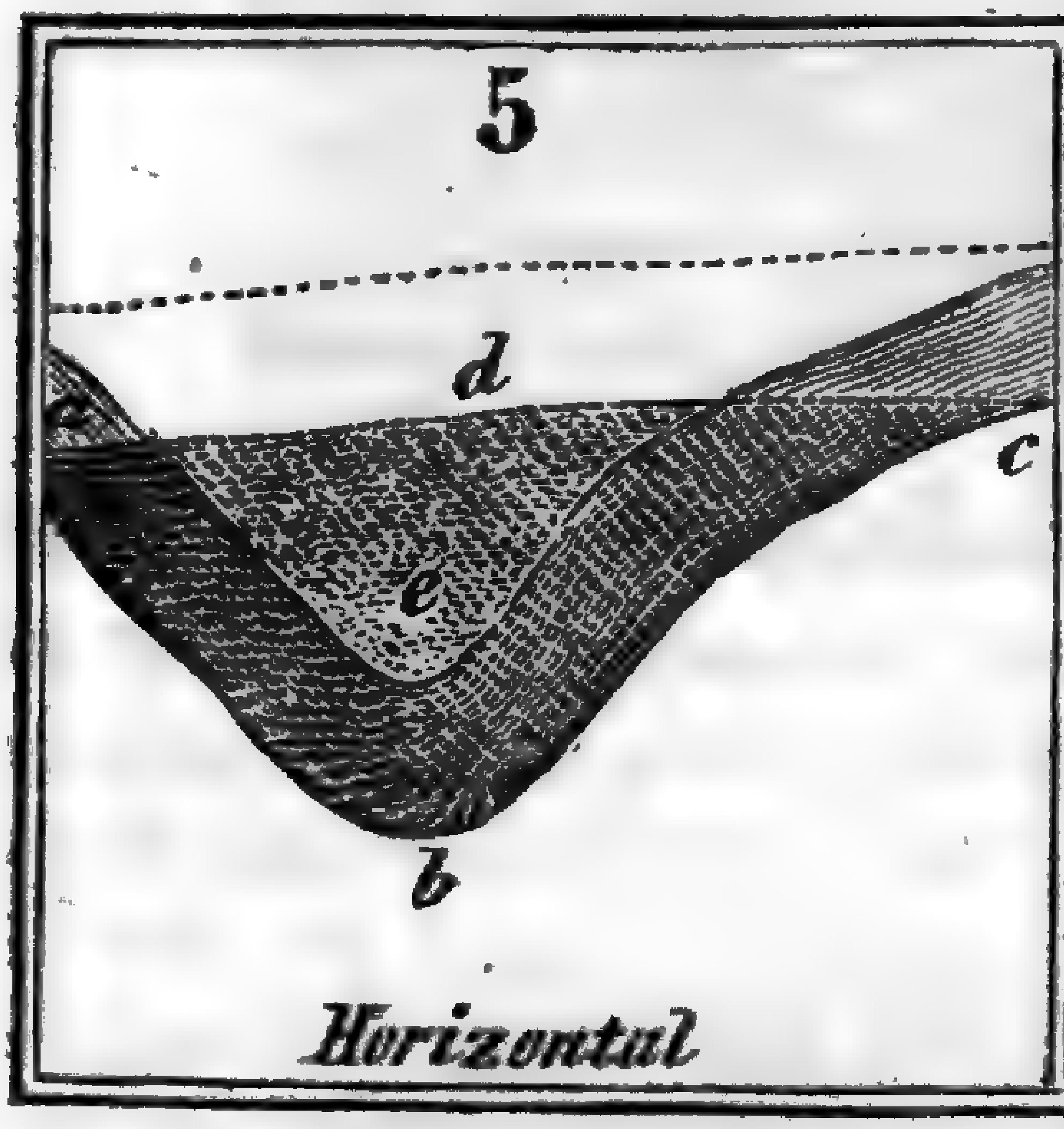


It is easy to conceive that such substances as may be moved by any of the disintegrating agents at *a* and *b*, would descend towards *c*, and that *d e* and *f* would intercept a part of them. The greatest accumulation, however, would be at *c*, as the side *b* may have no receptacles as that of *a* has, owing to the face of the strata resisting the agent better than thát of the latter, which also may be more decomposed and easily so abraded as to form receptacles and undermine veins at *a*.

The gravel in these branch deposits, is composed of fragments of quartz and such other rocks as occur in the immediate vicinity and over it there is generally a bed of clay from one to five feet deep, in which there are fragments of quartz with sharp angles. Besides the deposits on rivers and branches, which have unequivocally resulted from their mechanical agency, there are others, at present above the levels of the streams in the neighborhood. Their extent and the fact that the gravel is frequently very much rounded, seem clearly to indicate a *force* at least equal to that producing similar effects on the Chestalee, but being covered with *red clay* like that over the branch deposits, we are thus prevented from attributing the effect to its agency. If it were necessary to account for their formation by the river, then we may suppose that the following process was pursued.



Any stream having a bend as in Fig. 5, may abrade its banks *a b c*, until it becomes nearly straight, making deposits similar to *a* Fig. 6; and when it has attained the direction *a d c*, the greatest abrading action of the water, will be on the bottom near the middle of the river, and thus it will be cut deeper, leaving the deposits *e e* high and dry. The very reverse of this may happen, for the nature of the strata in the direction of *a d c*, may admit of abrasion towards *b* and not in any other, and consequently the river encroaches on *b*, with the same result as before, leaving *e e* high and dry, to receive a growth of vegetation. I am of opinion however, that these deposits and many on the branches, are of a date anterior to those previously noticed, on which the stratum of sand occurs. I rely chiefly on the evidence of the following facts already stated, that the sand contains scales of mica, and varies in depth from three to twenty feet; that it contains also, vegetable remains in a layer of black or bluish mud or clay, of a yellowish color, resting on the gravel and running into the sand above. The remains are in a state of decomposition, but sufficiently preserved to indicate the same botanical characters, exhibited on the vegetation of the present banks.

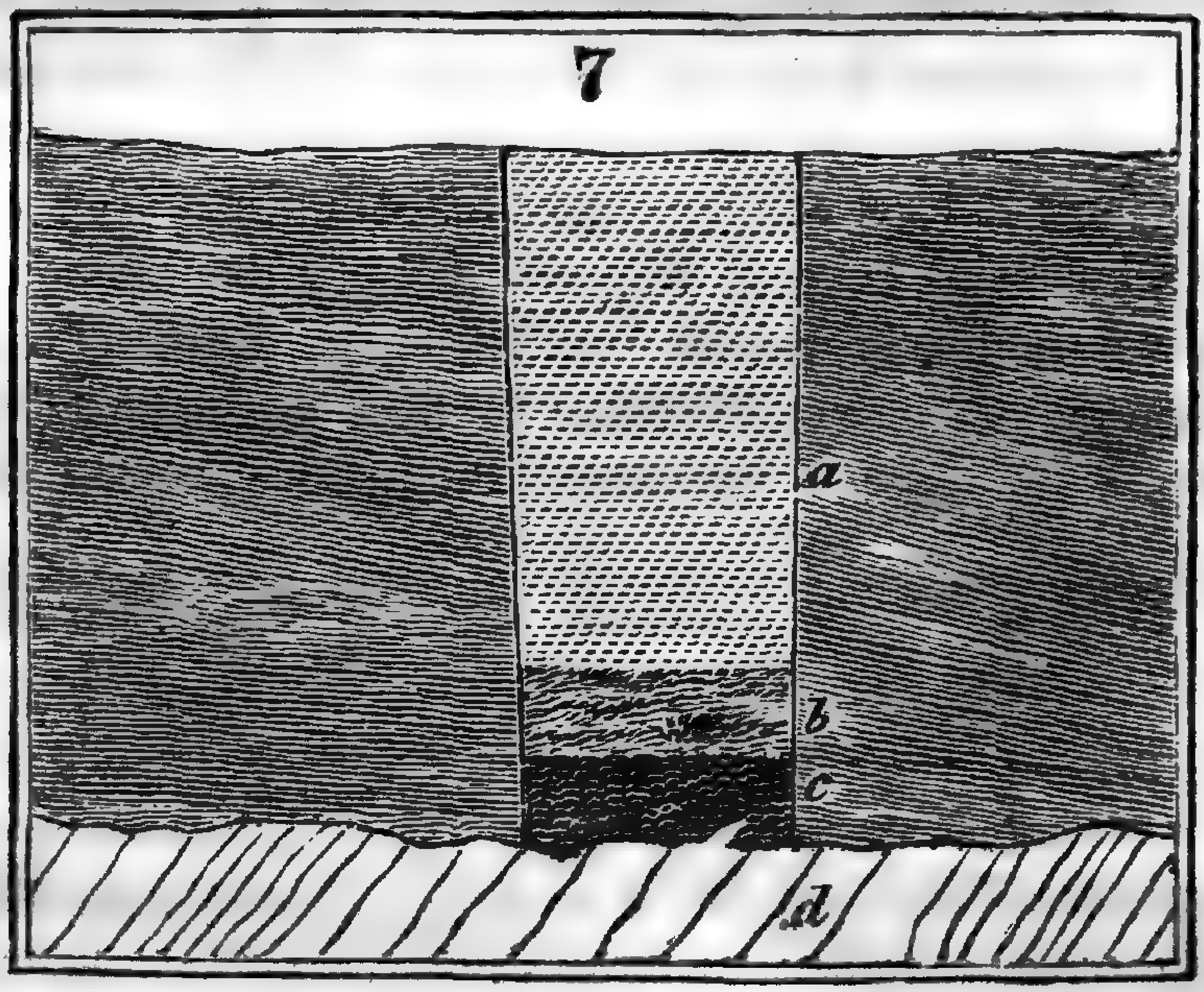
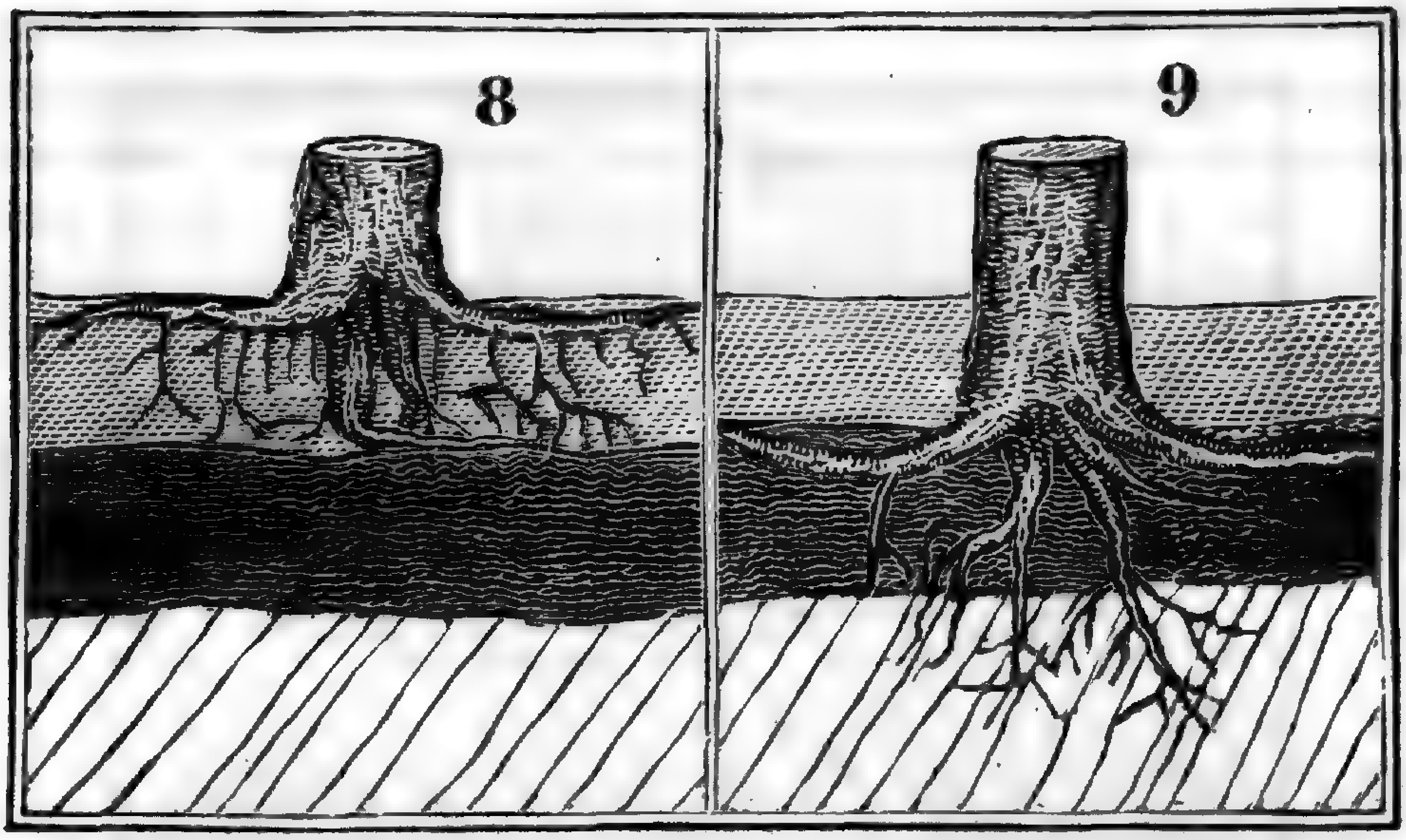
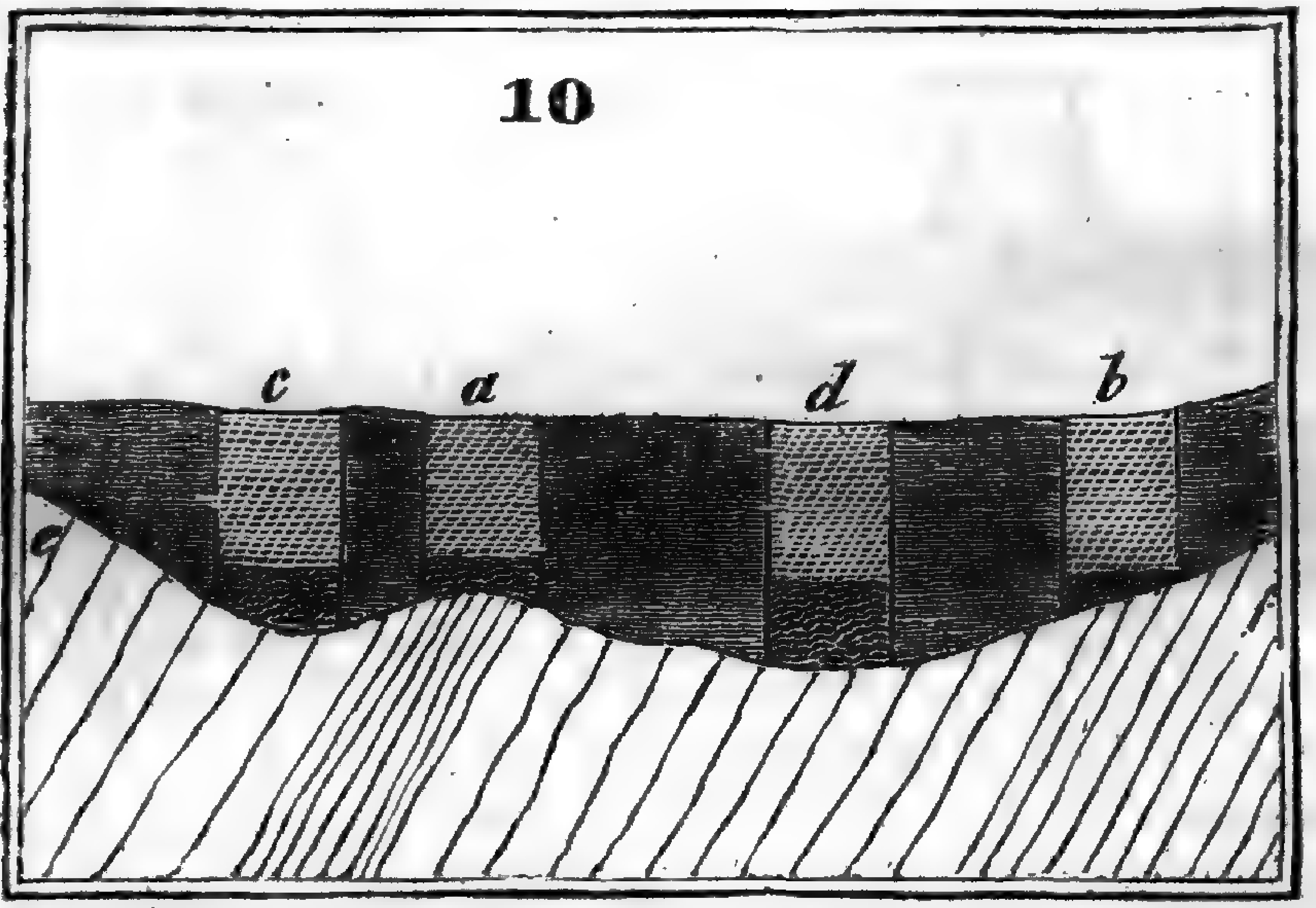


Fig. 7, exhibits a section of a pit, excavated on the bank of the Chestalee, fifty five feet from the river; *a* is a stratum of sand, *b* the mud or clay containing vegetables, and *c* the gravel resting on the original strata *d*. Now nothing can be more evident, than that this formation is of a more recent date than those in which no such remains occur. In fact it would seem that on this evidence, we must place the date of the latter, anterior to all vegetation. The clay and sand are now supporting a luxuriant growth of forest timber, of the same age as that on the mountains, and in excavating it is found that their roots penetrate only to the gravel and then spread; very rarely, however, passing through it, except in situations where the gravel runs out to the day. If vegetation existed anterior to these deposits, it would be reasonably expected, that we should discover its remains, unless we admit the very sudden action of the agent, such as the rush of a great deluge, sweeping away the forests to some basin in which they will be converted into coal.



Figs. 8 and 9, represent, what under ordinary circumstances, would be the present and past position of the roots of forest trees. In the first instance, the growth is maintained by the sand or clay, but in the latter, by the original strata and gravel. From this description of deposits, it will be easy to recognise them wherever they occur. In testing lots, however, there are indications to be observed externally, by which we endeavor to form a correct outline of the original strata, independently of what appears at the surface. Experience is the only instructor on this point, and of course, the inexperienced must resort to the more certain criteria, furnished by the pickaxe and spade.

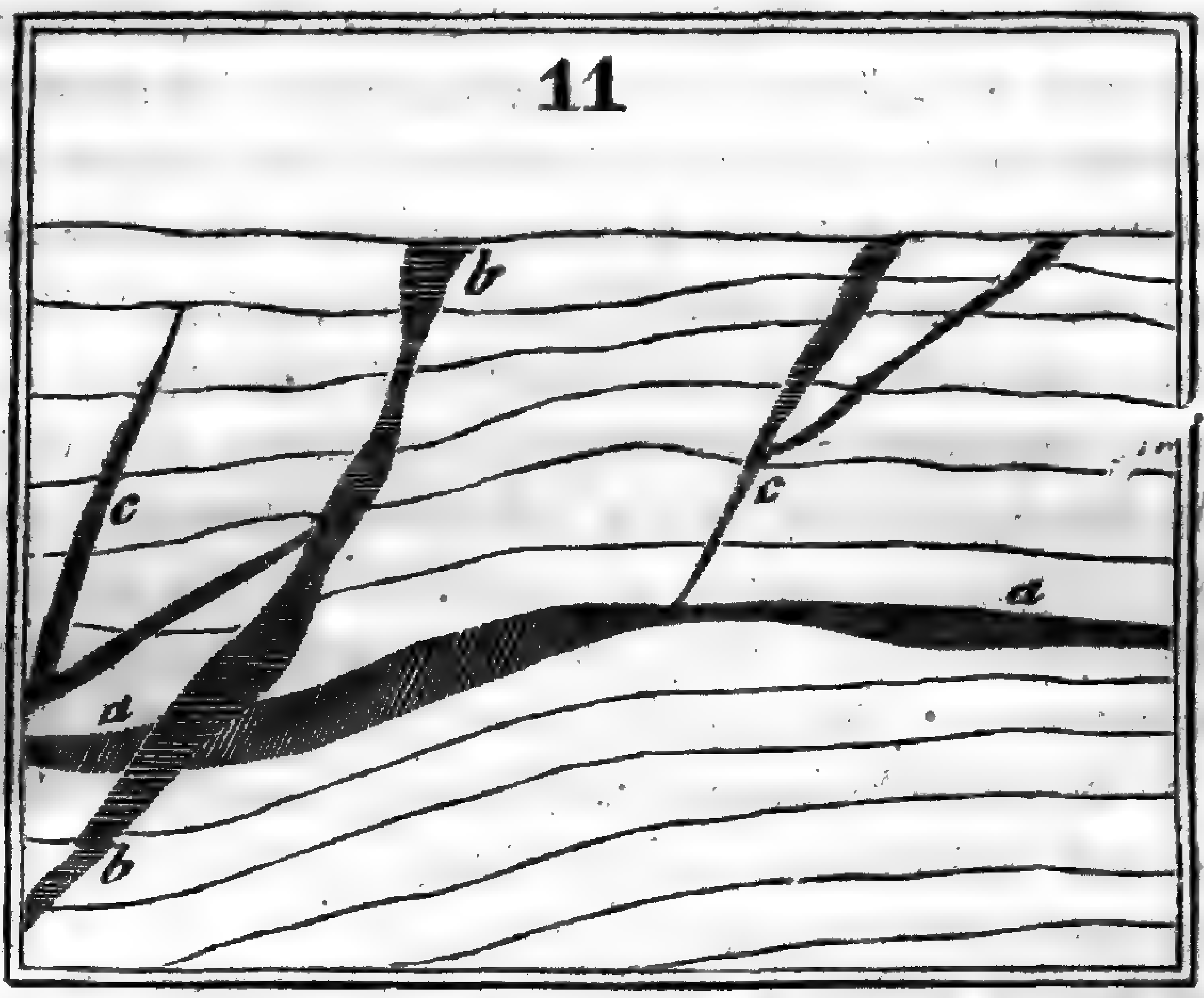
Fig. 10, shows how this is to be effected; *a* and *b* would be very discouraging excavations, but if we observe the directions in which the inclination of the bottoms of the pits run, we should be led to make excavations at *c* and *d*, which as they are in hollows of the outline, are receptacles to sustain whatever gold may occur in the deposit; *e* and *f*, are the extremities of the original outline before alluded to. The indications by the outline and bottom of the pits, are the best we are acquainted with, and ought to be closely examined. It may, sometimes occur, that deposits, similar to that described by Fig. 3, have been overlooked or abandoned, while that at *a* is worked out; but, before the works are entirely forsaken, they ought to be examined, particularly to ascertain that no such deposits as *d e f* exist on the sides of the ridges. The working of the rich Shelton Mine, in Habersham, was suspended during the inclement winter of 1831, while on a second deposit as *g* which yielded large particle of gold weighing 20 dwts. or more.



The surface mines are considered to be disintegrated veins, scarcely removed from their original position, and are not included in the list of deposits. They may be known by the quartz having very sharp angles.

The vein or ridge mines, now claim our attention. The veins traverse the original strata in various directions, and the phenomena attending them, do not clearly indicate the origin of their formation. It is remarked, that the general direction of the strata, is a little to the east and west of north and south, say NNE. N. and SSW. S; and as these strata are confusedly or rather imperfectly crystalline, it follows, that besides the direction already given, the veins may take another depending on the angle peculiar to the crystalline structure of the rock. The crystals appear to be rhomboids, but are only distinctly so in the neighborhood of veins.

Fig. 11, is the plan of a vein traversing the strata, as *b b*, and a vein in the direction of the strata, as *d d*; *c c* are called leaders. These veins are formed of quartz of different characters, varying generally with the original rock in which it is found; it is sometimes crystallized in beautiful transparent six sided prisms, terminated by a pyramid at one end and attached at the other to other crystals, or more frequently to a nucleus of felspar, &c. In some of the veins, the quartz is compact, with a slightly conchoidal fracture, and an appearance which at the mines in this variety, acquires for it the name of horn flint. The structure is frequently granular and slaty in the same specimen; there



are plates of talc interposed between the layers, and the gold occupies the same situation. The crystals of quartz are sometimes radiated from a nucleus. These various kinds of quartz are the gangues or matrices in which the gold is found, and besides gold, they contain iron pyrites in cubic and pseudomorphous crystals, filling irregular cavities, purple oxide of iron, ("Indian paint,") brown oxide of iron, sulphur, &c.

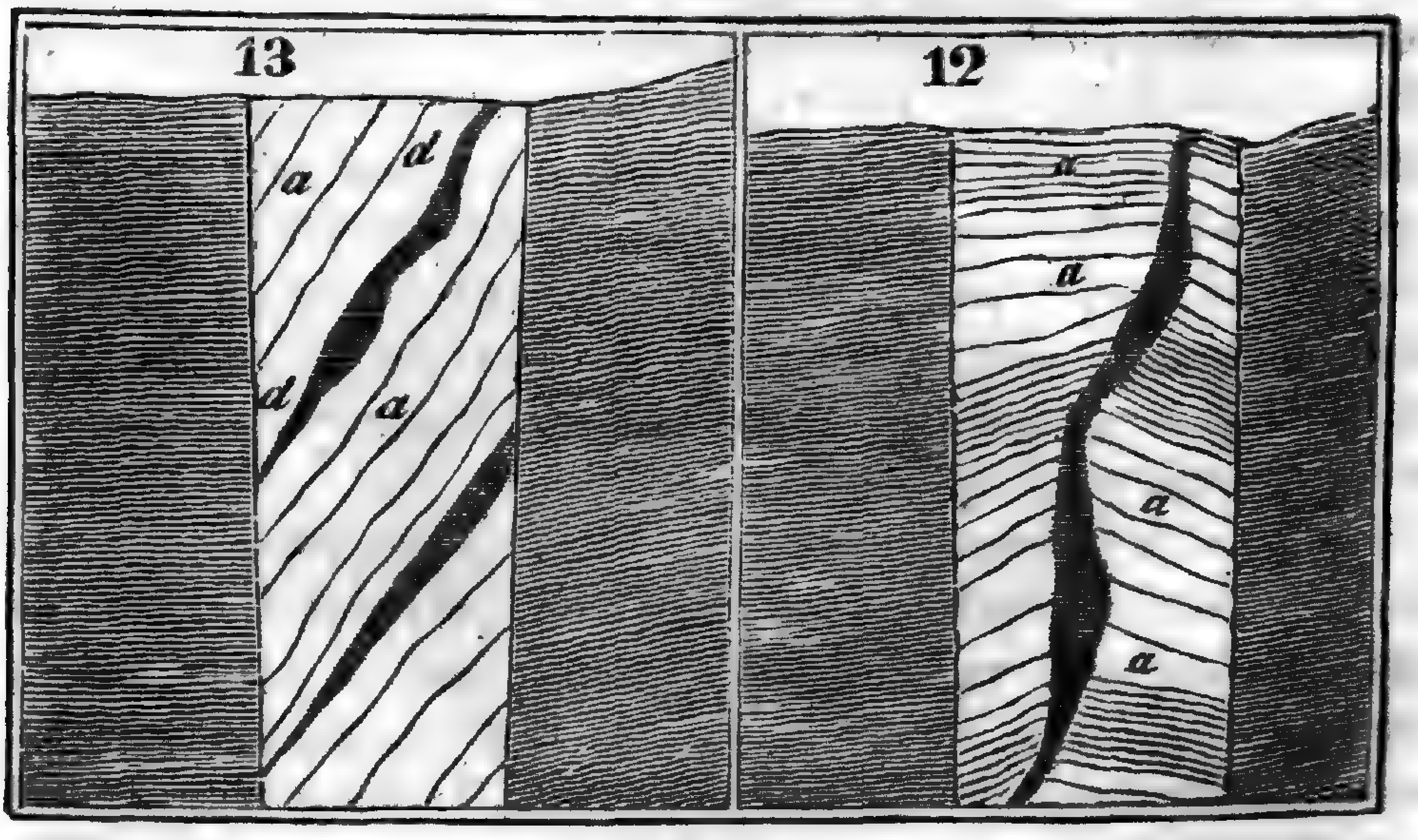


Fig. 12, is a vertical *section of a vein*, traversing strata *a a a a* which have obviously been disturbed, as they do not correspond with those on the other side of the vein.

Fig. 13, is another vertical *section crossing the strata* and exhibiting the vein *d d d* of Fig. 11; *a a a* are the strata and *b b* the veins.

If it is admitted that volcanic agency, has produced the fissures and filled them with the substances constituting veins. It would then appear probable that the quartz and elements of the metals, have been projected from below into the fissures, and that while the caloric was radiating, these elements were set free to combine and form the metals and their gangues. This idea appears well supported by various phenomena, concurring to produce such an effect. The interposition of gold in thin leaves between the plates and crystals of quartz, and its filling up irregular cavities, show that it was once in such a state as to be capable of insinuating itself into such places. It appears possible that it was disseminated in the quartz by heat, as it is well known that when gold is subjected to intense heat, it flies off in minute particles, and such heat as was sufficient to fuse quartz, may have evolved the gold, or if contrary to present opinions, it be a compound, may have formed it from its elements. "If we could detect nature in the act" of making gold, "it would be easy to imitate her," but as we do not find it in any other state than pure, or alloyed with some other metal and never half formed, we despair of ever discovering the "philosopher's stone." There may be something in the discovery, that quartz is an ore of silicium, and that quartz is, in this country, invariably the gangue or matrix of gold, but in the present state of chemical knowledge, we cannot satisfactorily account for the fact of their being found in such close alliance.

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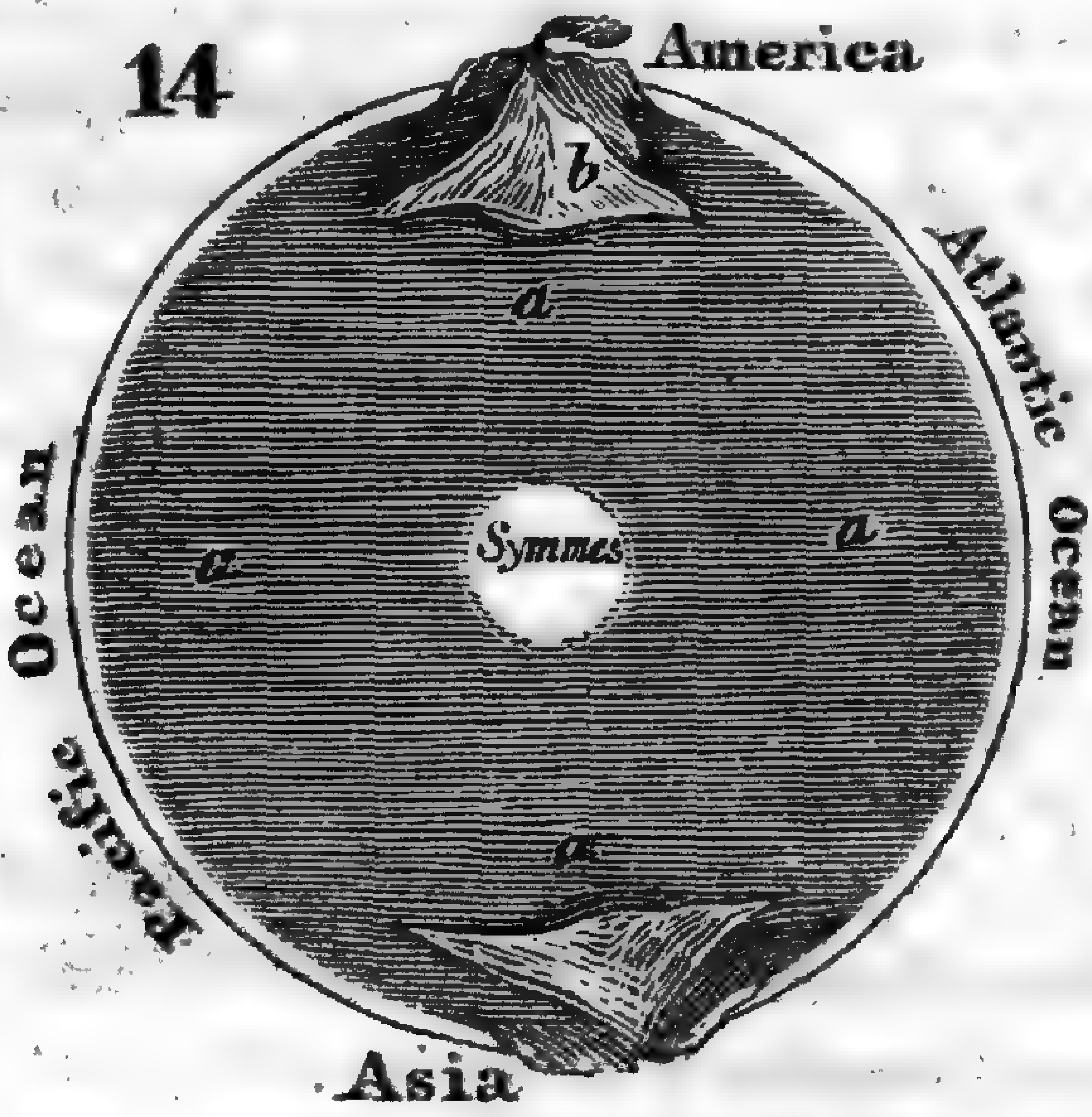

Fig. 14, is intended to represent the earth *a a a a*, the strata *b*, a subterranean cavity in which (according to the original suggestion of

Sir H. Davy, since extended and modified by others,) some very combustible substance, as potassium, sodium, or calcium, or some substance powerfully attracting water, as *quick lime*, may predominate and to which water may have percolated, or more probably have penetrated, in consequence of the hydrostatic pressure of the ocean; in either case it would happen, that a violent eruption must take place, attended with all the phenomena of earthquakes and volcanoes; should the exploding gas have sufficient force and meet with quartz in fusion near the fissures, it would of course, force it into them, filling them more or less, according to the supply of quartz, and the projecting force of the gas. The location of these supposed fires, seems to be in a subterranean region, abounding with quartz and the materials of granite, as they are the most frequent of the substances filling veins. The granite contains the following metals, or substances having metallic bases, sulphuret of molybdenum, lead, zinc, and copper; sulphate of lead and of barytes; magnetic iron and plumbago. I am not aware, however, that the granites of Georgia, contain any of these metals. It is a question of importance to the miner, how far when working a vein, he should go with his excavations. I know of no rule that would apply generally, for although mines have been wrought in Chili and Peru, to the depth of nine hundred feet, yet as we have no such description of the geological formations of those countries as would answer the purpose of the miners, we are compelled to suspend the exercise of our judgment, until we know that analogous or equivalent circumstances, exist in the geological character of those countries, and of this. Gold is said to occur in "vast quantities," at the depths, mentioned above. I think it advisable, in experimental excavations, to follow the vein as long as we can perceive a trace, or until we arrive at such depth, that it could not, though tolerably rich be profitably worked. It is usual with us, to sink a shaft on the vein and assay the quartz as we descend, and as soon as we arrive at a rich place, to commence tunneling* and separating the gold. It would, however, more surely lead to the attainment of the knowledge so much needed, if the former course were pursued, and the tunnel delayed until we were satisfied, that we had gone as deep as is required. It is probable that rich mines are, every day, abandoned, in consequence of disappointments in shafts of twenty, thirty,

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* I use the word tunnel, although the miner would probably express the same idea by the term "gallery," as in Jacob's Inquiry.

or forty feet. In working a shaft, in the decomposing rocks, or in clay, it will be requisite to curb them in a substantial manner with wood, as the work is sufficiently laborious and discouraging, without adding the risk of life. The roof of a tunnel should be stanchioned as the workmen proceed, and the number of stanchions, will depend on the consistency of the rock in which the excavation is made, and are never to be omitted, although it be in granite, for there are so many fissures in these rocks, that there is always danger to be avoided, by using the precautionary measures, adopted for those of a worse appearance.

Fig. 15, exhibits a method of stanchioning a tunnel, recommended

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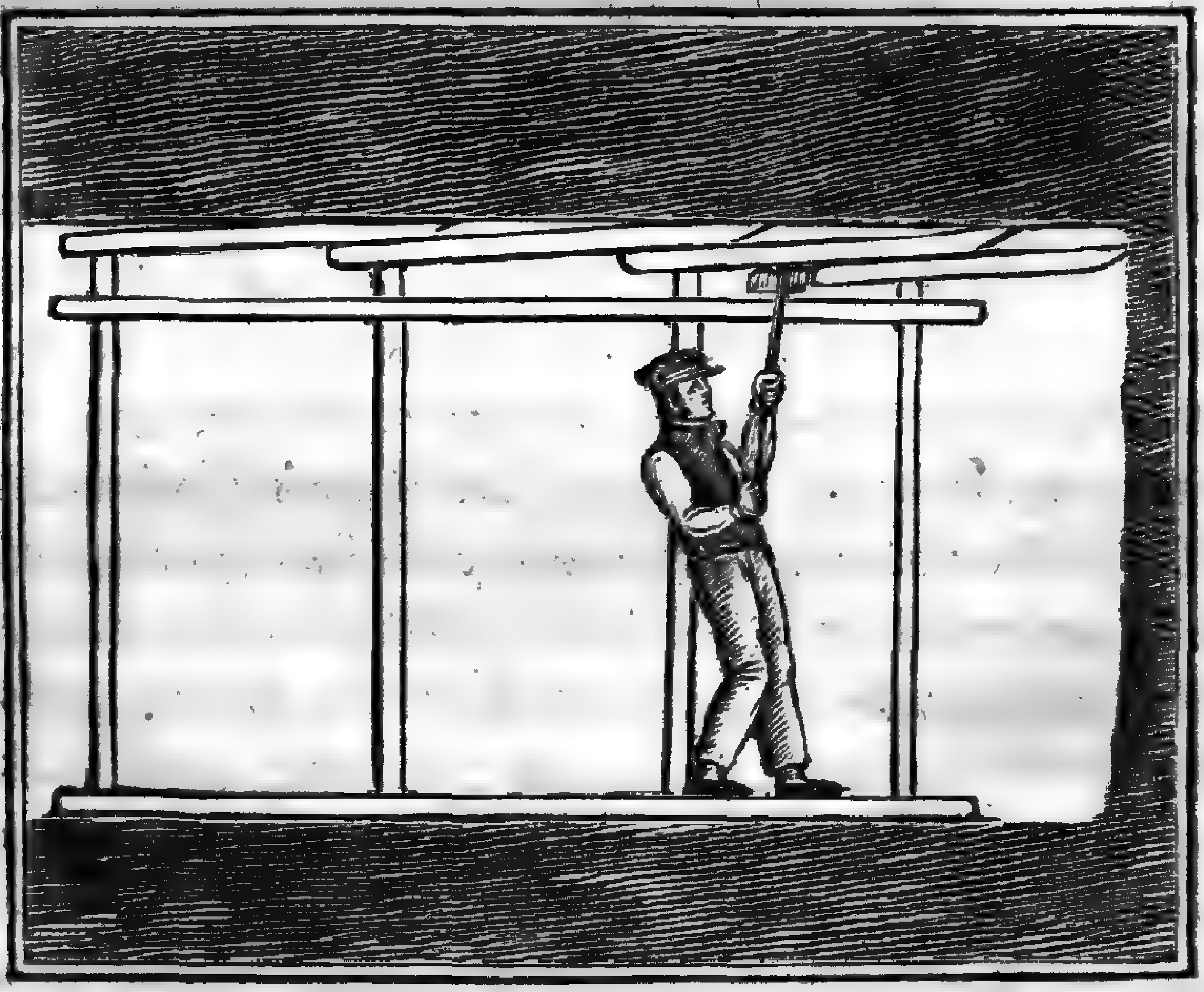

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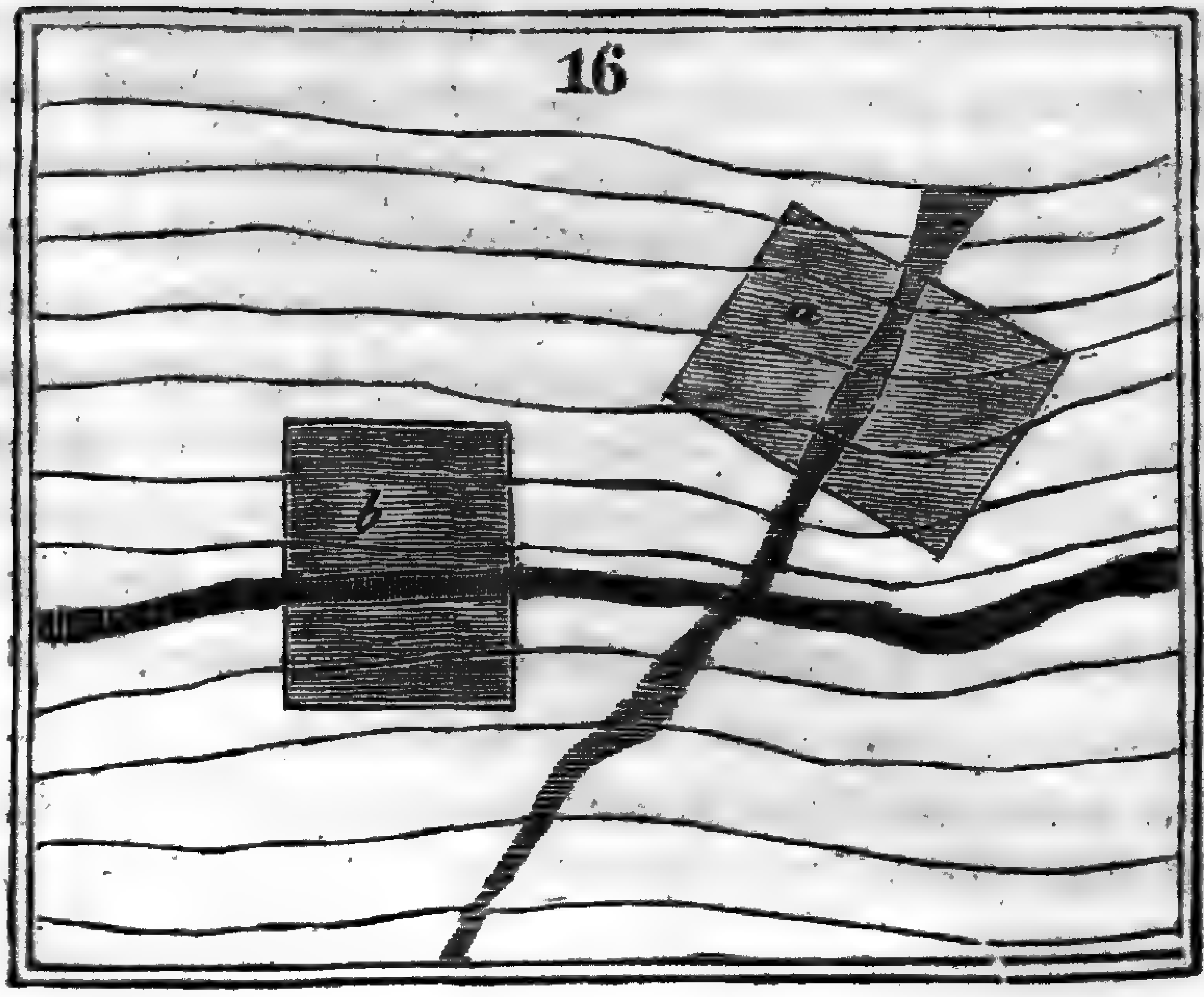

by its simplicity and economy of timber. Seven feet square is a good size for a shaft, in which it is intended to work two buckets by hand, although five feet will admit the free use of the tools, &c. without the buckets. Two of the sides of a shaft, should be in the same direction with the vein, and the other two crossing it, as exhibited in Fig. 16. It is not always requisite to commence a shaft on the vein at the surface, for if it dips much, it will soon run out as in Fig. 13. In such a case, it may be advisable, to begin so near to one side of the vein, that it may come into the shaft at any given depth. A vein may occur so near the side of a ridge, that it would be an advantage to drive a tunnel into the side as at Fig. 17.

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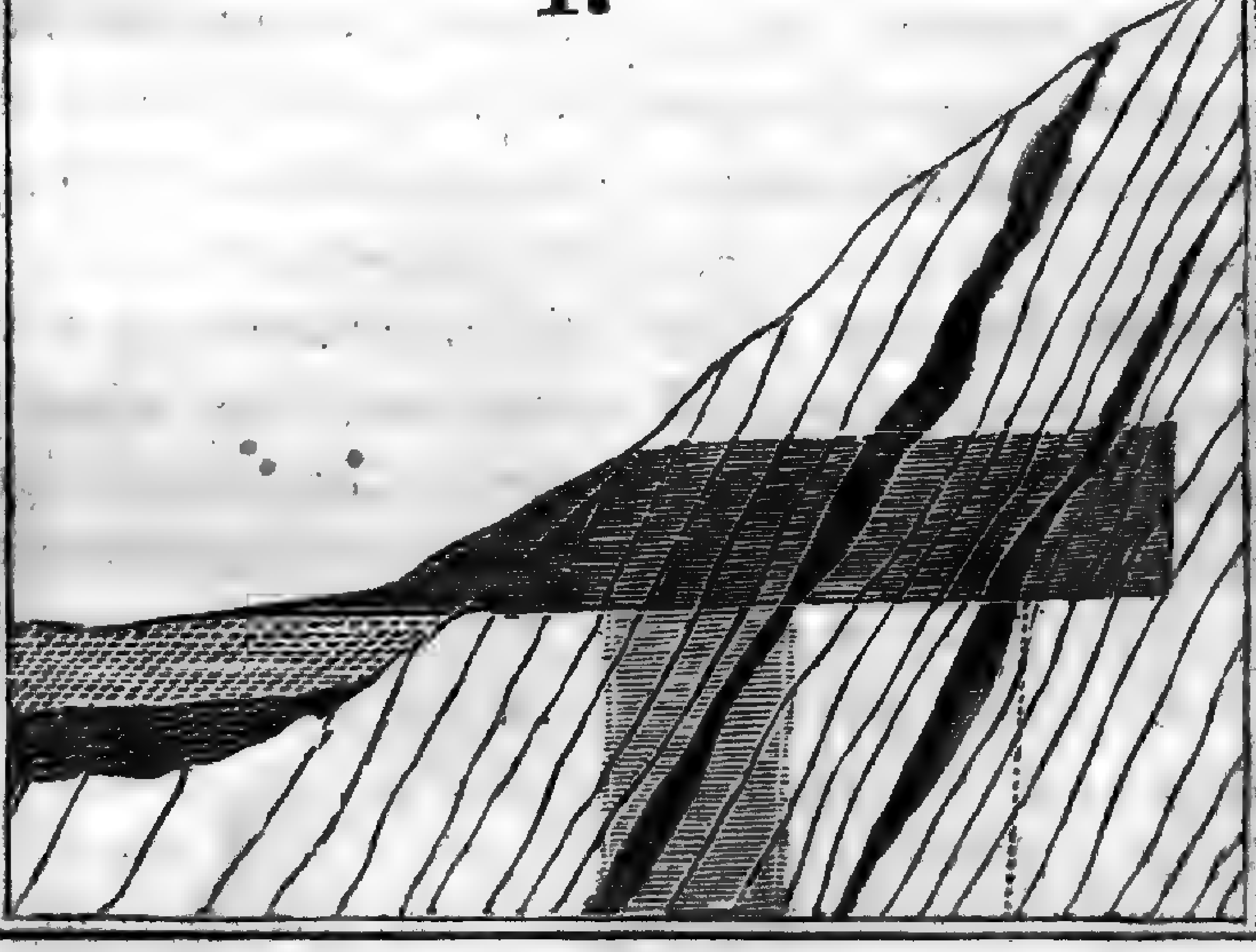

By this method, the chippings may be carried off in wheelbarrows, or even in carts, more conveniently, than when hoisted vertically the same distance. It should be remembered to give the floor sufficient inclination, to carry off whatever may come into the workings. A tunnel of this kind is often necessary for the purpose above, but by commencing operations in this way, so much may ultimately be saved. An improved excavator waggon, working on railways, could be used to advantage, when a situation occurs of the kind just mentioned.

Separating Process.

There are two properties of gold of which we may take advantage, in separating it from the ore in which it is found. These are its superior gravity and facility of amalgamation with mercury, and its resistance to the action of antimony and heat; and the acids cannot aid, except in refining it from alloy with other metals, by a process called "parting." All machines for separating, must be adapted to one or the other of the former properties; they are therefore denominated gravitating and amalgamating machines. The most simple process is called "panning out," and is performed on the gravitating principle. A tin or other pan, entirely free from grease, about fourteen inches diameter, and two inches and a half deep, is filled with the auriferous gravel and taken to a branch or other stream, and the same is washed by stirring it and by inclining the pan, until the lighter substances are carried off, leaving the gold and a fine black ferruginous sand at the bottom. This is a very tedious process, but a person expert in the practice can secure every particle of gold, however minute. The "hollow gum" is, apparently, the first improvement in the pan; it is a hollow semi-cylinder, about eight feet long and of a diameter depending on the size of the tree of which it is made, say of from twelve to twenty inches. On the inside there are cleats or riffles fitted close, to prevent the gold they intercept, from passing; they project about an inch. The gravel is thrown in at the upper end, and there stirred about with a rake, until the water from the conductor *a*, Fig. 18, washes off the dirt. The gravel is thus thrown

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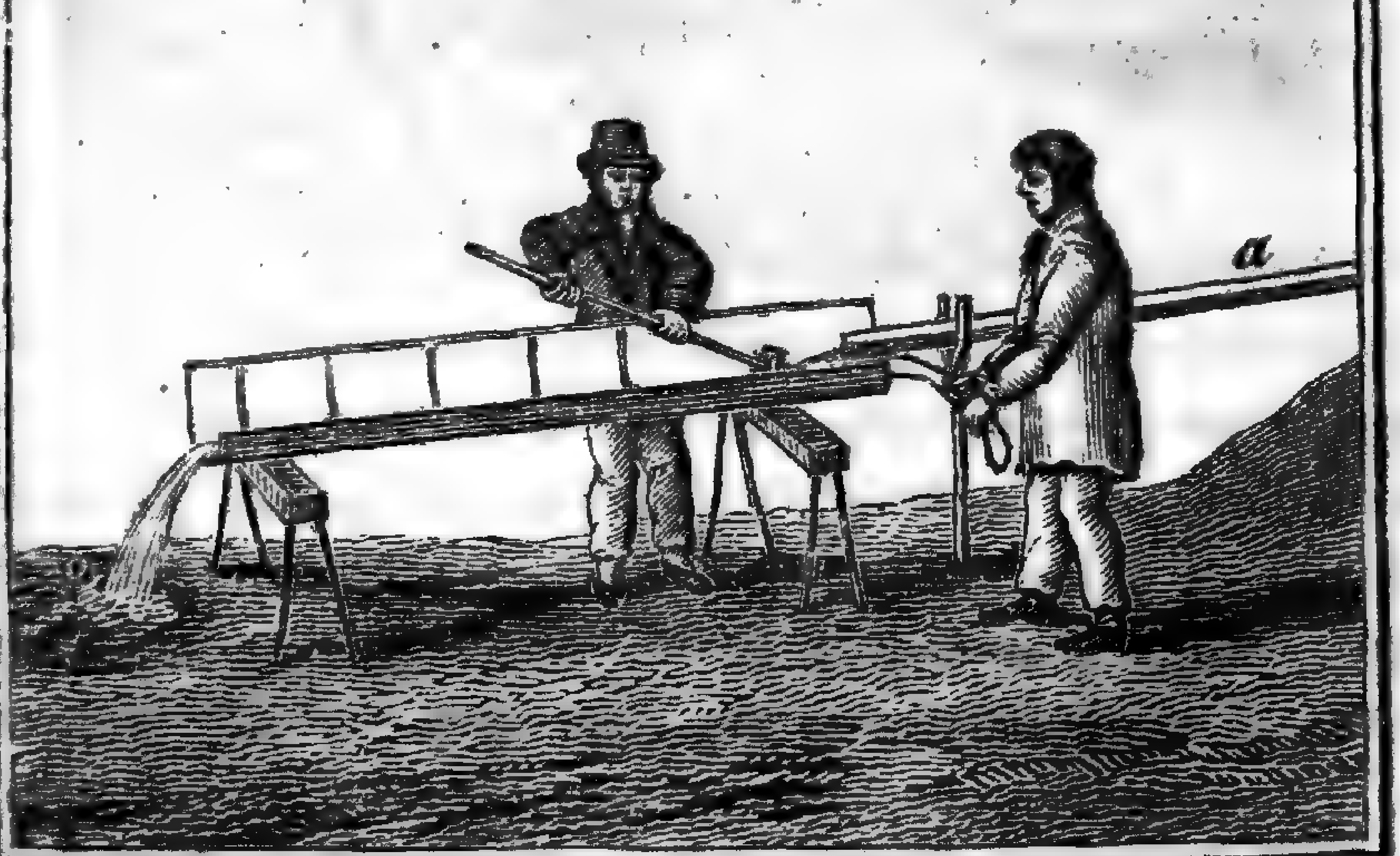

off, and a new supply put in to be acted on as before. When the work for the time is done, the contents of the gum are put into the pan, and the garnets, ferruginous sand, &c. washed off, thus completing the process. I should have mentioned that the gum was kept rocking by a man at the lever, as represented in the figure. Compared with the pan, there can be no doubt that the gum saves labor, but it, as certainly, in careless hands, increases the risk of not saving the gold.

At Fig. 19, we have represented another machine. It consist of an inclined plane and box *c*, with bars across. Half of the plane at the upper end is solid and lined with stout sheet iron; auriferous gravel is there manipulated by a man and rake, and when sufficiently done, it is allowed to descend to the lower end of the plane, which is perforated and the gold, &c. thus passes into the box *c*, while the gravel is thrown out at *d*. If this machine is cleared, two or three times a day, it answers very well, but when neglected and the bars get filled up and clogged, it loses the light particles; the process is closed with the pans in this machine, like the former.

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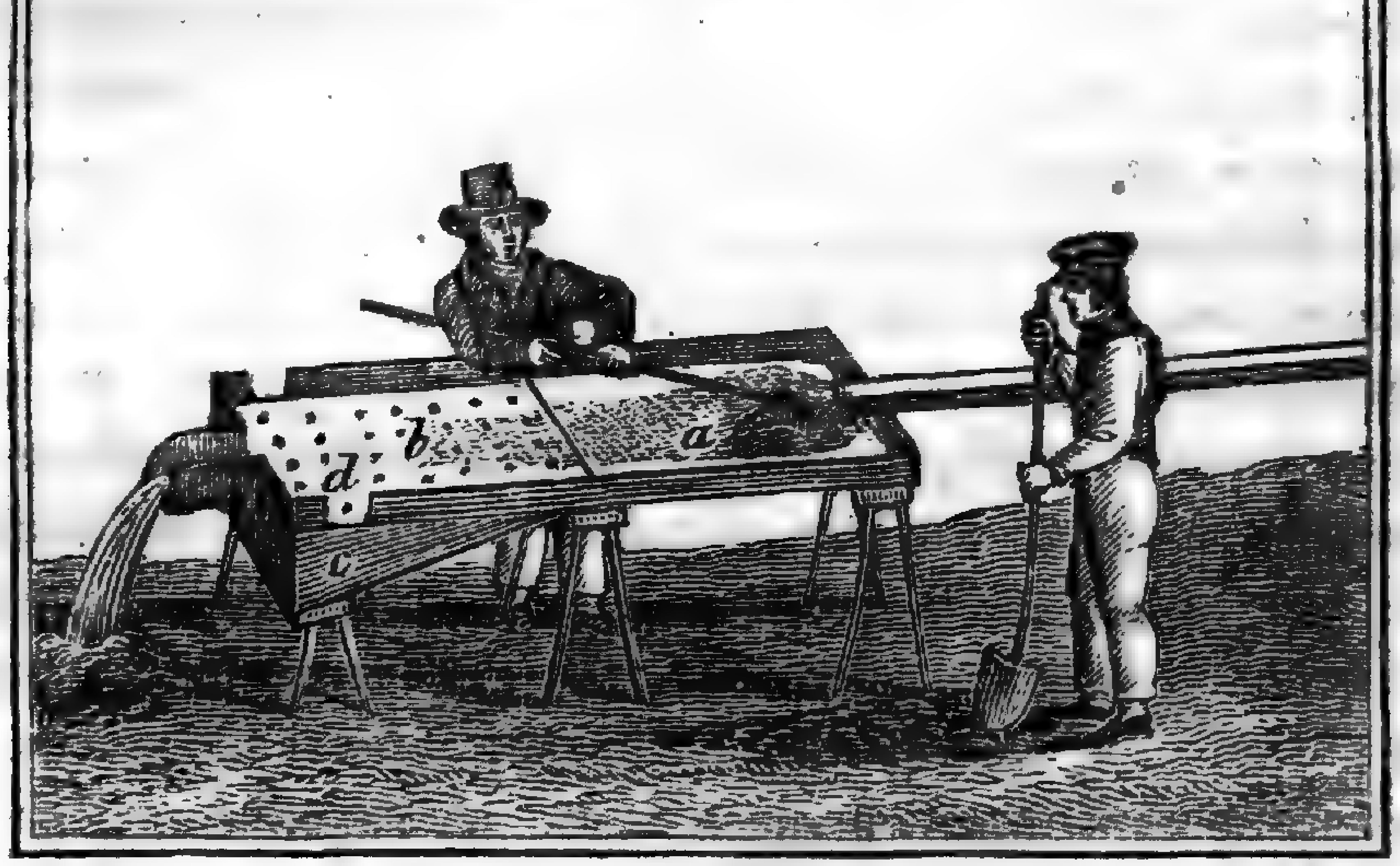

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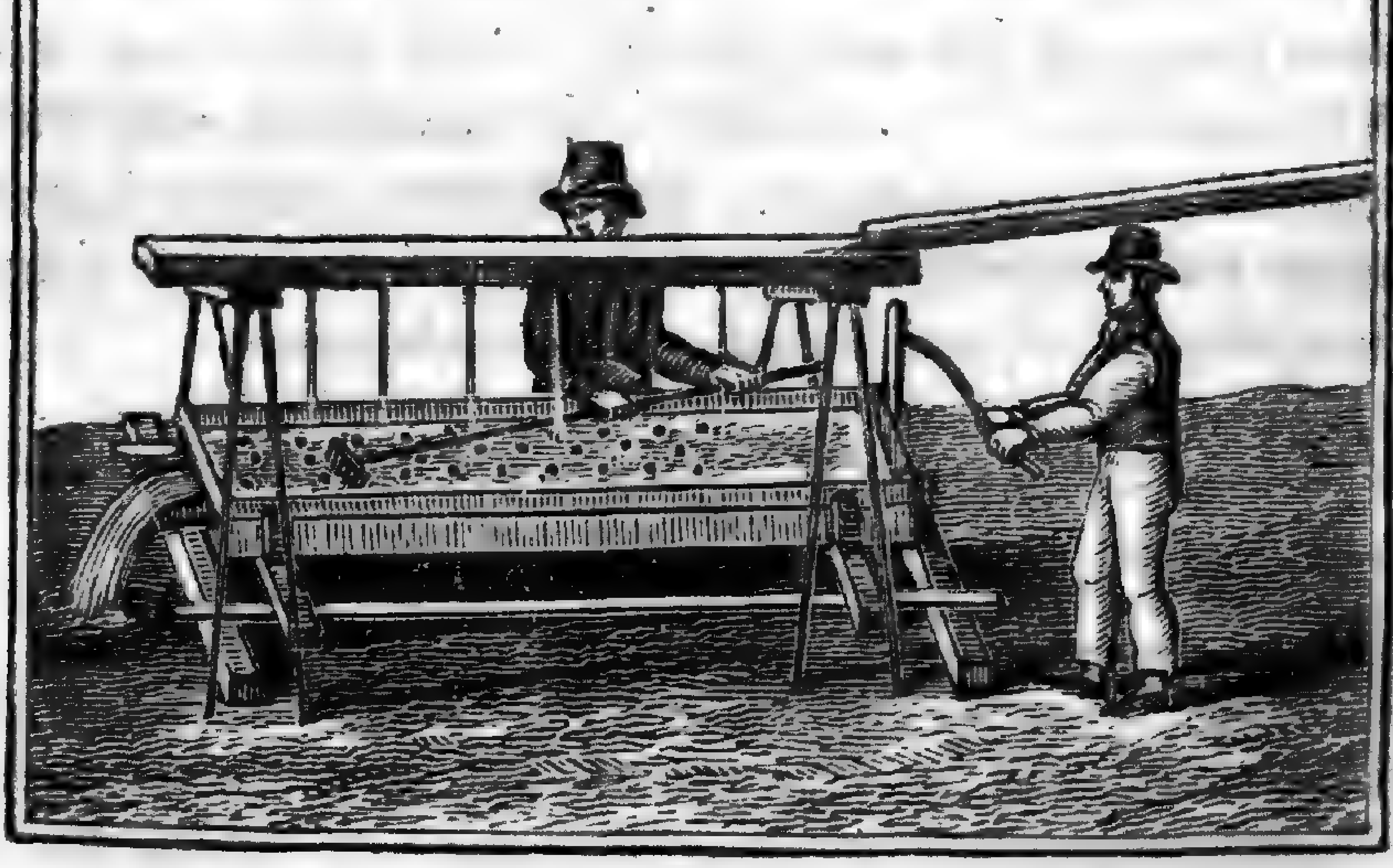

Fig. 20, appears to be an attempt to improve the gum by adding the inclined plane; *a* is a rectangular drawer instead of the gum or box *c* in the preceding figure, which is furnished with cleats, &c.; the water is distributed over the whole plane and the working is aided by the spring laths *b* on each side. This cannot be called an improvement as it is liable to all the objections which apply to the pan-gum or inclined plane, but especially to another which is the shape of the drawer, causing the water to act very forcibly in passing from one side to the other, and thus increasing the probability of the fine particles being carried off with it. The other machines in common use, are mere modifications of those already described. For those patented, the "Journal of the Franklin Institute" may be consulted. An arrangement tried by the author, is intended to unite the amalgamating to the gravitating process; it is used when the assay has shewn that mercury will be required to collect the minute particles. It is applied in the following manner. The preparatory washing of the gravel is to be effected in a revolving iron cylinder, similar to a bolter, which will also cause a separation of the large gravel to be discharged at the lower end. The gold and finer fragments of rock, garnets, &c. that have passed through the perforations of the cylinder, are to be swept over a perforated plane, the perforations being of such size as as to allow the largest particles of gold to pass through into rockers, on the principal of the "gum" but hinged by the edge instead of being hung on gudgeons at the centre. The machine, thus far, is capable of securing every particle having any appreciable gravity, but if there are as many minute particles as will pay the expense of saving, I then add the amalgamator, which receives the washings from the rockers and triturates them with the mercury.* There are not many deposit mines requiring the aid of mercury, and when used with the pulverized gangue of the veins or ridge mines, the process is some what different; heat, salt, or acid is then introduced with the ore, and a limited measure of water. The Mexican method is given in the Journal before alluded to. A mill for pulverizing, and a furnace for heating the quartz, are necessary to the vein mines.

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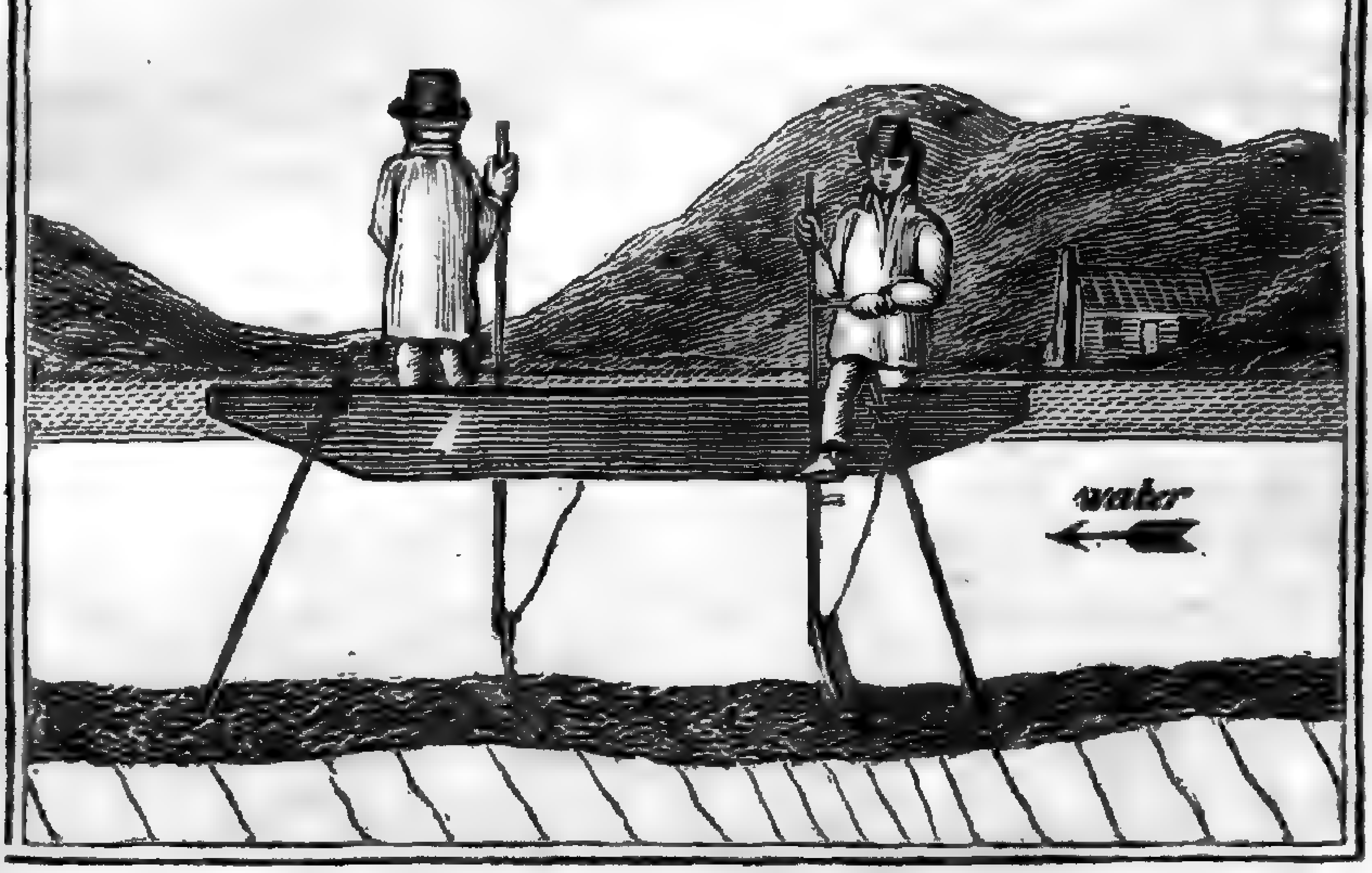
* The drawings are in the patent office, although the machine is not patented, but will be as soon as opportunity offers.

Fig. 21, is a representation of the process by which gravel is obtained by boats from the beds of the rivers. A man forces his shovel into the gravel near one end of the boat, and when he thinks he has it deep enough walks to the other end, bearing down the handle, and thus loosening the gravel so that it may be hoisted into the boat by an assistant, who also works a shovel on the other side. In this way a boat and two men make five loads per diem. I have known a load to yield 6 dwts. although the average is much less.

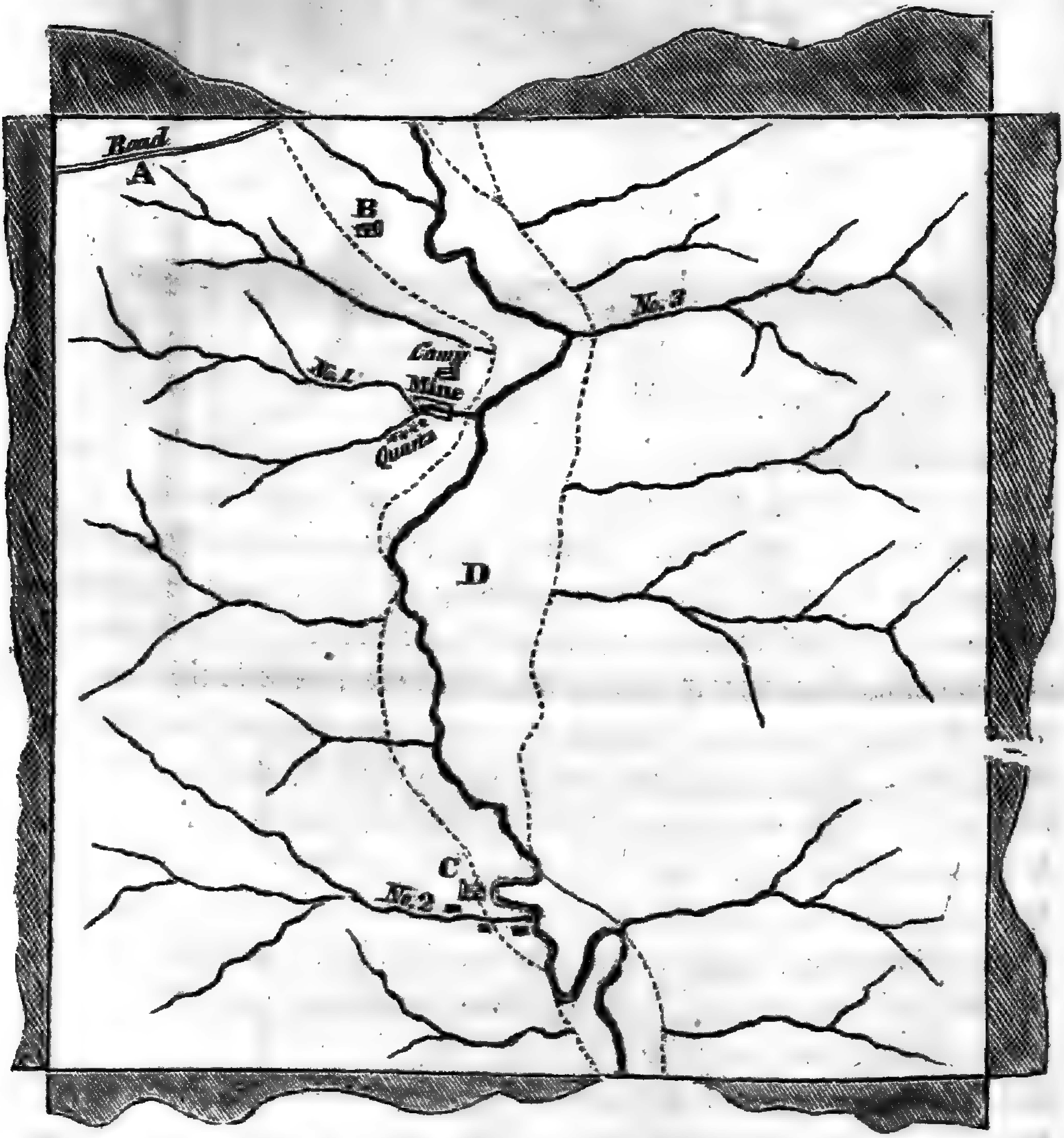
21



Shelton's Gold Mine.—This mine is on the waters of the Soquee a branch of the Chattahoochie river, and with ranges of lots in the fifteenth district, forms the dividing ridge between the Soquee and Tallulah, a branch of the Savannah river. The Oaky mountain is to the north of 35 about a mile, and from the top of it Clarksville can be distinctly seen; it is probably the highest peak in this ridge, as there are no others intercepting a view of the Apalachian terminating ridges. The large branch running through 35, terminates at the base of the Oaky mountains, and is supplied by the springs that issue from it and the neighboring elevations. The surface of the lot is very uneven, as may be seen on inspecting the sections attached to the plan. One corner of the lot appeared to be eight hundred feet above the level of the branch. The geological arrangement of the rocks is not ascertained. Gneiss predominates; there are strata of mica and talcose rocks, and fragments of quartz are abundantly scattered over the surface, indicating veins. The bottom described by the dotted lines, is alluvial and fit for cultivation; on the smaller branches, tolerable patches could be obtained, especially on No. 2. The branches 1, 2, and 3, are always wet and afford sufficient water to wash out the gold; the main branch could easily be made to work machinery for that purpose; all the other branches are dry, except in rainy weather, or after a wet season.

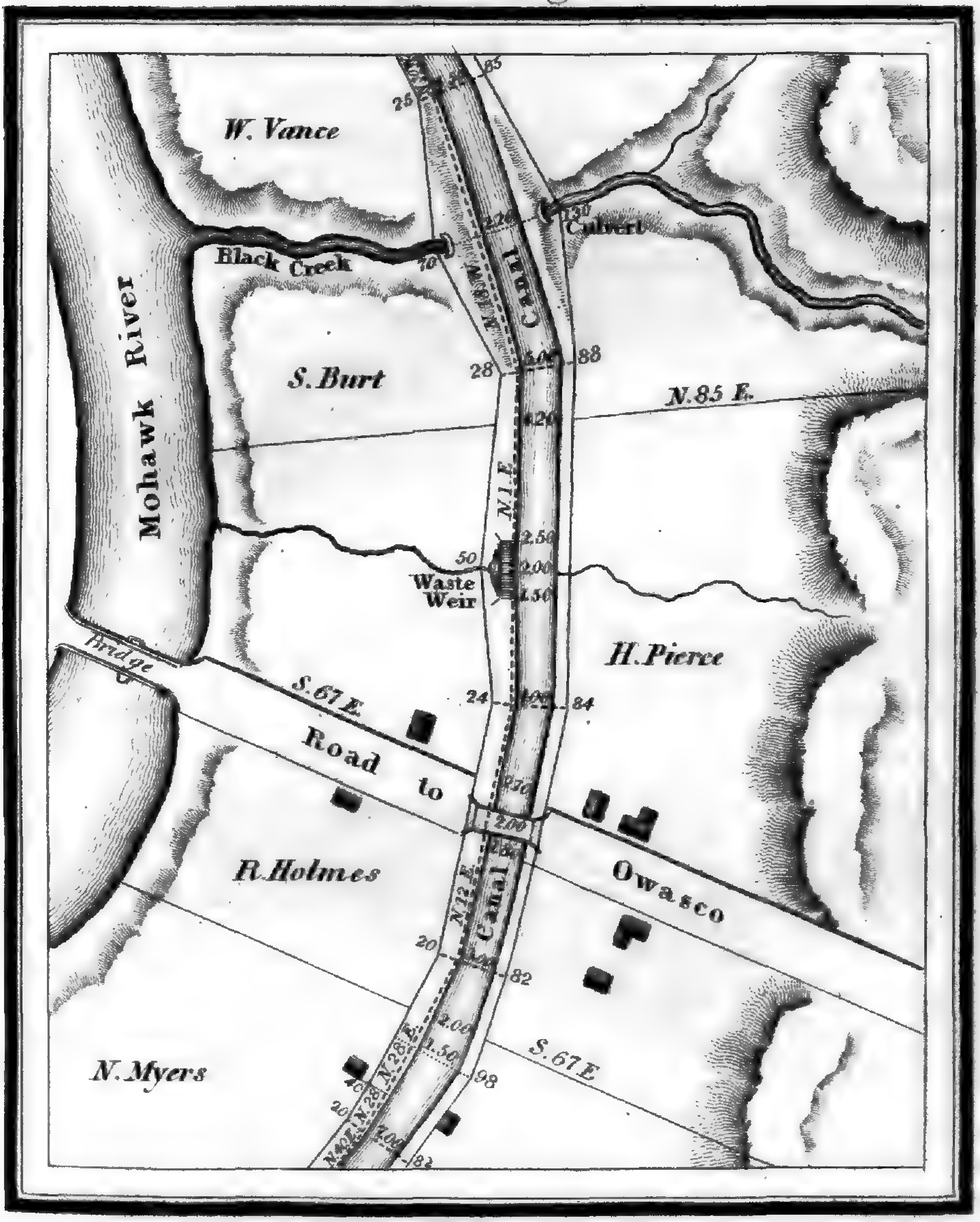
The great deposit of gold, was found on No. 1 and is supposed to have been disintegrated from veins on the adjacent ridge. No. 2 affords some beautiful and rich specimens, and I am told is considered fully as valuable as No. 1 although it has not been worked, except in some experimental pits.

Plan and sections of lot 35 in the eleventh district of Habersham, Geo. on which is the celebrated mine, known as Shelton's Gold Mine.



A, Stone ciphern road to Clarkesville.—B, John Fruc.—C, Watson's House.—D, This space between the dotted lines, fit for cultivation.

MAP. Fig. 2.



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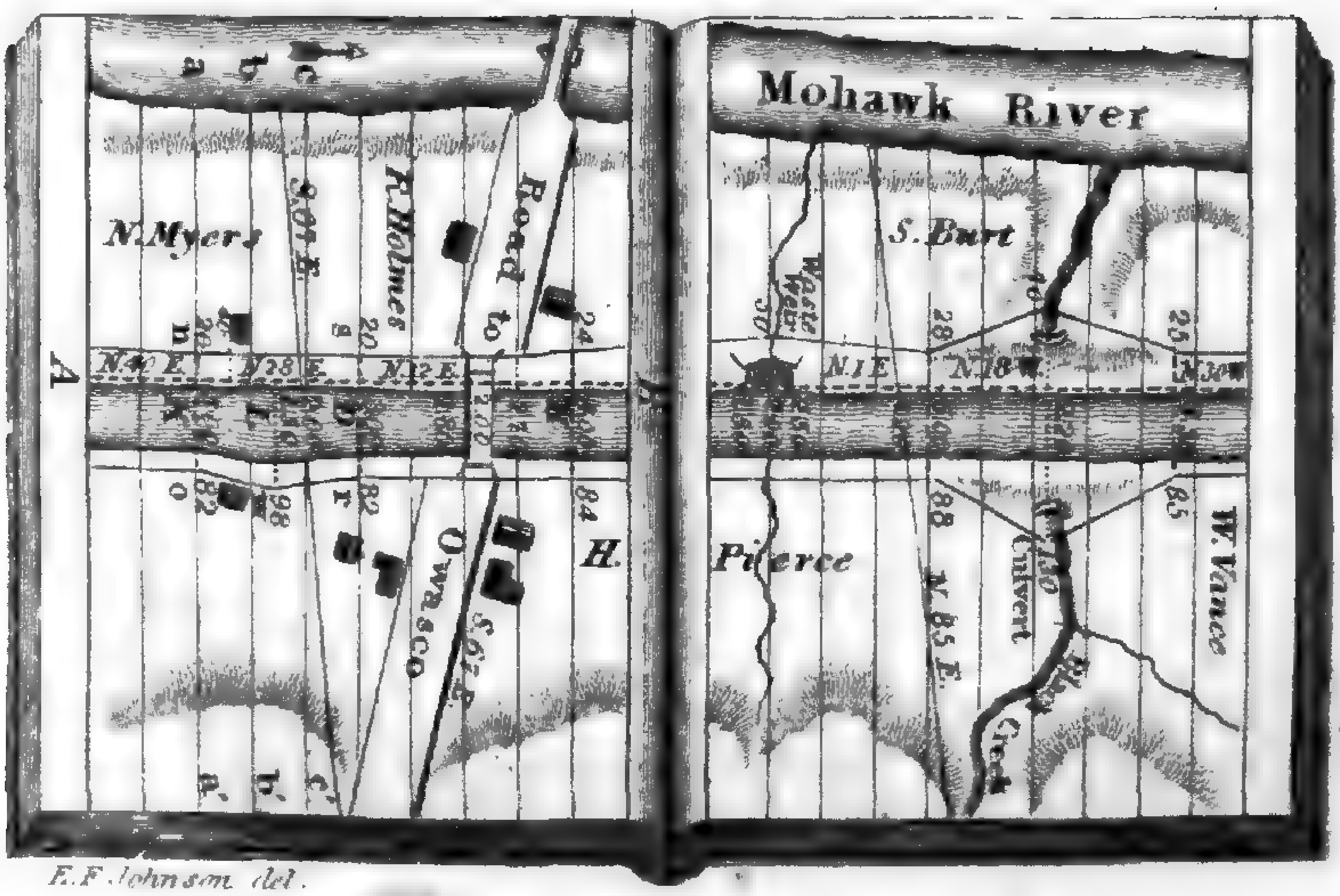

E.F.Johnson del.

FIELD-BOOK. Fig. 1.

Red lines thus .... Red dotted lines thus ....

Art. II.—*Method of Conducting the Canal Surveys in the State of New York;* by E. F. Johnson, Civil Engineer.

At the time when the two great Canals of the state of New York were constructed, the outlines or boundaries of the ground which they occupied were not established by any accurate or systematic surveys, and hence no means were afforded for ascertaining the precise extent of ground intended to be appropriated by the state for their use.

At the period of their completion, the damages to the different proprietors whose lands were intersected and injured by them, were assessed by commissioners duly appointed and authorized for the purpose. These commissioners in making their estimates directed measurements to be made, in very many instances, for determining as nearly as practicable, without too much delay and expense, the average length and breadth of the several portions of ground taken from the different proprietors through whose lands the Canals passed.

From these measurements the approximate quantity of ground contained in each portion was deduced, which compared with its value per acre, enabled the commissioners to determine, with greater certainty than could otherwise have been attained, the actual damage to individuals occasioned as above stated.

Although the measurements thus made, may have answered sufficiently well perhaps for the purpose for which they were instituted, yet the want of more perfect and systematic surveys in accurately defining the outlines of the Canals was soon felt. The proprietors of the adjoining grounds, being ignorant of the precise extent of the claims of the state, could only refer, in their instruments of conveyance, in a general manner, to the Canal as a boundary, and were equally at loss in the erection of buildings in those cases where as near an approach to the Canals as possible was desirable without infringing upon the rights of the state.

The inconvenience resulting from this state of things was not confined altogether to individuals. The rapid increase in the value of lands bordering the Canals, which followed their completion, and the numerous encroachments which were in consequence made upon the ground required for their efficient and successful operation, rendered it necessary for the state to devise some means of preventing any future inconvenience from the same source. This it was apparent could be done only through the medium of surveys properly executed, the maps, field-books, &c. of which, should be deposited in some place convenient for reference.

The result of the legislative action upon the subject is to be found in Part. I. Chap. IX, Title IX. of the Revised Statutes of the state of New York, in nearly the following words:

A complete manuscript map and field notes of every Canal that now is or hereafter shall be completed, and of all the lands belonging to the state adjacent thereto or connected therewith shall be made, on which the boundaries of every parcel of such lands to which the state shall have a separate title, shall be designated, and the names of the former owners and the date of each title be entered. The expense to be defrayed out of the Canal fund. The surveys to be executed under the direction of the Canal commissioners, and approved by the Canal board, and when completed to be filed in the office of the comptroller. Copies of the maps and field notes so filed are to be made under the direction of the Canal board, and transmitted by the comptroller to every county intersected by the Canals to which the maps shall relate, and filed in the Clerk's office of such county.

The portion of the revised statutes from which the preceding is taken received the legislative sanction in 1827, and in 1828 and '9 the attention of the Canal commissioners was directed to the subject with the view of making the necessary arrangements for the execution of the surveys.

The Canals which were at this time completed and considered as the property of the state, were the Erie, Champlain, Seneca and Cayuga, and Oswego, which, including the Chemung and Crooked Lake Canals, upon which operations had already been commenced, constituted an extent of nearly six hundred miles.

In accomplishing the survey of these works the importance was at once seen of a rigid adherence to the same uniform system throughout; and it was likewise obvious that the greatest caution and judgment should be exercised in selecting from the different modes which might be devised, the one which should afford the means of determining at any future day, with the greatest practicable degree of precision, the outlines of the land set apart by the state for the use of the Canals.

In the investigation of the subject, it became apparent that one of two modes differing materially from each other in their general principles, must be adopted.

The first method contemplated the measurement, in the usual manner with the circumferentor and chain, of the outlines of the ground occupied by the Canals, with such references to permanent objects and cross measurements as were necessary for verifying the accuracy of the survey.

In the other method the location of the outlines or boundaries was to be determined by offsets, made in a specified manner, from a base line situated upon and coinciding with the inner edge of the towing-path, the best defined, and, (as an object for general reference) the most permanent part of the Canal. References were likewise to be made as contemplated in the preceding method to all accessible objects of a permanent character for verifying the accuracy of the survey.

This latter method being the one which received the sanction of the commissioners and Canal board, its details will be more fully described as follows.

1. The measurements in the direction of the length of the Canal were made upon the base line above mentioned, situated upon or coinciding with the inner edge of the towing-path. The height of the surface of the towing-path, and the inclination of its inner slope being supposed the same as specified in the transverse profile adopted in the construction of the Canals.

2. The several changes in the direction of the base line were refered to the magnetic meridian. The whole line being thus resolved into as many separate alignments, as it contained portions having different courses or bearings.

3. The several alignments were accurately measured in chains and tenths; (fractions other than tenths being avoided by a very little care in arranging the stations) and the distances upon each to the several points where the lines of roads, counties, towns, patents, lots, &c. intersected the same, together with their courses or bearings, were carefully observed.

4. The distances likewise to all waste-weirs and culverts, and to all streams that discharged themselves into or otherwise intersected the Canals were taken, and the same was done with respect to the road and farm bridges, locks, aqueducts, &c. The distances to the bridges were taken to the lines joining the two nearest angles or cor-

ner-posts of their abutments—those to the locks to the lines passing through the centers of the two nearest quoin-posts, and those to the aqueducts to the faces of their abutments.

5. Offsets for determining the breadth of ground occupied by the Canal, were made from the base line at each angle or station and likewise at every other point where a variation in the breadth of the Canals required. The directions of the offsets were such as to bisect the angles formed by the two portions of the base line situated contiguous to them on each side, or in other words, the directions of the offsets at the several stations were such as to bisect the angles formed by the alignments, on the towing-path, the intermediate offsets being described perpendicular to, and the distances upon both reckoned from the same alignments in links.

6. The offsets on one side, across the towing-path, were made to extend at least twenty links (that being the minimum fixed by the commissioners) and in every case to reach to the base of the outer slope of the embankment. The offsets in the opposite direction, across the Canal, were made to extend at least fifteen links from the margin of the water, that being the minimum allowance for the breadth of the berm, and in every case to reach to the base of the exterior slope of the embankment, if any, upon that side.

7. Wherever an enlargement in the breadth of the Canal rendered the method of offsets inconvenient or impracticable, the portion included in said enlargement was surveyed in the usual manner by measuring the courses and distances of the several lines that enclosed it on the side opposite to the towing-path.

8. The survey embraced within its limits all grounds pertaining to the Canal including all tracts or lots of land, set apart or appropriated for the purposes of lock-houses, weigh-locks, collector's offices, &c. with the names of the former owners and the date of each separate title inserted as far as the same could be ascertained.

9. The results of the measurements made as above described were inserted in a field-book prepared as represented in the annexed drawing, Fig. 1. Each page of the book was ruled into parallel lines as *aa'*, *bb'*, &c. one fourth of an inch distant from each other. Near the center of each page and at right angles with those lines a red line as AB was drawn extending across all the pages of the book.

10. The red line thus drawn represented the base line of the survey. The portion of this line as KD or DH corresponding to any given alignment, was made to embrace in its length as many of the

spaces included by the parallel lines as there were chains in the alignments, or, if the smallness and number of the objects to be noted rendered it necessary to enlarge the scale, double the said number of spaces were taken for the purpose mentioned.

11. The offsets as K *o*, K *n*, D *r*, and DS, &c. for the breadth of the survey, were in every case represented upon the larger or double scale, that is, two spaces or one half of an inch was assumed as equal to one chain. The offsets at the several stations or angles K. D. H. &c. in the base line, were represented by continued red lines. The intervening offsets as L *w* were indicated by the red dotted lines.

12. The distances between the several stations, or the lengths of each separate alignment, were inserted at the ends of the same, within the space occupied by the Canal. The same was likewise done with respect to the intervening offsets and all other measurements upon the base line, the distances being in each case reckoned from the last preceding station. The lengths of the offsets were inserted on the right and left of the Canal, according as they were made on one side or upon the other.

13. In the field-book thus arranged all lines appertaining to the survey were described as nearly as possible in their true positions; likewise all such objects of interest of every description, including roads, streams, buildings, changes in the inclination of the ground, geological characteristics, localities of minerals, &c. &c. as came within the limits of the field-book, were carefully sketched. The sketches being executed with greater accuracy through the aid of the parallel lines as above described.

14. The results of the measurements for the several bearings and distances were distinctly put down upon the lines to which they respectively belonged, and the whole accompanied by such remarks as were necessary completely to elucidate every thing of importance relating to the survey.*

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* It is perhaps proper to remark that occasional observations for determining the variation of the magnetic needle were contemplated, but for the want of the necessary instruments, were omitted. The importance of such observations was however duly considered, and the precaution was frequently taken to note with precision the magnetic bearings of distant and permanent objects, so that, should suitable observations be hereafter instituted, the exact variation of the magnetic meridian as it existed at the time of making the survey can be easily ascertained.

Fig. 2. exhibits a portion of the map as constructed from the field minutes. It differs from the field-book principally in the circumstance of its several lines and angles being reduced to their proper relative positions and dimensions. The explanations therefore which have been given for the one will it is believed, be sufficient for a proper understanding of the other.

The maps were formed on separate sheets of super royal paper, bound in the Atlas style, each volume containing fifty sheets and comprehending about thirty or thirty-five miles of Canal. They were projected upon the same uniform scale of two chains to the inch and the border lines, on each separate sheet, were so drawn relatively as to coincide in direction with the magnetic cardinal points of the horizon. The shading and lettering were executed in a superior manner and the whole exhibited a style and perfection of finish corresponding with the importance of the survey.

Of the two modes of survey whose merits were canvassed by the commissioners, the one above described, was the one to which, as already stated, the preference was awarded.

In this method the principal measures in the direction of the length of the Canals, were made upon the base line, situated upon the level and even surface of the towing path, under circumstances, it will be conceded, in the highest degree favorable for accuracy; while in the other mode the measures would have been subject to all the errors arising from inequalities of ground, and the various obstacles to be met with upon the outlines, such as trees, fences, streams of water, ravines, swamps, rocks, &c. which occur more or less frequently upon all portions of the Canals; add to this, the absolute impracticability of making such a survey in the many places where the Canal is bounded on both sides by impassable swamps, as is the case at the Cayuga marshes, or is separated as it frequently is, from an adjoining river, by a high terrace wall or embankment, or is bounded upon the berm side by a steep and thickly wooded side-hill, or by lofty and precipitous rocks, similar to what is seen at the Little Falls, at Flint Hill, at the Big Nose, or at the Cohoes upon the Mohawk and at various other places.

In the method, as pursued, the base or governing line, is located upon the inner edge of the towing path, the best defined, and for the purpose of general reference, unquestionably the most permanent part of the Canal. The importance of maintaining a hard and even surface for the horse track, renders it necessary to construct it of materials of a solid and durable character. Its inner edge likewise is usually protected by a slope wall of stone or docking of timber to resist the action of the water, the abrasive effects of which if they occur at all, are confined to short distances and to particular places, and under circumstances, which render it an easy matter to determine the precise extent of the encroachment. Upon the New York Canals, and indeed upon most other works of the kind in the country, there are distances of miles together where substantial buildings or bridges or objects of an equally permanent character cannot be found, in consequence of which, and from the little reliance to be placed upon the directive property of the magnetic needle, in tracing long and irregular lines, in cases where an error of even one or two feet in the distance of a mile would be attended with serious inconvenience, and considering moreover, the imperfection and disagreement of different instruments, and the want of the requisite skill not uncommon with many surveyors, a constant reference to some part of the Canal, as a standard for preserving the location of the outlines becomes absolutely essential.

In selecting the part of the Canal for this purpose, the choice, it will be obvious, would necessarily fall, either upon the inner edges of the berm or towing path, or upon one or both margins of the water. Of these the towing path was considered as entitled to the preference, since the berm side is not only constructed of less durable materials, more liable to abrasion and seldom kept in proper repair, but for much of the distance where the Canal runs along sidelong ground no regular or artificial berm is formed, the water being allowed to flow back and conform to the natural irregularities of the surface. In some places likewise the berm, is subject to alteration from the gradual sliding or *giving* of the earth producing a contraction of the channel, while the embankment on the side of the towing path remains comparatively firm and undisturbed. Similar objections will likewise apply to either margin of the water, particularly on the berm side, while on both sides the marginal line is subject to constant variation from the fluctuations of droughts and floods, and the irregular demand for the supply of inferior levels and for the purposes of lockage.

From the preceding it will appear, that even in the mode of surveying the outlines, as rejected by the commissioners, a general reliance must necessarily have been placed, as in the other method, upon offsets to the inner edge of the towing path, with this difference, that as no survey is made along the inner edge of the towing path, any changes or variations in it cannot be so easily detected and rectified. These offsets likewise, owing to the great difference in level of the surface of the towing path, and the ground on which the outlines are situated, particularly in places where there are high embankments or deep excavations, would be subject to very great inaccuracy, which combined with the difficulty of reducing them to any regular system, would occasion many irreconcilable discrepancies between the measures upon the offsets and those upon the outlines, and render the precise location of the boundaries a matter of corresponding uncertainty. In the mode as pursued, the accuracy or inaccuracy of the offsets does not in the least affect the location of the base line, and by means of the measures upon it, and the uniform mode of describing the offsets, the bearings and distances of the outlines can be calculated, if required, with much greater precision than they could possibly be measured, and when so calculated, the different parts of the survey, will have the additional merit of a perfect agreement with each other, a desideratum which in the other method must be pronounced to be practically unattainable.

Another consideration of much importance in favor of this mode is found in the facilities afforded for recording the field notes and representing the whole by means of sketches end diagrams in such a manner as to avoid all liability to mistake or confusion and presenting at the same time a very tolerable map of the survey. The check likewise which the mode of sketching exercises over the measures with the chain—the one keeping pace in all cases with the other, and both under the immediate and constant supervision of the survey, or (each chain-distance on the base line being represented by its corresponding space in the field-book,) combined with the practice of requiring a separate account from each of the chainmen, rendered an error in the reckoning almost impossible.

In the other mode the frequent obstructions to be encountered upon the outlines and the constant necessity of deviating by offsets from a direct course, would add very much to the liabilities to error, and although the measures, upon the two outlines if the cross measures were repeated often enough, would serve to detect any errors or omissions of integer chains upon each, yet no evidence would be afforded, upon which of the lines it occurred, and an attempt to correct without an actual re-survey would be as likely to increase as to remedy the evil; add to this, the discrepancy that would unavoidably result from the circumstance of the two outlines being surveyed at perhaps different times by different surveyors with different instruments and different assistants, and the great inconvenience of referring, at any future time, for the results of the measures of a given portion of the Canal, to different field-books or to different parts of the same field-book, a necessity which from the nature of the case could not be avoided.

The disadvantage of this mode, is likewise evident in another respect. The law of the Legislature authorizing the survey, requires that the maps and field-books, with all that they contain, shall be sanctioned and certified by the commissioners, and for this purpose before the survey can be said to be completed, the whole ground must be examined by the commissioners in company with the surveyor, and in the many instances where the opinion of the former would probably differ from the latter, as to the precise extent of ground proper to be embraced in the survey, alterations in the measures and the field-books must necessarily be made. These cannot be effected without completely deranging the previous surveys, and requiring an entire re-survey of the objectionable portions, while in the method as adopted, the necessary alterations are speedily and easily effected by simply enlarging or diminishing the offsets to the extent required. In tracing the outlines, moreover, by the former mode, the surveyor from a natural desire to expedite his work, by reducing the number of separate courses or bearings, might perhaps extend his lines to an undue length, the consequence of which would be, that the outlines would, in many places approach nearer to, and in others recede farther from the Canal than would be proper, and too much or too little ground would be embraced within the survey. This would be particularly the case, upon the concave and convex sides of those portions of the Canal which were the most curved. In the method as pursued, this difficulty is entirely avoided, The variations in the breadth of the ground embraced in the survey are gradual, conforming as nearly as possible to the natural changes in the surface of the ground and the requisitions of the canal. It moreover completely secures to the State the possession of the specified breadth of ground, appropriated to the Canal, and in this respect it accords in its practical operation with the established principle that the interest of the public should always take precedence of that of individuals, in all cases where the means necessary for the perfect protection of the former, are so limited, that the extreme of abuse or encroachment which can possibly result, will not expose the rights of the latter to material or important injury.

There is still another consideration of great importance in favor of this method which does not exist in the other. In all ordinary cases the location of the boundaries may be determined without the aid of the circumferentor, by means of the chain only. The greatest error which can thereby result in the position of either boundary, will not, exceed ten or twelve inches, supposing the offsets to be made twelve degrees out of their proper direction, and in the majority of cases will not probably exceed one third or one fourth of that amount.

The expense likewise, of this mode is at least forty per cent. less than by the other, and when it is considered that the object to be attained is effected in a much more perfect and scientific manner, it must be conceded that it possesses a decided superiority.

The mode of survey above described is alike applicable to railways as to Canals, and the description of it is thus publicly made, that those who are engaged in the construction of works of inter-communication may avail themselves of the advantages which it possesses over the less perfect methods ordinarily pursued in such cases.

Middletown, Conn. Nov. 1832.

Art. III.—*An Estimate of the Philosophical Character of Dr. Priestley;* by William Henry, M. D., F. R. S., &c. &c.

Read to the first meeting of the British Association, for the promotion of science, at York, September 28th, 1831.

The principal source of the materials of the following pages, is the work, in which the discoveries of Dr. Priestley were originally announced to the public. It consists of six volumes in octavo, which were published by him, at intervals between the years 1774 and 1786; the first three under the title of "Experiments and Observations on different kinds of Air;" and the last three under that of "Experiments and Observations relating to various Branches of Natural Philosophy, with a continuation of the Observations on Air." These volumes were afterwards methodised by himself, and compressed into three octavos, which were printed in 1790. As a record of facts, and as a book of reference, the systematized work is to be preferred. But as affording materials for the history of that department of science, which Dr. Priestly cultivated with such extraordinary success; and, still more, for estimating the value of his discoveries, and adjusting his station as an experimental philosopher, the simple narrative, which he originally gave in the order of time, supplies the amplest and the firmest ground-work.

In every thing that respects the history of this branch of experimental philosophy, the writings and researches of Dr. Priestley, to which I have alluded, are peculiarly instructive. They are distinguished by great merits, and by great defects; the latter of which are wholly undisguised by their author. He unveils, with perfect frankness, the whole process of reasoning, which led to his discoveries; he pretends to no more sagacity than belonged to him, and sometimes disclaims even that to which he was fairly entitled; he freely acknowledges his mistakes, and candidly confesses when his success was the result of accident, rather than of judicious anticipation; and by writing historically, and analytically, he exhibits the progressive improvement of his views, from their first dawnings, to their final and distinct development. Now, with whatever delight we may contemplate a systematic arrangement, the materials of which have been judiciously selected, and from which every thing has been excluded, that is not essential to the harmony of the general design, yet there can be no question that as elucidating the operations of the human mind, and enabling us to trace and appreciate its powers of invention and discovery, the analytic method of writing has decided advantages.

To estimate, justly, the extent of Dr. Priestley's claim to philosophical reputation, it is necessary to take into account the state of our knowlege of gaseous chemistry, at the time when he began his inquiries. Without underrating what had been already done by Van Helmont, Ray, Hooke, Mayow, Boyle, Hales, Macbride, Black, Cavendish, and some others, Priestley may be safely affirmed to have entered upon a field, which, though not altogether untilled, had yet been very imperfectly prepared to yield the rich harvest, which he afterwards gathered from it. The very implements, with which he was to work, were for the most part to be invented; and of the merits of those, which he did invent, it is a sufficient proof that they continue in use to this day, with no very important modifications. All his contrivances for collecting, transferring, and preserving different kinds of air, and for submitting those airs to the action of solid and liquid substances, were exceedingly simple, beautiful, and effectual.

They were chiefly, too, the work of his own hands, or were constructed under his direction by unskilled persons; for the class of ingenious artists, from whom the chemical philosophers now derives such valuable aid, had not then been called into existence by the demands of the science. With a very limited knowledge of the general principles of chemistry, and almost without practice in its most common manipulations;—restricted by a narrow income, and at first with little pecuniary assistance from others;—compelled, too, to devote a large portion of his time to other pressing occupations, he nevertheless surmounted all obstacles; and in the career of discovery, outstripped many, who had long been exclusively devoted to science, and were richly provided with all appliances and means for its advancement.

It is well known that the accident of living near a public brewery at Leeds, first directed the attention of Dr. Priestley to pneumatic chemistry, by casually presenting to his observation the appearances attending the extinction of lighted chips of wood, in the gas which floats over fermenting liquors. He remarked, that the smoke formed distinct clouds floating on the surface of the atmosphere of the vessel, and that this mixture of air and smoke, when thrown over the sides of the vat, fell to the ground; from whence he deduced the greater weight of this sort of air than of atmospheric air. He next found that water imbibes the new air, and again abandons it when boiled or frozen. These more obvious properties of fixed air having been ascertained, he extended his inquiries to its other qualities and relations; and was afterwards led by analogy to the discovery of various others gases, and to the investigation of their characteristic properties.

It would be inconsistent with the scope of this Essay to give a full catalogue of Dr. Priestley's discoveries, or to enumerate more of them, than are necessary to a just estimate of his philosophical habits and character. He was the unquestionable author of our first knowledge of oxygen gas, of nitrous oxide, of muriatic, sulphurous, and fluor acid gases, of ammoniacal gas, and of its condensation into a solid form by the acid gases. Hydrogen gas was known before his time; but he greatly extended our acquaintance with its properties. Nitrous gas, barely discovered by Dr. Hales, was first investigated by Priestley, and applied by him to eudiometry. To the chemical history of the acids derived from nitre, he contributed a vast accession of original and most valuable facts. He seems to have been quite aware that those acids are essentially gaseous substances, and that they might be exhibited as such, provided a fluid could be found that is incapable of absorbing or acting upon them.* He obtained, and distinctly described,† the curious crystalline compound of sulphuric acid with the vapor of nitrous acid, or, more correctly, of sulphuric and hyponitrous acids, which, being of rare occurrence, was forgotten, and, has since been rediscovered, like many other neglected anticipations of the same author. He greatly enlarged our knowledge of the important class of metals, and traced out of their most interesting relations to oxygen and to acids. He unfolded, and illustrated by simple and beautiful experiments, distinct views of combustion; of the respiration of animals, both of the inferior and higher classes; of the changes produced in organized bodies by putrefaction, and of the causes, that accelerate or retard that process; of the importance of azote as the characteristic ingredient of animal substances, obtainable by the action of dilute nitric acid on muscle and tendon; of the functions and economy of living vegetables; and of the relations and subserviency, which exist between the animal and vegetable kingdoms. After trying, without effect, a variety of methods, by which he expected to purify air vitiated by the breathing of animals, he discovered that its purity was restored by the growth of living and healthy vegetables, freely exposed to the solar light.

It is impossible to account for these, and a variety of other discoveries, of less importance singly, but forming altogether a tribute to science, greatly exceeding, in richness and extent, that of any contemporary, without pronouncing that their author must have been furnished by nature with intellectual powers, far surpassing the common average of human endowments. If we examine, with which of its various faculties the mind of Dr. Priestley was most eminently gifted, it will, I believe, be found that it was most remarkable for clearness and quickness of apprehension, and for rapidity and extent of association. On these qualities were founded that apparently intuitive perception of analogies, and that happy facility of tracing and pursuing them through all their consequences, which led to several of his most brilliant discoveries. Of these analogies many were just and legitimate, and have stood the test of examination by the clearer light, since reflected upon them from the improved condition of sci-

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* Series I. Vol. ii. p. 175. † Series II. Vol. i. p. 26.

ence. But, in other cases, his analogies were fanciful and unfounded, and led him far astray from the path, which might have conducted him directly to truth. It is curious, however, as he himself observes, that in missing one thing, of which he was in search, he often found another of greater value. In such cases, his vigilance seldom failed to put him in full possession of the treasure upon which he had stumbled. Finding by experience, how much chance had to do with the success of his investigations, he resolved to multiply experiments, with the view of increasing the numerical probabilites of discovery. We find him confessing, on one occasion, that he "was led on, by a random expectation of some change or other taking place." In other instances, he was influenced by theoretical views of so flimsy a texture, that they were dispersed by the first appeal to experiment. "These mistakes," he observes, "it was in my power to have concealed; but I was determined to show how little mystery there is in the business of experimental philosophy; and with how little sagacity, discoveries, which some persons are pleased to consider great and wonderful, have been made." Candid acknowledgments of this kind were, however, turned against him by persons envious of his growing fame; and it was asserted that *all* his discoveries, when not the fruits of plagiarism, were "lucky guesses," or owing to mere chance.* Such detractors, however, could not have been aware of the great amount of credit, that is due to the philosopher, who at once perceives the value of a casual observation, or of an unexpected result; who discriminates what facts are trivial, and what are important; and selects the latter, to guide him through difficult and perplexed mazes of investigation. In the words of D'Alembert, "*Ces hazards ne sont que pour ceux qui jouent bien.*"

The talents and qualifications, which are here represented as having characterized the mind of Dr. Priestley, though not of the rarest kind, or of the highest dignity, were yet such, as admirably adapted him for improving chemical science, at the time when he lived. What was then wanted, was a wider field of observation;—an enlarged sphere of chemical phenomena;—an acquaintance with a far greater number of individual bodies, than were then known; from the properties of which, and from those of their combinations, tenta-

* These charges, especially that of plagiarism, which had been unjustly advanced by some friends of Dr. Higgins, were triumphantly repelled by Dr. Priestley, in a pamphlet entitled, "Philosophical Empiricism," published in 1775.

tive approximations to general principles might at first be deduced; to be confirmed or corrected, enlarged or circumscribed, by future experience. It would have retarded the progress of science, and put off, to a far distant day, that affluence of new facts, which Priestley so rapidly accumulated, if he had stopped to investigate, with painful and rigid precision, all the minute circumstances of temperature, of specific gravity, of absolute and relative weights, and of crystalline structure, on which the more exact science of our own times is firmly based, and from which its evidences must henceforward be derived. Nor could such refined investigations have then been carried on with any success, on account of the imperfection of philosophical instruments. It would have been fruitless, also, at that time, to have indulged in speculations respecting the ultimate constitution of bodies;—speculations that have no solid ground-work, except in a class of facts developed within the last thirty-five years, all tending to establish the laws of combination in definite and in multiple proportions, and to support the still more extensive generalization, which has been reared by the genius of Dalton.

It was, indeed, by the activity of his intellectual faculties, rather than by their reach or vigor, that Dr. Priestley was enabled to render such important services to natural science. We should look, in vain, in any thing that he has achieved, for demonstrations of that powerful and sustained attention, which enables the mind to institute close and accurate comparisons;—to trace resemblances that are far from obvious;—and to discriminate differences that are recondite and obscure. The analogies, which caught his observation, lay near the surface, and were eagerly and hastily pursued; often, indeed, beyond the boundaries, within which they ought to have been circumscribed. Quick as his mind was in the perception of resemblances, it appears (probably for that reason) to have been little adapted for those profound and cautious abstractions, which supply the only solid foundations of general laws. In sober, patient, and successful induction, Priestley must yield the palm to many others, who, though far less fertile than himself in new and happy combinations of thought, surpassed him in the use of a searching and rigorous logic; in the art of advancing, by secure steps, from phenomena to general conclusions;—and again in the employment of general axioms as the instruments of farther discoveries.

Among the defects of his philosophical habits, may be remarked, that he frequently pursued an object of inquiry too exclusively, neglecting others, which were necessarily connected with it, and which, if investigated, would have thrown great light on the main research. As an instance, may be mentioned his omitting to examine the relation of gases to water. This relation, of which he had indistinct glimpses, was a source of perpetual embarrassment to him, and led him to imagine changes in the intimate constitution of gases, which were in fact due to nothing more than an interchange of place between the gas in the water and that above the water, or between the former and the external atmosphere. Thus he erroneously supposed that hydrogen gas was transposed into azotic gas, by remaining long confined by the water of a pneumatic cistern. The same eager direction of his mind to a single object, caused him, also, to overlook several new substances, which he must necessarily have obtained, and which, by a more watchful care, he might have secured and identified. At a very early period of his inquiries, (viz. before November, 1771), he was in possession of oxygen gas from saltpetre, and had remarked its striking effect on the flame of a candle; but he pursued the subject no farther untill August, 1774, when he again procured the same kind of gas from the red oxide of mercury, and, in a less pure state, from red lead. Placed thus a second time within his grasp, he did not omit to make prize of this, his greatest, discovery. He must, also, have obtained chlorine by the solution of manganese in spirit of salt; but it escaped his notice, because, being received over mercury, the gas was instantly absorbed.* If he had employed a bladder, as Scheele afterwards did, to collect the product of the same materials, he could not have failed to anticipate the Swedish philosopher, in a discovery not less important than that of oxygen gas. Carbonic oxide early and repeatedly presented itself to his observation, without his being aware of its true distinctions from other kinds of inflammable air; and it was reserved for Mr. Cruickshank of Woolwich to unfold its real nature and characters. It is remarkable, also, that in various parts of his works, Dr. Priestley has stated facts, that might have given him a hint of the law, since unfolded by the sagacity of M. Gay Lussac, 'that gaseous substances combine in definite volumes.' He shows that

1 measure of fixed air unites with $1\frac{6}{7}$ measure of alkaline air,
1 measure of sulphurous acid with 2 measures of do.

* Series II. p. 253.

1 measure of fluor acid with 2 measures of do.

1 measure of oxygen gas with 2 measures nitrous, very nearly; and that by the decomposition of 1 vol. of ammonia, 3 vols. of hydrogen are evolved.

Let not, however, failures such as these, to reap all that was within his compass, derogate more than their due share from the merits of Dr. Priestley: for they may be traced to that very ardor of temperament, which, though to a certain degree a disqualification for close and correct observation, was the vital and sustaining principle of his zealous devotion to the pursuit of scientific truth. Let it be remembered, that philosophers of the loftiest pretensions are chargeable with similar oversights;—that even Kepler and Newton overlooked discoveries, upon the very confines of which they trod, but which they left to confer glory on the names of less illustrious followers.

Of the general correctness of Dr. Priestley's experiments, it is but justice to him to speak with decided approbation. In some instances, it must be acknowledged, that his results have been rectified, by subsequent inquirers, chiefly as respects quantities and proportions. But of the immense number of new facts originating with him, it is surprising how very few are at variance with recent and correct observations. Even in these few examples, his errors may be traced to causes connected with the actual condition of science at the time; sometimes to the use of impure substances, or to the imperfection of his instruments of research; but never to carelessness of inquiry or negligence of truth. Nor was he more remarkable for the zeal, with which he sought satisfactory evidence, than for the fidelity, with which he reported it. In no one instance is he chargeable with misstating, or even with straining or coloring, a fact, to suit an hypothesis. And though this praise may, doubtless, be conceded to the great majority of experimental philosophers, yet Dr. Priestley was singularly exempt from that disposition to view phenomena through a colored medium, which sometimes steals imperceptibly over minds of the greatest general probity. This security he owed to his freedom from all undue attachment to hypotheses, and to the facility, with which he was accustomed to frame and abandon them;—a facility resulting not from habit only, but from principle. "Hypotheses" he pronounces, in one place, "to be a cheap commodity;" in another to be "of no value except as the parents of facts;" and so far as he was himself concerned, he exhorts his readers "to consider new facts only as discoveries, and to draw conclusions for themselves." The only exception to this general praise is to be found in the pertinacity with which he adhered, to the last, to the Stahlian hypothesis of phlogiston; and in the anxiety, which he evinced, to reconcile to it new phenomena, which were considered by almost all other philosophers, as proofs of its utter unsoundness. But this anxiety, it must be remembered, was chiefly apparent at a period of life, when most men feel a reluctance to change the principle of arrangement, by which they have been long accustomed to class the multifarious particulars of their knowledge.

In all those feelings and habits that connect the purest morals with the highest philosophy, (and that there is such a connection no one can doubt), Dr. Priestley is entitled to unqualified esteem and admiration. Attached to science by the most generous motives, he pursued it with an entire disregard to his own peculiar interests. He neither sought, nor accepted when offered, any pecuniary aid in his philosophical pursuits, that did not leave him in possession of the most complete independence of thought and of action. Free from all little jealousies of contemporaries or rivals, he earnestly invited other laborers into the field, which he was cultivating; gave publicity, in his own volumes, to their experiments; and, with true candor, was as ready to record the evidence which contradicted, as that which confirmed, his own views and results. Every hint, which he had derived from the writings or conversation of others, was unreservedly acknowledged. As the best way of accelerating the progress of science, he recommended and practised the early publication of all discoveries; though quite aware that, in his own case, more durable fame would often have resulted from a delayed and more finished performance. "Those persons," he remarks, "are very properly disappointed, who, for the sake of a little more reputation, delay publishing their discoveries, till they are anticipated by others."

In perfect consistency with that liberality of temper, which has been ascribed to Dr. Priestley, it may be remarked also, that he took the most enlarged views of the scope and objects of Natural Science. In various passages of his works he has enforced, with warm and impressive eloquence, the considerations, that flow from the contemplation of those arrangements in the natural world, which are not only perfect in themselves, but are essential parts of one grand and harmonious design. He strenuously recommends experimental philosophy as an agreeable relief from employments, that excite the feelings or overstrain the attention; and he proposes it to the young, the high-born, and the affluent, as a source of pleasure unalloyed with the anxieties and agitations of public life. He regarded the benefits of its investigations, not merely as issuing in the acquirement of new facts, however striking and valuable; nor yet in the deduction of general principles, however sound and important; but as having a necessary tendency to increase the intellectual power and energy of man, and to exalt human nature to the highest dignity, of which it is susceptible. The springs of such inquiries he represents as inexhaustible; and the prospects, that may be gained by successive advances in knowledge, as in themselves "truly sublime and glorious."

Into our estimate of the intellectual character of an individual, the extent and the comprehensiveness of his studies must always enter as an essential element. Of Dr. Priestley it may be justly affirmed, that few men have taken a wider range over the vast and diversified field of human knowledge. In devoting, through the greater part of his life, a large portion of his attention to theological pursuits, he fulfilled, what he strongly felt to be his primary duty as a minister of religion. This is not the fit occasion to pronounce an opinion of the fruits of those inquiries, related as they are to topics, which still continue to be agitated as matters of earnest controversy. In Ethics, in Metaphysics, in the philosophy of Language, and in that of General History, he expatiated largely. He has given particular histories of the Sciences of Electricity and of Optics, characterized by strict impartiality, and by great perspicuity of language and arrangement. Of the mathematics, he appears to have had only a general or elementary knowledge; nor, perhaps, did the original qualities, or acquired habits, of his mind, fit him to excel in the exact sciences. On the whole, though Dr. Priestley may have been surpassed by many, in vigor of understanding and capacity for profound research, yet it would be difficult to produce an instance of a writer more eminent for the variety and versatility of his talents, or more meritorious for their zealous, unwearied, and productive employment.

Appendix.—Since the foregoing pages were written, I have added a few remarks on a passage contained in a recent work of Victor Cousin, in which that writer has committed a material error as to the origin of Dr. Priestley's philosophical discoveries. "La chimie," he observes, "est une création du dixhuitième siècle, une création de la France; c'est l'Europe entière qui a appelé chimie Francaise le mouvement qui a imprimé à cette belle science une impulsion si forte et une direction si sage; c'est à l'exemple et sur les traces de Lavoisier, de Guyton, de Fourcroy, de Berthollet, de Vauquelin, que se sont formés et que marchent encore les grands chimistes étrangers, ici Priestley et Davy; là Klaproth et Berzelius." (Cours de l'Histoire de la Philosophie, tom. i. p. 25.)

It is to be lamented that so enlightened a writer as Victor Cousin, yielding, in this instance, to the seduction of national vanity, should have advanced pretensions in behalf of his countrymen, which have no foundation in truth or justice. Nothing can be more absurd or unprofitable than to claim honors in science, either for individuals or for nations, the title to which may be at once set aside by an appeal to public and authentic records.

It was in England, not in France, that the first decided advances were made in our knowledge of elastic fluids. To say nothing of anterior writers, Dr. Black had traced the causticity acquired by alkalies, and by certain earths, to their being freed from combination with fixed air; and Mr. Cavendish, in 1766, had enlarged our knowledge of that gas and of inflammable air. In England, the value of these discoveries was fully appreciated; in France, little or no attention was paid to them, till the philosophers of that country were roused by the striking phenomena exhibited by the experiments of Priestley. Lavoisier, it is true had been led, by an examination of evidence derived from previous writers, to discard the hypothesis of phlogiston. The discovery of oxygen gas by Dr. Priestley not only completed the demonstration of its fallacy, but served as the cornerstone of a more sound and consistent theory. By a series of researches executed at great expense, and with consummate skill, the French philosopher verified in some cases, and corrected in others, the results of his predecessors, and added new and important observations of his own. Upon these, united, he founded that beautiful system of general laws, chiefly relating to the absorption of oxygen by combustible bodies, and to the constitution of acids, to which, alone, the epithet of the Antiphlogistic or French theory of chemistry is properly applied. Of the genius manifested in the construction of that system, and the taste apparent in its exposition, it is scarcely possible to speak with too much praise. But it is inverting the order of time to assert, that it had any share in giving origin to the researches of Priestley, which were not only anterior to the French theory, but were carried on under the influence of precisely opposite views. This, too, may be asserted of the discoveries of Scheele, who, at the same period with Dr. Priestley, was following, in a distant part of Europe, a scarcely less illustrious career.

It is the natural progress of most generalizations in science, that at first too hasty and comprehensive, they require to be narrowed as new facts arise. This has happened to the theory of Lavoisier, in consequence of its having been discovered, that combustion is not necessarily accompanied with an absorption of oxygen, and that acids exist independently of oxygen, regarded by him as the general acidifying principle. But after all the deductions, that can justly be made on that account from the merits of Lavoisier, he must still hold one of the highest places among those illustrious men, who have advanced chemistry to its present rank among the physical sciences. It is deeply to be lamented that his fame, otherwise unsullied, should have been stained by his want of candor and justice to Dr. Priestley, in appropriating to himself the discovery of oxygen gas. This charge, often preferred and never answered, would not have been revived in this place, but for the claim so recently and indiscreetly advanced by M. Victor Cousin. To the credit of Dr. Priestley it may be observed, that in asserting his own right, he exercised more forbearance, than could reasonably have been expected under such circumstances. In an unpublished letter to a friend, he thus alludes to the subject of M. Lavoisier's plagiarism. "He," (M. Lavoisier) "is an *Intendant of the Finances*, and has much public business, but finds leisure for various philosophical pursuits, for which he is exceedingly well qualified. He ought to have acknowleged that my giving him an account of the air I had got from *Mercurius Calcinatus*, and buying a quantity of M. Cadet while I was at Paris, led him to try what air it yielded, which he did presently after I left. I have however, barely hinted at this in my second volume."* The communication alluded to was made by Dr. Priestley to M. Lavoisier in October, 1774; and the Memoir, in which the latter assumes to himself the discovery that *mercurius calcinatus* (red oxide of mercury) affords oxygen gas when distilled *per se*, was not read to the Academy of Sciences before April, 1775.† In evincing so little irritability about his own claim, and leaving its vindication with calm and just confidence to posterity, the English philosopher has lost nothing of the honor of that discovery, which is now awarded to him, by men of science of every country, as solely and undividedly his own.

* Letter to the late Mr. Henry, dated Calne, Dec. 1775.

† See an Abstract of this Memoir in the *Journal de Rozier*, Mai, 1775.

Art. IV.—*Motions of a System of Bodies;* by Prof. Theodore Strong.

Continued from p. 345, Vol. xxii.

Let m, m', m'', &c. denote the quantities of matter in the moving bodies, or the number of times which they severally contain the assumed unit of masses: supposing them so small that every unit of each may be considered as acted on by the forces (which are supposed to affect their motions,) with the same intensity.

1. Motions of the system when estimated in the directions of three fixed rectangular axes drawn (at pleasure,) through any assumed point for their origin.

Let the coördinates be designated by the axes of x, y, z, severally: put x, y, z, x', y', z', &c. for the coördinates (reckoned from their origin,) which define the places of m, m', &c. at any time t.

Let P, Q, R, P′, Q′, R′, &c. be the resultants of all the forces which affect a unit of m, m', &c. when reduced to the directions of the axes of x, y, z, severally; then by known formulæ, supposing dt=const. ((*a*) p. 284, vol. xvi.) $\frac{d^2x}{dt^2}=\text{P}$, $\frac{d^2x'}{dt^2}=\text{P}'$, &c. (1); $\frac{d^2y}{dt^2}=\text{Q}$, $\frac{d^2y'}{dt^2}=\text{Q}'$, &c., (2); $\frac{d^2z}{dt^2}=\text{R}$, $\frac{d^2z'}{dt^2}=\text{R}'$, &c. (3); which are the equations of motion required. It is supposed that P, Q, R, &c. are the resultants of all the accelerations or retardations which m, m', &c. receive, whether from their mutual attractions or repulsions, or from bodies foreign to the system, also that the reäctions of the surfaces or curves on which any of the bodies may be supposed to move are included; it is also supposed that P, Q, R, &c. tend to increase x, y, z, &c.; but should any of them tend the contrary way their signs must be changed. The forces which arise from the actions of the bodies on each other may be made to destroy each other by the following method.

Let p denote any force which a unit of m exerts on a unit of m', then it is evident that a unit of m' will reäct on a unit of m with the force $-p$ which is directly opposite to p, agreeably to the well known law of action and reäction; hence mp=the whole force of m on a unit of m', and $-m'p$ is the whole force of the consequent reäction of m' on a unit of m; if mp' equals the value of mp when reduced to the axis of x, then evidently $-m'p'$ equals the value of $-m'p$ when reduced to the same axis. Hence $-m'\,p'$ is one of the forces which compose P in the first of (1), and $m\,p'$ is one of the components of P' in the second of (1); but these forces may be made to disappear by multiplying the first of (1) by m, the second by m', and then adding the products. It is hence evident that if the first of (1) is multiplied by m, the second by m', and so on, and the products added, there will result $m\frac{d^2x}{dt^2}+m'\frac{d^2x'}{dt^2}+\&c.=mP+m'P'+\&c.$ which is independent of any actions of the bodies on each other; for the terms arising from the reciprocal actions of every two of them will destroy each other as above: in the same way (2) and (3) give $m\frac{d^2y}{dt^2}+m'\frac{d^2y'}{dt^2}+\&c.=mQ+m'Q'+\&c.$, $m\frac{d^2z}{dt^2}+m'\frac{d^2z'}{dt^2}+\&c.=mR+m'R'+\&c.$; put $m+m'+\&c.=M$, $mx+m'x'+\&c.=MX$, $my+m'y'+\&c.=MY$, $mz+m'z'+\&c.=MZ$, and let $mP+m'P'+\&c.$ be denoted by SmP, $mQ+m'Q'+\&c.$ by SmQ, $mR+m'R'+\&c.$ by SmR; then by substitution and reduction the above equations become $\frac{d^2X}{dt^2}=\frac{SmP}{M}$, $\frac{d^2Y}{dt^2}=\frac{SmQ}{M}$, $\frac{d^2Z}{dt^2}=\frac{SmR}{M}$ (4); which are independent of any terms arising from the actions of the bodies on each other. X, Y, Z, are evidently the coördinates of the center of gravity of the system; and it is manifest by (4) that the center of gravity moves in the same manner that the unit of masses would do if it was collected at the center, and acted on by the forces $\frac{SmP}{M}$, $\frac{SmQ}{M}$, $\frac{SmR}{M}$, in the directions of the axes of x, y, z, respectively.

If the bodies are subjected to no forces but their mutual actions, then as shown above $SmP=0$, $SmQ=0$, $SmR=0$; $\therefore \frac{d^2X}{dt}=0$, $\frac{d^2Y}{dt}=0$, $\frac{d^2Z}{dt}=0$; whose integrals give $\frac{dX}{dt}=V$, $\frac{dY}{dt}=V'$, $\frac{dZ}{dt}=V''$, (5); V, V', V'', being the arbitrary constants, they also express the velocities of the center of gravity in the directions of the axes of x, y, z, severally, which are hence constant; and it is easy to see that the motion of the center is rectilineal and uniform, unless V, V', V'' are each $=0$, in which case the center is at rest. The equations (4) are easily adapted to the motion of a solid by putting $M=$ to its mass, and denoting any indefinite element of it by dM; and representing indefinitely by P, Q, R, the forces which act on dM in the directions of the axes of x, y, z, respectively, and by considering S as the sign of integration. It may be remarked, that if the bodies m, m', &c. receive finite changes in their motions in the indefinitely small portion of time dt, by the actions of the forces P, Q, R, &c., that (1), (2), (3) will be changed to $D.\frac{dx}{dt}=Pdt$, $D.\frac{dx'}{dt}=P'dt$, &c. (1′); $D.\frac{dy}{dt}=Qdt$, $D.\frac{dy'}{dt}=Q'dt$, &c., (2′); $D.\frac{dz}{dt}=Rdt$, $D.\frac{dz'}{dt}=R'dt$, &c. (3′); D being the characteristic of finite differences. Hence we may find by the same reasoning as before used, $D.\frac{dX}{dt}=\frac{dtSmP}{M}$, $D.\frac{dY}{dt}=\frac{dtSmQ}{M}$, $D.\frac{dZ}{dt}=\frac{dtSmR}{M}$, (4′); which are independent of any finite changes which the bodies receive from their reciprocal actions in the instant dt; also if the bodies are subjected only to their mutual actions, $SmP=0$, $SmQ=0$, $SmR=0$; ∴ as before $D.\frac{dX}{dt}=0$, $D.\frac{dY}{dt}=0$, $D.\frac{dZ}{dt}=0$, whose finite integrals give $\frac{dX}{dt}=V$, $\frac{dY}{dt}=V'$, $\frac{dZ}{dt}=V''$; hence the same remarks concerning the motion of the center of gravity apply as in the former case, when the bodies were only subjected to their mutual actions. From what has been proved, it is manifest that (4) are independent of any changes in the motions of the bodies, and that whether they are gradual, or finite in an instant; provided they arise from the mutual actions of the bodies on each other. See Prin. cor. 4 to the laws of motion; Méc. Anal. vol. i, p. 259, Méc. Cél. vol. i, pp. 54, 70.

II. When the bodies which compose the system are supposed to revolve around a center of force situated at the origin of the coördinates, and acted on by any other forces.

I shall consider all the forces except that which is directed towards the origin of the coördinates as disturbing forces. Let each body, (regarded as collected at its center of gravity,) and the forces which affect it be reduced orthographically to the plane x, y, (or fixed plane,) as at p. 134, vol. xxii; put r=the distance of m thus projected from the origin of the coördinates, v=the angle made by r and the axis of x at the time t, $\frac{c}{2}=\frac{r^2dv}{2dt}$=the area described by r around the center of force in a unit of time, T=the intensity of the resultant of all the disturbing forces which affect a unit of m, when reduced to the plane x, y, and then resolved in a direction at right angles to r; let r', v', $\frac{c'}{2}=\frac{r'^2dv'}{2dt}$, T$'$, denote the corresponding quantities for m', and so on for m'', &c. Then as at p. 134, $cdc=\mathrm{T}r^3dv$, or, (since $\frac{r^2dv}{c}=dt$,) $dc=\mathrm{T}rdt$, in the same way $dc'=\mathrm{T}'r'dt$, and so on; hence the equations of motion are $dc=\mathrm{T}rdt$, $dc'=\mathrm{T}'r'dt$, &c. (6). If the first of (6) is multiplied by m, the second by m', and so on for all the bodies, and the products be added, the resulting equation will, (as before,) be independent of any terms arising from the actions of the bodies on each other.

For let a unit of m act on a unit of m' with the force p, then, as before shown, mp=the whole force with which m acts on a unit of m', and $-m'p$=the whole force with which m' reäcts on a unit of m; and if mp'=the projection of mp on the plane x, y, then evidently $-m'p'$=the projection of $-m'p$ on the same plane. Let the extremities of r and r' be joined by the straight line q, put φ, φ', for the angles of the triangle, (thus formed,) opposite r, r', respectively; then mp' sin. φ, $-m'p'$ sin. φ' are the forces mp', $-m'p'$, when resolved at right angles to r', r, severally; $\therefore -m'p'$ sin. φ' is a component of T in the first of (6), and mp' sin. φ is a component of T$'$ in the second; hence multiplying the first of (6) by m, and the second by m', then adding the products, there results the term $dtmm'p'(-r\,\sin.\varphi'+r'\sin.\varphi)$ from the action of m and the consequent reäction of m'; but the triangle, (sides r, r', q,) gives $r:r'::\sin.\varphi:\sin.\varphi'$, $\therefore -r\sin.\varphi'+r'\sin.\varphi=0$, which reduces the above term to zero: hence $mdc+m'dc'+\&c.=dt\times(m\mathrm{T}r+m'\mathrm{T}'r'+\&c.)$ is manifestly independent of any terms which arise from the actions of the bodies on each other. In a similar way, two other equations which are analogous to the above, may be obtained; by projecting the bodies and the forces on the planes x, z and y, z; and by representing the quantities corresponding to c, T, r, v, &c. by $_{,}c$, $_{,}\mathrm{T}$, $_{,}r$, $_{,}v$ for the plane x, z; and by $_{,,}c$, $_{,,}\mathrm{T}$, $_{,,}r$, $_{,,}v$, for the plane y, z; they will be $md_{,}c+m'd_{,}c'+\&c.=dt\times(m_{,}\mathrm{T}_{,}r+m'_{,}\mathrm{T}'_{,}r'+\&c.)$ and $md_{,,}c+m'd_{,,}c'+\&c.=dt\times(m_{,,}\mathrm{T}_{,,}r+m_{,,}\mathrm{T}'_{,,}r'+\&c.)$ Let $mc+m'c'+\&c.$ be denoted by Smc, $m\mathrm{T}r+m'\mathrm{T}'r'+\&c.$ by SmTr, and so on for the other equations; then the above equations become $d\mathrm{S}mc=dt.\mathrm{S}m\mathrm{T}r$, $d\mathrm{S}m_{,}c=dt.\mathrm{S}m_{,}\mathrm{T}_{,}r$, $d\mathrm{S}m_{,,}c=dt.\mathrm{S}m_{,,}\mathrm{T}_{,,}r$, (7); which are independent of any terms arising from the actions of the bodies on each other, they are also independent of any force which acts towards the origin of the coördinates, as was remarked of the motion of a particle of matter at p. 133, vol. xxii. If the forces cause finite changes in the motions of the bodies in the indefinitely small time dt, (7) will be changed to $D.Smc=dt.SmTr$, $D.Sm_{,}c=dt.Sm_{,}T_{,}r$, $D.Sm_{,,}c=dt.Sm_{,,}T_{,,}r$, (8); which are also independent of any changes which the bodies receive in their motions from their finite actions in the instant dt, they are also independent of any finite changes caused by forces, which are directed towards the origin of the coördinates.

(7) and (8) are easily adapted to the motion of a solid by putting M=to its mass, and changing m into dM=any indefinite element of the solid, and representing indefinitely by c, the values of c, c', &c. in the first of those equations; and by $_{,}c$, $_{,,}c$ the corresponding quantities in the second and third; and using S as the sign of integration. If the solid revolves around the axis of z as a fixed axis, the second and third equations in the case of (7) will evidently not exist; also $dv=dv'=$ &c.=the angle described by the solid around the fixed axis in the time dt; and r, r', &c. will each be invariable; ∴ since $c=r^2dv$, $c'=r'^2dv$, &c. it is easy to find, (by the first of (7),) $\frac{d^2v}{dt^2}=\frac{SdMTr}{SdMr^2}$; put $SdMr^2=Mk^2$=the moment of inertia of the solid around the axis of z, and there results $\frac{d^2v}{dt^2}=\frac{SdMTr}{Mk^2}$, (9); which formula is well known: in the same way by (8) when the forces are impulsive, or cause finite changes in the time dt; by putting $D.\frac{dv}{dt}\div dt=w=$ the angular velocity of the solid, (caused by the forces,) we have $w=\frac{SdMTr}{Mk^2}$, (10). Again, since $x=r\cos.v$, $y=r\sin.v$, &c., by putting $P=-T\sin.v$, $Q=T\cos.v$, &c. then $c=\frac{r^2dv}{dt}=\frac{xdy-ydx}{dt}$, &c., also $Tr=xQ-Py$, &c.; ∴ the first of (7) becomes $Sm\left(\frac{xd^2y-yd^2x}{dt^2}\right)=Sm(xQ-Py)$, which agrees with the equation found at p. 66, Vol. i, of the Mécanique Céleste, and by making similar changes in the second and third of (7), the two other equations given at the place cited, are easily found: I would also observe that the same equations may easily be found by (1), (2) and (3), but I have preferred the method which I have used because it has some advantages over the other.

If the bodies are affected by no forces but their mutual actions, and forces directed towards the origin of the coördinates; then in the use of (7), their right hand members are each$=0$; $\therefore dSmc=0$, $dSm_{,}c=0$, $dSm_{,,}c=0$, whose integrals are $Smc=A$, $Sm_{,}c={}_{,}A$, $Sm_{,,}c={}_{,,}A$, (11); A, ${}_{,}A$, ${}_{,,}A$, being the arbitrary constants, also the same results are true in the use of (8). (11) are evidently the same that they would be if the bodies did not act upon each other; but in this case each of them would manifestly describe a plane curve around the center of force situated at the origin of the coördinates; put $\frac{D}{2}=$the area described by the radius vector of m in a unit of time, $\frac{D'}{2}=$the area described by the radius vector of m' in the same time and so on; let $a, b, c,\ a', b', c'$, &c. denote the angles which the first, second, &c. of these planes make with the planes $x, y,\ x, z,\ y, z$, severally; then evidently $mD\cos. a+m'D'\cos. a'+$ &c. $=A$, $mD\cos. b+m'D'\cos. b'+$ &c. $={}_{,}A$, $mD\cos. c+m'D'\cos. c'+$&c. $={}_{,,}A$, (12); it is also evident that equations analogous to (12) will exist for any other rectangular coördinates, ${}_{,}x$, ${}_{,}y$, ${}_{,}z$, whose origin is the same as that of x, y, z; for the position of the coördinates is arbitrary, although they are to be considered as fixed during the motion of the system: hence $mD\cos. {}_{,}a+m'D'\cos. {}_{,}a'+$ &c. $=B$, $mD\cos. {}_{,}b+m'D'\cos. {}_{,}b'+$ &c. $={}_{,}B$, $mD\cos. {}_{,}c+m'D'\cos. {}_{,}c'+$ &c. $={}_{,,}B$, (13); where B, ${}_{,}B$, ${}_{,,}B$, are what A, ${}_{,}A$, ${}_{,,}A$, become when the planes, $x, y,\ x, z,\ y, z$, are changed to the planes ${}_{,}x$, ${}_{,}y$, ${}_{,}x$, ${}_{,}z$, ${}_{,}y$, ${}_{,}z$, severally, and ${}_{,}a$, ${}_{,}b$, ${}_{,}c$, &c. are what a, b, c, &c. become respectively. Let l, m, n denote the angles made by the plane ${}_{,}x$, ${}_{,}y$, with the planes $x, y,\ x, z,\ y, z$; and l', m', n' the corresponding angles for the plane ${}_{,}x$, ${}_{,}z$; also l'', m'', n'' those for the plane ${}_{,}y$, ${}_{,}z$, $\therefore \cos. {}_{,}a=\cos. a\cos. l+\cos. b\cos. m+\cos. c\cos. n$, $\cos. {}_{,}a'=\cos. a'\cos. l+\cos. b'\cos. m+\cos c'\cos. n$, &c.; hence by (12) and (13) $A\cos. l+{}_{,}A\cos. m+{}_{,,}A\cos. n=B$, also $A\cos. l'+{}_{,}A\cos. m'+{}_{,,}A\cos. n'={}_{,}B$, $A\cos. l''+{}_{,}A\cos. m''+{}_{,,}A\cos. n''={}_{,,}B$, (14). By adding the squares of (14) there results $A^2+{}_{,}A^2+{}_{,,}A^2=B^2+{}_{,}B^2+{}_{,,}B^2$, (15); since $\cos.^2 l+\cos.^2 l'+\cos.^2 l''=1$, $\cos.^2 m+\cos.^2 m'+\cos.^2 m''=1$, $\cos.^2 n+\cos.^2 n'+\cos.^2 n''=1$, $\cos. l\cos. m+\cos. l'\cos. m'+\cos. l''\cos. m''=0$, &c.; now since the position of the plane ${}_{,}x$, ${}_{,}y$ is arbitrary let it be so assumed that $\cos. l = \frac{A}{\sqrt{A^2 + {}_{,}A^2 + {}_{,,}A^2}}$, $\cos. m = \frac{{}_{,}A}{\sqrt{A^2 + {}_{,}A^2 + {}_{,,}A^2}}$, $\cos. n = \frac{{}_{,,}A}{\sqrt{A^2 + {}_{,}A^2 + {}_{,,}A^2}}$, (16); then by substituting these values in the first of (14) it gives $\sqrt{A^2 + {}_{,}A^2 + {}_{,,}A^2} = B$, (17); also the second and third of (14) by substituting the values of $A, {}_{,}A, {}_{,,}A$ from (16) give $B(\cos. l \cos. l' + \cos. m \cos. m' + \cos. n \cos. n') = {}_{,}B = 0$, $B(\cos. l \cos. l'' + \cos. m \cos. m'' + \cos. n \cos. n'') = {}_{,,}B = 0$, since $\cos. l \cos. l' + \cos. m \cos. m' + \cos. n \cos. n' = 0$, $\cos. l \cos. l'' + \cos. m \cos. m'' + \cos. n \cos. n'' = 0$. The plane ${}_{,}x, {}_{,}y$, determined by (16) is the invariable plane; on which the sum of the products of each body by the area which its radius vector describes in a unit of time (or in any given time,) is the greatest possible; and it is evident by what has been proved that the sum of the products of each body by the area which its radius vector describes on any plane which is perpendicular to ${}_{,}x, {}_{,}y$, in any given time is always $=0$. See Méc. Cél. Vol. I. p. 60, also Méc. Anal. Vol. I. p. 269.

Note.—By unit of masses, as used in this paper, is to be understood a portion of matter, so small that it may be considered as a particle.

Art. V.—*Observations on the Saliferous Rock Formation, in the Valley of the Ohio*; *by* Dr. S. P. Hildreth, of Marietta.

For many years after settlements had been commenced west of the Alleghany Mountains, the inhabitants were entirely dependent on their brethren, east of the Appalachian ridge, for salt; an article so necessary to the existence and the comfort of civilized man. It was transported, with immense labor, through narrow defiles, and almost impassable roads across the mountain ranges, on the backs of horses. Long trains of these useful animals, might be seen toiling up the steep sides of the mountains, their uncouth pack-saddles laden with kegs of salt, iron ware, and other merchandise, destined for the use of the early settlers. This, for a long time, was the only mode of transportation. At length rude roads were constructed which could be traversed with wagons, and they caused some reduction in the cost of transportation, but it was not until the completion of the "National, or Cumberland road," that travelling in carriages could be effected with either ease or safety. From the year 1788 to the year 1800, the price of salt varied from four to eight dollars per bushel; and it was supposed by the inhabitants, that its cost would always prove a serious drawback on the prosperity of the country. The upward navigation of the Ohio and Mississippi rivers was so long and tedious, requiring from four to six months to accomplish the voyage from New Orleans, and the outlet being owned by a foreign nation, forbade the expectation of relief from that quarter. Iron, so indispensable in agricultural pursuits, was another heavy item of expense, and was, for many years, transported in the same tedious way, until iron ore was discovered in the Laurel Mountains and furnaces were erected. From that period, they have been gradually extending down the river, until no portion of the United States is more cheaply or more abundantly supplied with iron than the valley of the Ohio. Salt, so valuable and so scarce in these early days, as to be looked upon almost as a luxury, has now become so abundant as to sell for half a cent per pound. The all wise and beneficent Creator, who formed this earth for the habitation of man, has stored it with all things necessary for his comfort and happiness. In every region remote from the ocean, he has deposited in the bowels of the earth, vast magazines of salt. The interior of Africa, Asia, and America, contains, in the form of rock or native salt, or of springs, fountains or lakes, or of efflorescences, a sufficient supply for the wants of all the inhabitants. The valley of the Ohio, from its head water to Shawneetown, in Illinois, may be said to be based on a saliferous rock, affording an abundance of water, highly charged with muriate of soda, and affording it in abundance, wherever perforations have been made, of a sufficient depth to reach the precious deposit. There are many evidences of its extending, along the course of the Alleghany range, for more than one hundred miles in breadth, and for several hundred in length. The salt rock commences near its western and northern base, in the coal and sandstone region, and extends as far north and west, as these two interesting formations are found. In Ohio, sandstone and coal are abundant, from the mouth of Big Beaver, to some miles below the mouth of the Scioto, and they cover a tract of country, between these two points, from forty to eighty miles in width on the northern bank of the Ohio. If the salt deposit extends as far north as Lake Erie, it is probably very thin, or else it descends deep into the earth; as few or no indications of salt are found north of these boundaries. A few miles below the mouth of the Big Sandy, the Ohio takes a more westerly course and the sandstone is left on its southern shore. At the western and northern termination of the sand rock, the lime rock commences and continues with little interruption to the Mississippi river, and the great northern lakes. Salt water can doubtless be found in all that region, where sandstone prevails, as the two formations are known to accompany each other. The superincumbent strata, composed of sandstone, argillite, marl-slate, &c., as will be more fully shown in another place, varies in thickness from five hundred to twelve hundred feet; and it appears to sink deeper into the earth, on or near the Ohio, as the salt rock is reached at less and less depths, as we ascend the streams discharging their waters into this river. This is especially the fact with the salt wells in the Muskingum and Big Kenhawa rivers. A few miles above the falls at Zanesville the salt rock is found short of two hundred and fifty feet, while thirty miles below it is eight hundred and fifty feet to the lower salt stratum. From several circumstances, it would seem to be a fact that the ancient inhabitants of this valley were not unacquainted with the use and the manufacture of salt. In excavating wells at the Scioto Salines, and at the Blue Licks in Kentucky, the beds of furnaces, and large fragments of broken pots, made of coarse earthen ware, were repeatedly found, at considerable depths below the present surface; affording strong presumptive evidence, that the quality of the water was known and that it had been applied to the wants of man in ages long since passed away. Tusks and grinders of the Elephant and Mastodon, were also found in digging the salt wells at both these places. The attraction of wild beasts to these salines, probably first brought them to the notice of man. At the licks on the Kenhawa, several indications were discovered of their having been in use, long before they were known to any white man.

The first attempt at manufacturing salt in Ohio, was made about the year 1798, at what is now called the "Old Scioto salt works." This spot is in Jackson County, on the banks of a small creek, called Salt Creek, a tributary of the river Scioto. The wells were dug near the creek to the depth of twenty or thirty feet, and the salt water rose into the excavations from crevices in the rock below. The present mode of piercing the rocks was not known until many years after. The water thus procured was but weakly impregnated with salt, and required from six to eight hundred gallons to make a bushel of fifty pounds weight. It was also very dark colored, and filled with the bittern, composed chiefly of muriates of lime and magnesia; the manufacturers not giving it time to drain, but transferring it immediately from the kettles to the pack horses of the purchasers, who, transporting it into the various settlements, sold it to the inhabitants for three and four dollars per bushel, as late as the year 1808. This saline was thought to be so important to the country, that when this territory was erected into a state in the year 1802, a tract of six miles square, was set apart by Congress for the use of the state, embracing this saline. Two other tracts of six hundred and forty acres each, were also reserved for the same purpose, one on Salt Creek in Muskingum County, and one in Delaware County, as too valuable to fall into the hands of individuals, lest they should create a monopoly of the article; these being the only places then known in Ohio, where salt could be made. A special act was passed by the Legislature, in the year 1804, regulating the management of these salines, and an agent appointed to rent out the small lots to manufacturers, laid out on the borders of the creeks, where salt water was found most abundant. The rent demanded was sixteen cents per year on each gallon of capacity in the kettles, and no one person was allowed to use more than four thousand, nor less than six hundred gallons in each furnace, guarding here also, carefully, against monopoly. The agent was authorized to inspect the salt before it was offered for sale, and to lay off suitable wood lots for the use of the furnace holders, free of expense. The amount manufactured in any one year, never produced a revenue to exceed five hundred dollars. As other and much better saline springs were discovered on the navigable streams, the works at the agencies went gradually to decay; and finally in the year 1826, the "salt reservations" were sold and the proceeds placed in the treasury of the state. In the year 1808, a new era commenced in the manufacture of salt. Previously to this time, the water had been obtained from wells, sunk no deeper than to perforate the superincumbent earth to the rocks below, through some crevice in which it had made its way to the surface. But now, attempts were made to come at the sources of the fountain, by boring, or drilling through the rock formations, to the saline deposit itself. The first trial of this kind was made on the Big Kenhawa, six miles above Charleston, and only to the depth of seventy or eighty feet; on further trials, it was discovered, that the water became stronger as they descended, and the first wells were gradually deepened to three hundred and fifty feet, with the most satisfactory results. Water was obtained of such strength that seventy five gallons would make a bushel of salt of fifty pounds weight, or as much as four hundred gallons from the old surface wells; producing an immense saving of time and labor to the manufacturer, and a much better article to the consumer. The space, now occupied by the salt wells, extends to the distance of twelve or fourteen miles along the shores of the Kenhawa, and is about seventy miles from the mouth of the river. The upper wells reach the salt rock at two hundred and fifty feet. The lower wells strike it at a number of feet deeper, the rock dipping to the north as it recedes from the mountains, or descends the river.

Salt Region on the Muskingum River.

The first attempt at procuring salt on this river, was made by Mr. Ayers, in the year 1817, a few miles below, and at the foot of the rapids at Zanesville, in the year 1819, by S. Fairlamb. He being a man of considerable mechanical ingenuity, constructed some simple machinery, connected with a water mill, which performed the operation of boring without much expense. Salt had been made for many years at the works on Salt Creek, nine miles S. E. of Zanesville, and some slight indications of salt on the rocks at low water, led to this trial. Water was found, impregnated with muriate of soda, at about three hundred and fifty feet. It afforded salt of a good quality, but was not abundant, nor sufficiently saturated to make its manufacture profitable. Within the period of a few years after, several other wells were bored in this vicinity, but generally lower down the river. It was soon discovered, that the water was stronger as they descended, and that the salt deposit was at a greater depth. At Duncan's falls, nine miles below and at the mouth of Salt Creek, the rock had descended to four hundred and fifty feet, and with a proportionate increase in the strength of the water. At the latter place, the owner of a well not finding a sufficient supply of water for his furnace, although it was of the desired strength, pushed his well to the depth of four hundred feet below the salt rock. His praise-worthy perseverance, however, met not with its proper reward. No additional salt water was found, although it is highly probable that other salt strata are deposited below those already discovered, but at such a depth as to render it very difficult to reach them, by the present mode of boring. As we descend the river, wells are found, at short distances, for thirty miles below Zanesville, gradually deepening, until the salt rock is reached, at eight hundred and fifty feet below the surface. The water is also so much augmented in strength, as to afford fifty pounds of salt to every fifty gallons. Twenty two miles below the rapids, a stratum of flint rock from nine to twelve feet in thickness, comes to the surface and crosses the river, making a slight ripple at low water. This rock has a regular dip to the south, and at McConnelsville, five miles below, it is found at one hundred and fourteen feet; and two and a half miles further down, it is struck, at one hundred and sixty feet. Where wells have been sunk through this rock, it affords a sure guide to the saliferous deposit, as the intermediate strata are very uniform in quality and thickness, and the practical operator can tell, within a foot or two, the actual distance to be passed between the two rocks, although the interval is six hundred and fifty feet. Above the point where the flint rock crops out, the rock strata appear to have been worn away, so that as you ascend the river, the salt rock comes nearer to the surface, until at the forks of the Muskingum, it is only two hundred feet below. This flint rock is so very hard and sharp grained, that it cuts away the best cast steel from the augers, nearly or quite as rapidly as the steel cuts away the rock, and requires three weeks of steady labor, night and day, to penetrate ten feet. With a few exceptions, the other strata are readily passed.

The lower salt rock often occasions much difficulty to the workmen, from the auger's becoming fixed in the hole. The sand of this rock, when beaten fine and allowed to settle compactly about the augur in the bottom of the well, becomes so hard and firm, as to require the greatest exertions to break it loose, frequently fracturing the stout ash poles in the attempt. From the sand and small particles of the rock brought up by the pump, the salt stratum appears to be of a pure pearly whiteness; and the more porous and cellular its structure, the greater is the quantity of water afforded; as more freedom is given to the discharge of gas, which appears to be a very active agent in the rise of the water, forcing it, in nearly all the wells, above the bed of the river, and in some to twenty five or thirty feet above the top of the well.

Salt region on the Big Kenhawa.

As before stated, salt was first made there in 1808; the indications of salt being discovered at an old buffalo lick, near the margin of the river, six miles above Charleston. Numerous wells are now dug for six miles above and five miles below the lick. The "gum" or coffer-dam, is usually sunk into the rock about eighteen feet below the bed of the river, and rises six feet above, being in all about twenty four feet. Within this the boring of the rock-strata commences. The depth of a well is on an average about three hundred and eighty feet. The salt rock is reached at two hundred and fifty feet, and penetrated until a supply of water is obtained, sufficient for the demands of the furnace, evidently shewing the salt deposit to be much thicker here than on the Muskingum river, where it probably approaches its northern termination. When the supply of water grows scanty, as, at low stages of the river, in the autumnal months, is frequently the case, the auger is again introduced, and the depth increased fifteen or twenty feet, when a more abundant quantity is caused to flow. The rock in which the salt water is found is apparently the same with that on the Muskingum, being a white calcareous sand rock, full of fissures and cavities of some inches in diameter, and affording more or less water, as these are more or less abundant. The superincumbent strata are, different qualities of sandstone, slate, ironstone, and stone coal, but in much less variety than on the latter river. The formation in the adjoining hills, through which the Kenhawa passes, is principally of sandstone, to the height of five or six hundred feet, with thick beds of stone coal at their bases, affording an inexhaustible supply of fuel to the manufacturers of salt. Fossil organic remains of plants and trees, are also found in the lower sand rocks. In boring the wells, one bed of coal is usually passed in the first one hundred and fifty feet, varying in its thickness from two to six feet. The salt water rises in the heads or "gums" to near the surface of the river at low water, but not so uniformly, nor so certainly, as it did ten or twelve years past, serving to imply that the gas, finding so many outlets, had diminished in its upward pressure. Since that period, recourse has therefore been had to "suck or force pumps," to aid the rising of the water into the heads or cisterns. Little, if any, difference is found in the strength of the water, whether a well has lain idle for a few weeks, or whether it has been kept in constant use. Neither has there been any perceptible change in that respect, in the course of twenty four years, the period of time since the manufacture commenced, proving the sources of supply to be vast, if not inexhaustible; in as much as the quantity made has, for several years, been more than one million of bushels per year. The process of manufacturing salt is the same with that pursued on the Muskingum, which is fully described in this paper. In the course of the last season, the manufacture of alum or coarse salt has been commenced upon new principles and with flattering success. It is thus described in the Kenhawa Banner.

"The manufactory now in operation consists of a large pan, about thirty five feet long, set in a furnace, and is closely sided up and covered over, so as to prevent the escape of any portion of the steam evolved. Connected with this furnace, is a vat, made of plank, one hundred and thirty five feet long and sixteen feet wide, underneath and along the bottom of which is a trunk, sixteen inches square, of strong plank, which is connected with the pan at the furnace and conducts the steam the whole length of the vat. The upper surface of this trunk or conduit is upon a level with the floor of the vat, and is composed of lead. The pan is used to convert the water into brine, which is then drawn off into vats and settled, when it is again conducted into the large vat, where it is evaporated and converted into alum salt of the finest quality. The heat applied in the furnace to the pan, rapidly reduces the water into brine; and the steam, generated by this process, and conducted under the vat, as before described, raises the temperature of the brine therein contained to upwards of a hundred and fifty degrees, and renders the progress of crystallization very rapid. With these very simple fixtures, the proprietors are now making not less than two hundred bushels of salt per day, with much less labor and a consumption of a smaller quantity of coal than is required by an ordinary furnace, which produces much less salt. In the process, all the foreign matter is excluded, and the salt produced is, both in appearance and quality, equal to any in the world. With the means of production almost unlimited, the salt from this region would have supplied nearly the whole territory on the Mississippi and its tributaries, had not alum salt been deemed indispensable in putting up provisions for commercial purposes, distant shipments and the like. This led to the introduction of alum salt from the West Indies, which, to the extent used, excluded the domestic salt from market. The alum salt* now manufactured here, being in no respect inferior to the imported, and furnished at a lower price, will, ere long, entirely exclude or supersede the use of the foreign article, on all of the western waters."

Messrs. Donally and Patrick, two of the company engaged in this new mode of manufacturing coarse salt, were amongst the earliest

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* An injudicious name: the salt in question appears to have no resemblance to alum, except in forming larger and more distinct crystals.—*Ed.*

engaged in the salt business on the Kenhawa. The principles of the process are probably the same with those now in operation in the manufacture and crystallization of sugar, and found to be far superior to the mode formerly, and still generally, in use.

Process pursued in sinking a salt well.

The operator having fixed on a spot suitable for the purpose, always near some water course, and where the adjacent hills are high, proceeds to excavate the earth down to the rock, and then the rock itself to the depth of twenty or thirty feet, and from four to six feet in diameter. In this cavity, called "the head," is usually placed a hollow sycamore trunk, called "a gum," which is imbedded firmly in the rock, in such a way as to exclude the springs of fresh water; others make use of planks to form the head. When this part of the work is accomplished, the process of boring, or drilling, commences. This was formerly done by hand, with the assistance of a spring pole, and was a tedious and laborious operation. It is now performed by a horse or horses, placed on an inclined tread wheel, and machinery very simply, but ingeniously arranged, so as to act, by means of a lever, on the poles attached to the auger, raising it from two to three feet, at each rise of the lever, and letting it drop again very regularly. A grass rope, with which the poles are suspended to a high frame, by its spiral convolutions, at each rise and fall gives them a slight rotary motion, so necessary to the progress of the work. Two men are employed in this business, who stand regular tours, of six hours each, night and day. When so much of the rock is chiseled up, and comminuted so finely as to make, with the water, which always fills the hole, a soft muddy mass, and impedes the motion of the auger, the poles are withdrawn, and a tube, made of copper, five or six feet in length and three inches in diameter, called "the pump," is screwed to the pole and let down. A valve, at the lower end, prevents the escape of the contents, which are discharged through a hole made for that purpose, near the top. A cord or rope is sometimes made use of in this process, in place of the poles. The poles are made of tough, white ash wood, twenty five feet in length and two inches in diameter. They are attached to each other by strong iron sockets and screws, so as that a screw at the lower end enters into a socket at the upper end of each pole. By the addition of fresh poles, as the well descends, they are lengthened to any desirable depth. The auger is pointed with the best cast steel, and is from twelve to fourteen inches in length, and from three to four inches wide, as the operator may think best, it being very useful to have the well of a greater diameter at the top, as it necessarily and unavoidably grows narrower as it descends, and would not afford sufficient water, unless an allowance of this kind were made. The operation gradually cuts away the sides of the auger, and as it is repaired or a new one applied, unless this adaptation is carefully attended to, it becomes fast in the bottom of the well, and is with great difficulty removed. The progress made, each day, varies, with the density of the rock, from one inch to five or six feet, but is necessarily slower as the well deepens; for much time is necessarily consumed in taking up and letting down the poles, for the purpose of pumping or clearing out the detritus, which is composed of sand or mud, according to the nature of the rock. It is often necessary to line the upper portion of the well, for one hundred and fifty or two hundred feet, with a copper tube, to prevent the process of caving, occasioned by the disintegration of the soapstone or argillite, which principally composes the upper strata to this depth. It is also sometimes needed to keep out the springs of fresh water, which, mingling with the salt, would occasion additional labor in the evaporation.

Process of making the salt.

When a sufficient supply of water is obtained, the next operation is the erection of the furnace, with the cisterns, salt house, shed over the furnace, &c. The evaporation of the water is conducted in large cast iron kettles, of the capacity of sixty or ninety gallons, set over a flue made of stone, sunk so much in the earth as to bring the tops of the kettles nearly on a level with the surface of the soil. The bottom of the flue gradually rises, as it goes forward under the kettles, and ends in a chimney.

The wood required is from five to six cords per day, for a furnace of thirty or forty kettles. One half the kettles are used for boilers, and the other half for graining the salt. This, however, varies according to the strength of the water, the strongest requiring more grainers than boilers. In some furnaces, the boilers, or evaporators, are made of large sheets of cast iron, with their sides turned up an inch or two, and connected to each other with rivets in their bottoms. As the water flows or is pumped from the well, it falls into a large cistern, made of planks. This being higher than the kettles in the furnace, the water is conducted by means of a bored log, or logs, as the distance may be from the furnace, some carrying the water a long way to the fuel, and others bringing the fuel to the water. When the water reaches the furnace, it is let into the kettles by wooden stop-cocks, placed at different points in a log, which lies lengthwise of the furnace, for the purpose of preserving the temperature nearly the same in all the kettles. When it is evaporated to a certain strength, the brine is dipped out of the kettles into a large trough or cistern, where it cools, and deposits a fine, red, earthy sediment, colored by oxide of iron, and held in solution by carbonic acid gas, which is set free when the water first commences boiling, giving it quite a turbid appearance, although it is as clear as rock crystal when running from the well. When sufficiently settled, the brine is led by a conductor to the graining kettles. Into each kettle is now thrown a small quantity of beef's blood, and the contents brought to the boiling temperature, when the impurities all rise to the top and are skimmed off, leaving the brine of extreme purity and transparency. When salt was first manufactured in the west, this depuration was effected by means of aluminous earth, found in caves and clay banks. As the boiling proceeds, the crystallizing process commences on the surface of the water, in small hollow cubes, gradually enlarging, until their specific gravity forces them to the bottom. When the kettles stand some time without heat, as is the case at these works, on the Sabbath, the water becomes cold, and on the surface are found most beautiful specimens of salt crystallization, resembling an inverted hollow pyramid, nearly an inch in diameter at the base. These are generally found one within another.

While the water is evaporating, the salt, as it forms, is piled up in the middle of the kettle, and when the kettles are dry, it is shoveled into a large trough, whose inclination suffers the bittern, or "mother water," to drain off. When tolerably dry, it is transferred to the "salt house," where it again drains still more, and is then packed in barrels, ready for market. Each barrel contains from five to six bushels, of fifty pounds weight. A furnace of the above size, when well managed, will make three hundred bushels of salt per week, the average price of which, for some time past, has been about twenty five cents per bushel. At some of the furnaces, a beautifully white and delicate salt is made, for table use, fully equal to any of the best Liverpool "blown salt." Alum, or coarse salt, has not yet been made at any of the Muskingum works.

A plan and description of the rock formation, in the salt region on the Muskingum river, near McConnelsville, Ohio, eight hundred and twenty feet of which are taken from the original minutes of L. G. Barker, kept while boring his salt well in 1831.

N. B. As it would occupy too much space to give a regular scale, in proportion to each formation, therefore the table will be so constructed as to take up no more room than will be needed to describe each deposit, with its thickness and color. The first column contains the number of the series, with their order; the second, the stratum; the third, its thickness in feet and inches. The description commences with the most recent deposit, one hundred and eighty two feet above the top of the salt well.

Remark of the Editor.—Dr. Hildreth has given the local terms of the country to the strata; this accords with the general practice in Europe, where, local matters of fact, relating to mining operations, are frequently stated in the language of the workmen; for, the miners and borers for salt water and coal are rarely familiar with the terms of geological science. By applying the scientific language, now adopted in England and elsewhere, for the members of the salt formation, the list of strata, in the subsequent table, would doubtless be greatly reduced in the number of its members, and the names of some of them would, undoubtedly, be altered; but we will not venture on the task; certainly not without access to arranged specimens, from the places described, or better still, to the strata themselves.

No.	Description of strata.	Thickness—feet.	inch.
1.	*Superincumbent soil,* composed of alluvion, diluvion, plastic clay, marl, and earths of different colors, embracing red,* orange, pale dun, and ash colored, with vegetable mould, by estimation, - -	50	
2.	*Sand rock.*—This rock embraces many different varieties, from very coarse grained to very fine, and		

* Beds of fine nodular oxide of iron, are found in many places, formed in the red or brown marl of the uppermost formation. This marl, before exposure to the atmosphere is in a stony state, and of a slaty structure, often containing impressions of fern. These impressions are also found on the ore itself. As the side hills are washed away by rain, the nodules of ore tumble out and are found lying on the surface along the face of the slope, in large quanties. This red, marly deposit seems to be peculiar to the salt region, and increases in frequency and in thickness as we approach the Alleghany range of mountains. The soil formed from its decomposition is stiff, but very productive. It contains a large share of calcareous matter.

No.	Description of strata.	Thickness—feet. inch.
	often contains mica between the layers or beds. Near the top of this formation the beds are thin, varying from two to twelve inches, and increasing to many feet in thickness near its bottom; the lower strata often contain fossil vegetable remains. *Beds of coal* are also found at various depths, but generally thin, the thickest being near the base of the hills.	80
3.	*A grey colored, fine, argillaceous stone,* generally free from mica; very compact and heavy, containing geodes of argillaceous iron. This rock is sometimes of a laminated structure, containing many fossil vegetable remains of fern, palm leaves, &c. - -	20
4.	*Bituminous coal.**—This deposit, with the superincumbent slate, varies in thickness from three to nine or more feet. Vegetable impressions are common in the slate stone above the coal. The coal is easily fractured in the course of its horizontal direction, every lamina being divided by a thin layer of pure charcoal, exhibiting the grain and fibre of a woody structure. Its vertical fracture is glistening. Large quantities of iron pyrites are found amongst the slate and sometimes in the coal itself. It contains much bitumen, and burns with great freedom, - -	9
5.	*Sparry lime rock;* eight or ten feet in thickness, with a bed of fine white clay over it, between the coal and limestone; color light grey, and often containing iron pyrites, in rhombic and many sided crystals, but generally free of fossil shells, from this place to the mouth of the Muskingum. Higher up, in the vicinity of Zanesville the lime rock abounds in fossils. - - - - - -	10
6.	*Argillaceous sandstone.*—Color bluish. The rock in which the boring for salt water commences, when exposed to rain and atmospheric influence, it is readily decomposed, into a light pulverulent earth. -	53

* In some places two or three beds of coal are found, between the bottom and the top of the sandstone hills, but generally thin, or only one or two feet thick.

No.	Description of strata.	Thickness—feet.	inch.
7.	*A rock called here red argillite, or soapstone, being a species of marl*, and boring very easily, from ten to twelve feet in twenty four hours. - - -	22	6
8.	*Lime rock*, hard and compact, boring about eighteen inches in twenty four hours. This stratum in some wells contains iron pyrites of very brilliant appearance. - - - - - - - - -	3	
9.	*Blue sandstone*, more compact than the upper stratum.	21	
10.	*Slate rock.*—At this depth, fossil shells were found in bituminous shale, on Salt Creek, a few miles north east of this. - - - - - -	10	6
11.	*Grey flint rock* in some portions of it mixed with a little sand. This rock is extremely hard, the workmen, with the greatest exertions, being unable to penetrate more than two or three inches per day, of twenty four hours. Five miles above McConnelsville, this rock comes to the surface in the bed of the river, making a small ripple; and showing a corresponding dip to the south, in all the rock strata, of a little more than one hundred feet in that distance. The dip still continues for several miles below, as far as any wells have been bored. - - -	9	
12.	*Very hard slaty rock*, probably mixed with iron.	1	5
13.	*Black soapstone.* - - - -	4	
14.	*Yellow soapstone,** with sand intermixed. - -	15	
15.	*Blue soapstone,** without sand. - - -	8	
16.	*Sandstone*, very compact, and the lower part of the stratum nearly white, or very light colored. -	11	
17.	*Red soapstone*, highly colored with oxide of iron, soft in texture, and boring from four to five feet per day. - - - - - - -	52	
18.	*Stratum of dark carbonaceous matter*, highly impregnated with petroleum, and resembling powdered charcoal. - - - - -	10	
19.	*Blue slate* mixed with grit, some parts of which are tolerably dense, boring from three to four feet per day. - - - - - -	66	
20.	*Slate stone*, soft and fine, light blue color. -	20	

* Called also argillite, in the MS.

No.	Description of strata.	Thickness—feet.	inch.
21.	*Soapstone,* in which appears some salt water from the stratum of sandstone below, boring from five to seven feet per day. - - - - - -	12	
22.	*Hard white sand rock,* called the upper salt rock; in this appeared some salt water, with a discharge of carburetted hydrogen gas. - - -	24	
23.	*Slate stone.* - - - - -	5	
24.	*White or light grey sandstone.* - -	13	
25.	*Slate stone* with yellow ochre mixed. - -	14	
26.	*Bituminous coal.* - - - -	1	6
27.	*White sandstone.* - - - -	14	
28.	*Bituminous coal.* - - - -	3	
29.	*Slate and soapstone.* - - - -	10	
30.	*Slate* intermixed with sand of bluish tint. -	19	
31.	*Soapstone.** - - - - -	3	
32.	*White or light grey sandstone.* - -	5	
33.	*Slate rock.* - - - - -	7	
34.	*Very hard, dark colored rock,* probably mixed with iron.	2	
35.	*Light colored slate* mixed with sand. - -	15	
36.	*Blue slate stone,* the upper portion of stratum nearly black. - - - - -	34	
37.	*White sandstone,* very hard. - - -	4	
38.	*Blue slate rock.* - - - - -	36	
39.	*Very hard rock,* iron stone, boring only one inch per day. - - - - - -	0	4
40.	*Light colored slate,* mixed with sand. -	31	
41.	*Very hard rock,* iron stone boring, one inch per day.	1	
42.	*Black slate rock.* - - - -	6	
43.	*Hard blue sandstone.* - - - -	17	
44.	*Bituminous coal.* - - - -	0	3
45.	*Hard sandstone,* part brown and part light colored.	24	
46.	*Bituminous coal.* - - - -	2	
47.	*White slate.* - - - - -	3	
48.	*Very light colored sandstone.* - -	13	
49.	*White calcareous sandstone,* with particles of pure salt intermixed, very dense in its texture, and affording but a small quantity of water. - - -	34	

* Called also argillite, in the MS.

No.	Description of strata.	Thickness—feet, inch.	
50.	*Grey or dirty sand rock*, tolerably hard and very uniform in its texture or density. - - -	52	
51.	*Blue sandstone*, hard and uniform in density, boring from eight to twelve inches in twenty four hours.	71	
52.	*Pure white* calcareous sand rock, full of cells and vacant places, as if dissolved by water, the auger sometimes dropping several inches at once. This stratum is only about forty feet in thickness, and is the lower salt rock, affording much stronger water than the upper, and a more steady and copious supply. - - - - - -	40	
53.	*Light blue sand rock*, lying under the salt rock, this was penetrated only ten or fifteen feet, but afforded no additional water, and here the boring ceased; no salt water has ever been found below the white calcareous sand rock, although at the mouth of Salt Creek, eighteen miles above, where the lower salt rock is only four hundred and fifty feet from the surface they have penetrated four hundred feet, below it. - - - - - - -	10	
	Total, feet,	1001	7

The first one hundred and eighty two feet in the foregoing estimate are occupied by the uplands and rock strata above the well. The last eight hundred and nineteen feet and seven inches are occupied by the strata through which the well passes.

Carburetted Hydrogen Gas.

All salt wells afford more or less of this interesting gas; an agent intimately concerned in the free rise of the water, and universally present where salt water is found. Indeed so strong is the evidence afforded by the rising of this gas to the surface, of the existence of the salt rock below, that many wells are sunk on this evidence alone. It is, without doubt, a product of the saliferous formation, as it rises in many wells without any appearance of petroleum, which latter product is probably generated, by bituminous coal, and in all wells from a depth far below where coal has been discovered in sufficient quantity to furnish such an immense and constant supply as is continually rushing from the earth in these saliferous regions. In many wells, salt water and inflammable gas rise in company with a steady uniform flow. In others, the gas rises at intervals of ten or twelve hours, or perhaps as many days, in vast quantity and with overwhelming force, throwing the water from the well to the height of fifty, or a hundred feet in the air, and again retiring within the bowels of the earth to acquire fresh power for a new effort. This phenomenon is called "blowing," and is very troublesome and vexatious to the manufacturer. The explosion is sometimes so powerful as to cause the copper tube which lines the upper part of the well to collapse, and to entirely misplace and derange the fixtures about it. By constant use this difficulty is sometimes overcome, by the exhaustion of the gas, and in others the well has been abandoned as hopeless of amendment. A well on the Muskingum, ten miles above McConnelsville, at six hundred feet in depth, afforded such an immense quantity of gas, and in such a constant stream, that while they were digging, it several times took fire, from the friction of the iron on the poles against the sides of the well, or from scintillations from the auger; driving the workmen away, and communicating the flame to the shed which covered the works.

It spread itself along the surface of the earth, and ignited other combustible bodies at the distance of several rods. It became so troublesome and difficult to extinguish, when once ignited, being in this respect a little like the "Greek fire," so celebrated by Gibbon, that, from this cause only, the well has been entirely abandoned. In the days of superstition and ignorance, this would doubtless have been attributed to the anger of the Genius, who presided over the spot, and thus protected it from the unhallowed approaches of man.

At R. P. Stone's well, on the opposite side of the river a little below McConnelsville, the gas rises in small regular puffs, or discharges, averaging one to every minute or two; causing the water to flow in jets from the spout, as it falls into a large cistern below. The water rises in the head through a bored log to the height of twenty five feet above the surface of the earth. Through a hole in the top of a small receiver, or cap, the gas issues in a constant stream, and when a candle or torch is applied, kindles into a beautiful flame, burning steadily, until extinguished by closing the hole, affording in the stillness and darkness of midnight, a striking and interesting phenomenon. It is supposed, that this well alone furnishes sufficient gas, if properly applied, to light the town very handsomely. No petroleum rises with it, and very little in any of the other wells at this locality. The quantity of gas in different wells varies very considerably; all however afford sufficient to keep the water in constant agitation over the mouth of the well. The supply of water depends very much on the quantity of gas discharged.

A few miles above Charleston, on the Big Kenhawa, great quantities of the carburetted hydrogen are slowly emitted, through the earth A tract of several rods in extent near the river bank is so charged with it, that on making shallow cavities in the sand, and applying a fire brand, it immediately becomes ignited and burns with a steady flame for an indefinite period, or until extinguished by covering it with sand. The boatmen, a rude but jolly race, often amuse themselves by tracing a circle in the sand around some one of the company unacquainted with the mystery, and applying fire, a flame immediately springs up, as if by magic, around the astonished wight, which being entirely confined to the circle traced, adds much to his terror, and increases the delight of the boisterous spectators. In a short time the sand beneath the burning gas becomes red hot. The neighboring women sometimes make use of it to boil their water, when washing clothes on the bank of the river; and boatmen occasionally cook their food in the same easy and cheap manner. This spot would afford a fine site for the temple of the fire worshippers of ancient Persia. In low stages of the water, gas and oil are seen oozing from the bed of the river at various points. On the little Muskingum river, a few miles from Marietta, this gas is discharged in many places; often through a pool, or sink hole filled with water, in which case it is called "a burning spring." Petroleum is often found rising from the earth near the spring. Throughout the whole saliferous region, so far as I have any knowledge, on penetrating the salt rock, a greater or less quantity of carburetted hydrogen gas is discharged through the opening—in some places accompaned by Petroleum, and in others without this coëxistent production.

Petroleum or Fossil Oil.

Since the first settlement of the regions west of the Apallachian range, the hunters and early pioneers have been acquainted with this oil. Rising in a hidden and mysterious manner from the bowels of the earth, it soon arrested their attention, and acquired great value in the eyes of these simple sons of the forest. Like some miraculous gift from heaven, it was thought to be a sovereign remedy for nearly all the diseases common to those primeval days, and from its success in rheumatism, burns, coughs, sprains, &c. was justly entitled to all its celebrity. It acquired its name of Seneca oil, that by which it is generally known, from having first been found in the vicinity of Seneca Lake, N. York. From its being found in limited quantities, and its great and extensive demand, a small vial of it would sell for forty or fifty cents. It is, at this time, in general use among the inhabitants of the country, for saddle bruises, and that complaint called the scratches, in horses. It seems to be peculiarly adapted to the flesh of horses, and cures many of their ailments with wonderful certainty and celerity. Flies and other insects have a natural antipathy to its effluvia, and it is used with much effect in preventing the deposit of eggs by the "blowing fly," in the wounds of domestic animals during the summer months. In neighborhoods where it is abundant, it is burned in lamps in place of spermaceti oil, affording a brilliant light but filling the room with its own peculiar odor. By filtering it through charcoal, much of this empyreumatic smell is destroyed and the oil greatly improved in quality and appearance. It is also well adapted to prevent friction in machinery, for being free of gluten, so common to animal and vegetable oils, it preserves the parts to which it is applied, for a long time, in free motion—where a heavy vertical shaft runs in a socket, it is preferable to all or any other articles. This oil rises in greater or less abundance in most of the salt wells on the Kenhawa, and collecting as it rises, in the head on the top of the water, is removed, from time to time, with a ladle, and put by for sale or use. The greater abundance of stone coal in this locality, than that of the Muskingum, gives it a decided advantage in the elaboration of petroleum. On the latter river, the wells afford but little oil, and that only during the time the process of boring is going on; it ceases soon after the wells are completed; and yet all of them abound more or less in gas. A well on Duck Creek, about thirty miles north of Marietta, owned by Mr. McKee, furnishes the greatest quantity of any in this region. It was dug in the year 1814, and is four hundred and seventy five feet in depth. Salt water was reached at one hundred and eighty five feet, but not in sufficient quantity; however, no more water was found below this depth. The rocks passed, were similar to those on the Muskingum river above the flint stratum, or like those between the flint and salt deposit, at McConnelsville. A bed of coal two yards in thickness, was found at the depth of one hundred feet, and gas, at one hundred and forty four feet, or forty one feet above the salt rock.

The hills are sandstone, based on lime, one hundred and fifty or two hundred feet in height, with abundant beds of stone coal near their feet. The oil from this well is discharged periodically, at intervals of from two to four days, and from three to six hours duration at each period. Great quantities of gas accompany the discharges of oil, which for the first few years, amounted to from thirty to sixty gallons at each eruption. The discharges at this time are less frequent, and diminished in amount, affording only about a barrel per week, which is worth at the well from fifty to seventy five cents a gallon. A few years ago, when the oil was most abundant, a large quantity had been collected in a cistern holding thirty or forty barrels. At night, some one engaged about the works approached the well-head with a lighted candle. The gas instantly became ignited, and communicated the flame to the contents of the cistern, which giving way, suffered the oil to be discharged down a short declivity into the creek, whose waters pass with a rapid current close to the well. The oil still continued to burn most furiously; and spreading itself along the surface of the stream for half a mile in extent, shot its flames to the tops of the highest trees, exhibiting the novel, and perhaps never before witnessed spectacle of a river actually on fire.

Strength of the salt water.

The greater or less degree of saturation in the water of the different salines must depend on circumstances, and is influenced by several causes. It may meet with springs of fresh water as it rises near the surface, which, often times, greatly diminishes its strength. A well may perhaps only reach the upper stratum, which generally affords a weaker water than the lower, or if it descends to the lower saliferous rock, it may be at a spot not so fully impregnated with saline matter, and thus it will afford a much weaker water. The strength of a water is usually ascertained by its weight; whatever it may weigh over and above the weight of an equal amount of rain water, is put down for its salt producing quality. This quality when put to the test by the manufacturer, it will, however, more than sustain,* although the strict chemical analysis would produce a result coinciding with its actual weight. On comparing the two modes, they stand as follows. One pint of water from the Muskingum saline, weighs one pound, two ounces and one hundred and sixty grains, and requires seventy five

* Owing obviously to other substances besides the salt.—*Ed.*

gallons by weight to produce fifty pounds of salt, allowing it to contain no other ingredient than muriate of soda. One pint of rain water by the same measure weighs one pound and one ounce. On evaporating the same water, it produced within fifty grains of two ounces of salt, equally dry with that put up for sale at the furnaces. On lying a few months, the weight is diminished ten or fifteen per cent, by the drainage of bittern, composed principally of the muriate of lime, and the muriate of magnesia. By this experiment, one gallon of the water affords fifteen ounces of salt, and it would require less than fifty four gallons to make fifty pounds. The general estimate of the manufacturers, is however, from fifty five to sixty gallons for every bushel of salt. Some of the wells afford a stronger water, than this, making a bushel from fifty gallons.

One pint of the Kenhawa water, weighs one pound, two ounces and forty four grains, giving of saline water, one ounce and forty four grains; the water from the river weighing one pound and one ounce by the same measure. By this estimate, it will require ninety one gallons to make a bushel of fifty pounds weight of salt. But, as manufactured at the furnaces seventy five gallons will produce that amount, when by the weight of the water that number of gallons should afford only forty one pounds of salt. This difference can be readily accounted for, by the aqueous particles contained in the salt, it seldom or never being perfectly dry. When carefully manufactured, the western salt is as pure and as white as the Liverpool; but, for preserving meat in a hot climate is not considered by the packers and inspectors to be quite equal to the alum or rock salt, the crystallization of which being conducted by slow evaporation, is freer from earthy muriates, than the salt made by fire. The recent discovery of making coarse or alum salt by the aid of steam and now in operation at the Kenhawa salines, (as described in this paper,) will obviate or remove this difficulty; and be of immense advantage to the farming and commercial interests of the country.

Temperature and analysis of the water.

From the theory espoused by late writers on the subject of the increased heat of the earth, as we descend towards the centre, I was led to expect that the water rising from the deepest wells would show a temperature above that of the adjacent springs, wells of fresh water, or the mean annual temperature of the place where the wells are situated. On conversing with the manufacturers on the subject, they were generally of the opinion that the water was not any warmer and some thought it to be evidently colder. On application of the thermometer to one of the deepest wells at McConnelsville, being eight hundred and nineteen feet, the water, as it rushed up from the bottom of the well in a constant stream, was found to be only fifty two degres of Fahrenheit, which is very near the actual mean temperature of that spot. In a well four hundred feet deep, three miles below Zanesville, the water as it rises is 50°, and in a fresh water well, forty feet deep, the thermometer stands at 53°, near by the salt well. Whether the salt can have any operation in reducing the temperature I do not know. Salts, while in the act of dissolving, produce cold, but, unless the solution is constantly going on, we can see no reason why the saline waters should remain permanently cold; whatever may be the reason, I was disappointed in the result. The water of the Muskingum salines has not been accurately analyzed, but the following is the analysis of the Kenhawa water, conducted by a gentleman fully competent to the task.

Muriate of soda,	56.
Muriate of lime,	35.
Carbonate of iron,	2.
Free carbonic acid,	1.
Water,	906.
	1000.

The analysis of the bittern shows some additional ingredients.

Muriate of lime,	335.
Muriate of magnesia,	39.
Muriate of potash,	22.
Muriate of soda,	93.
Bromide of calcium, a trace,	
Water,	511.
	1000.

From these analyses it would appear that no sulphates are contained in the waters, and that neither Epsom or Glauber's salts could be made, as they are at the works on the sea board. They would afford some magnesia but not in sufficient quantity to make its manufacture profitable. The amount of muriate of soda that might be produced is without limit. At present, the quantity manufactured at the several works established along the valley of the Ohio, from Kiskiminitas above Pittsburgh to Shawaneetown in Illinois amounts to between two and three millions of bushels annually. The works at Kenhawa alone furnish twelve hundred thousand bushels, and those on the Muskingum between three and four hundred thousand. Large quantities are made at Kiskiminitas or Konemaugh, Pa. and at Yellow Creek in Columbiana County, Ohio. Salt is also made in considerable quantities on the Big Hockhocking and on Leading Creek. When that beautiful, but simple process of manufacturing by atmospheric evaporation, and that still more interesting one by steam, are carried more extensively into use, the people of the west will have nothing farther to desire, either in the abundance, or in the excellency of that great and indispensable article, marine or culinary salt.

Art. VI.—*On the Expression of the sides of Right-angled Triangles, by Rational and Integral numbers;* by Rev. Daniel Wilkie.

In a late number of your excellent Journal,* there appear two ingenious methods of finding the sides of right-angled triangles in integral numbers.

The first of these methods is the following—*Rule.*—"Take any two numbers whose difference is 2. Their sum will be the root of one square; their product that of the other. Add 2 to the product just found, and you obtain the root of the sum of the squares, or the hypothenuse."

This method affords a number of curious results, and furnishes a great number of answers,† yet it is evidently limited to those cases in which the hypothenuse exceeds the next greater side by 2, or to multiples of these.

The second method is simpler and more general. It is as follows. "Assume m, n, p, any rational numbers, so that n be greater than p, then, $m(n^2+p^2)$, $m(n^2-p^2)$ and $2\,m\,n\,p$, will be the sides of the required triangle."

As the quantity m is a multiplier of all the terms, and does not otherwise enter into the formation of the rule, it may be omitted. The limitation that n be greater than p, is also unnecessary.

The following method is proposed, as somewhat simpler, and more general than those above stated.

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* Vol. xx, No. 2.

† And is accompanied by a demonstration.

Let m, and n, be any rational numbers whatever; then m^2+n^2, m^2-n^2, and $2mn$, will be sides of a right-angled triangle. For,

$$(m^2+n^2)^2=(m^2-n^2)^2+(2mn)^2.$$

If m remains constant for any set of examples, and n be successively increased by unity; the hypothenuse will increase by the following series, 3, 5, 7, &c. the base will decrease by the same series, and the perpendicular will increase constantly by $2m$.

In the following examples m remains constantly equal to 10, and n increases by successive units. The required triangular sides may be extended ad infinitum by the process above explained, without changing the value of m. If m be changed, other series equally unlimited will arise.

m	*n*		*hyp.*		*base.*		*perp.*
10	1	-	101	-	99	-	20
	2	-	104	-	96	-	40
	3	-	109	-	91	-	60
	4	-	116	-	84	-	80
	5	-	125	-	75	-	100
	6	-	136	-	64	-	120
	7	-	149	-	51	-	140
	8	-	164	-	36	-	160
	9	-	181	-	19	-	180
	10	-	200	-	0	-	200
	11	-	221	-	21	-	220
	12	-	244	-	44	-	240
	13	-	269	-	69	-	260
	14	-	296	-	96	-	280
	15	-	325	-	125	-	300
	16	-	356	-	156	-	320
	17	-	389	-	189	-	340
	18	-	424	-	224	-	360
	19	-	461	-	261	-	380
	20	-	500	-	300	-	400 &c.
	30	-	1000	-	800	-	600
	40	-	1700	-	1500	-	800
	50	-	2600	-	2400	-	1000 &c.

From this set of examples, it will be seen,

1. That when $m=n$, then the hypothenuse and perpendicular are equal, and the base vanishes.

2. That as n increases above m, the bases are negative, that is, they lie on the contrary side of the perpendicular.

3. That they now increase.

4. That from this point, the bases and hypothenuse have all a common difference, in this case 200.

5. As n increases from 1 to m, the ratio of the perpendicular to the hypothenuse increases, till it reach its maximum, namely a ratio of equality, when $m=n$.

6. This ratio afterwards decreases from equality.

7. The legs of the isosceles right-angled triangle, cannot be expressed in this manner, not being rational numbers.

8. Nor for the same reason can the triangle of 30°, at the base, be thus expressed, since, though the base is half the hypothenuse, the perpendicular is not rational.

9. While n is less than m, the sum of the base and hypothenuse remains constant, and is equal to the co-versed sine of the angle contained by these two sides.

10. When n exceeds m, the sum of the base and hypothenuse, (the former being negative,) is still equal to the same constant quantity, but is then, the versed sine of the same angle.

Quebec, December 28, 1832.

Art. VII.—*Plan of the Locks at Cincinnati, Ohio;* by Darius Lapham, Assistant Engineer.

TO PROFESSOR SILLIMAN.

Dear Sir.—As there have, within a few years, been many improvements in the construction of locks on canals, which have not been noticed in any treatise on that subject, within the knowledge of the writer, it has been thought that a concise description of the locks which are now in an advanced stage of construction in the city of Cincinnati, Ohio, accompanied with a drawing, would be acceptable to the numerous readers of your valuable Journal. Should you think that the following description and plan of those locks, have sufficient merit to justify their insertion in the American Journal of Science and Arts, they are entirely at your disposal.

From the intersection of the Miami canal with Main street, in the city of Cincinnati, to the lowest water in the Ohio river, there is a fall of one hundred and twelve feet, which is overcome by ten locks; nine of eleven feet, and the lower one, of thirteen feet lift. They are placed in a right line, and at such distance apart as will admit of two boats passing each other between them. For the purpose of admitting keel boats, coal arks, sections of lumber rafts, &c. to pass to the upper part of the city, the locks are increased in width to eighteen feet. The stones for the face of the walls, are obtained one hundred miles up the Ohio river, at a place which the proprietor has named Rockville; and brought down on scows by the aid of a steam boat. The whole work is taken by contract by MR. JOHN LOUGHRY; and it is under the direction and superintendance of MR. SAMUEL FORRER, whose reputation as an Engineer is no unenviable distinction.

In the drawing are represented, the ground plan, and an elevation, of one of those locks, by a scale of twelve feet to an inch.

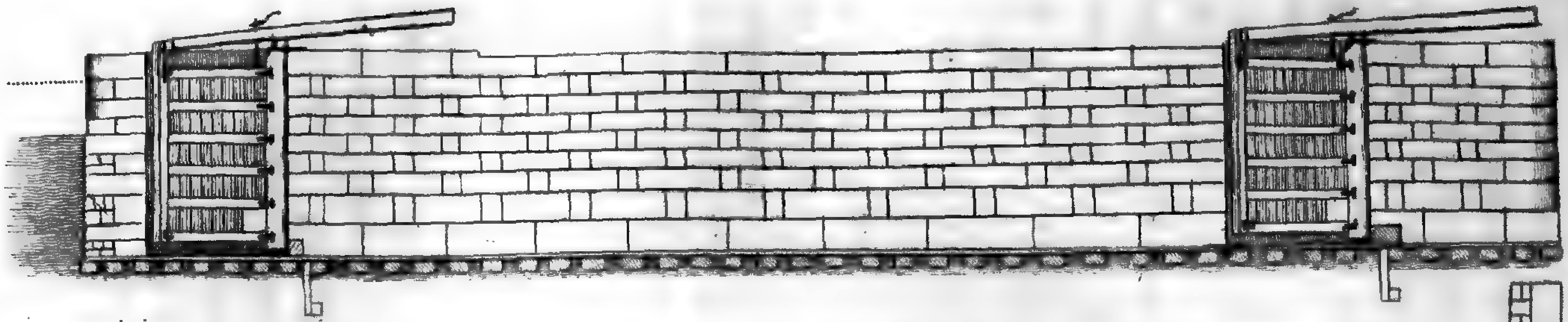
The foundation is composed of timber one foot thick, and laid transversely, from four to six inches asunder; the interstices are filled with puddle of clay and gravel slightly wetted and compressed with wooden rammers. Sheet piling are placed at each gate entirely across the foundation, four feet deep, consisting of two inch plank, jointed, and placed on end, resting against a stick of timber in the bottom, and against one of the dogs at the top. On these timbers is laid a floor of three inch plank, which is jointed except under the walls. Both mitre sills are placed on this floor. The lower one is nine inches high; the top of which coincides with the bottom of the canal; the upper one is made eighteen inches high, so that the gates will be less liable to obstruction from gravel. They are made at an angle of twenty eight degrees; and fastened down near the vertex with bolts. Over the three inch floor, within the walls, a lining of two inch plank is laid, and the whole secured to the timbers with ten inch spikes.

The face stone of the masonry is laid in mortar, and the rubble wall is grouted. It is required by the contract that there shall be a header in every ten feet in length; the stones are obtained of such size, that it is very seldom, that there is not a header at each end of every stretcher. The edges of the face stones are rusticated or chamfered, which gives to the walls a bold and beautiful appearance. Particular attention is paid, in placing the headers at the hollow coins, so that each stone which has a hollow coin cut in it, shall have a header resting upon it. This is effected by placing them alternately, in each course, above and below the hollow coin. The walls are covered with coping three feet wide, and not less than one foot in thickness; at the head of the lock the coping is two feet thick.

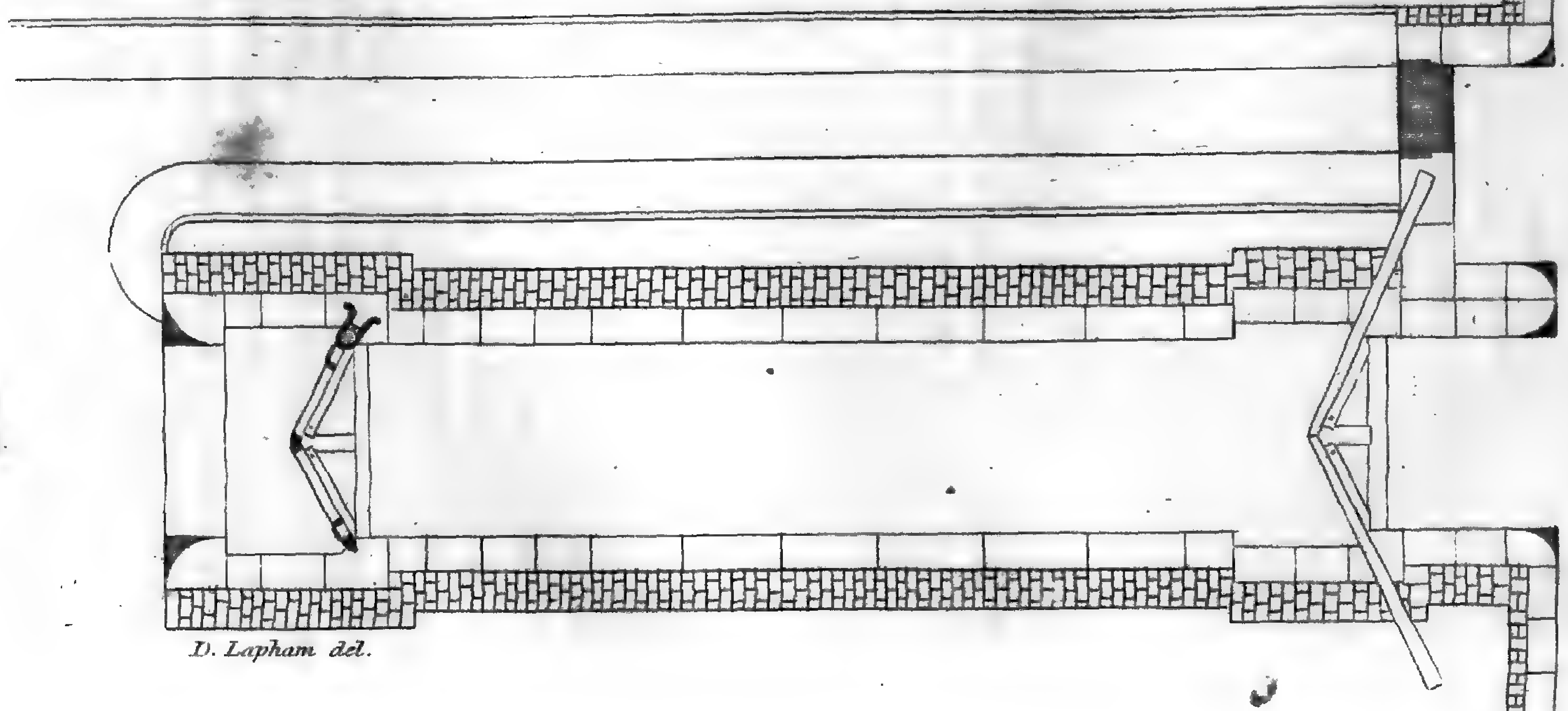
Around each lock, the water for the supply of the canal, is carried in a canal for that purpose; and near the foot, it tumbles over a breast of masonry, into the basin below. This *tumble* is connected with the lock walls, and from below, exhibits the appearance of a double lock. Recesses are made in the sides of the tumble for the insertion of plank to regulate the supply of water.

The lock gates are constructed of timber in the usual manner, consisting of a coin and mitre post, connected together by ties or arms. On the top of these posts, rests a large lever or balance beam, which serves to keep the gate balanced, and by means of which the gate is opened and shut. The gates lap two inches and a half below the top of the mitre sill, but the coin post extends to within an inch of the floor. In the lower end of this post is inserted the cast iron socket, *a*, Fig. 1, and secured by a band of iron; the step *b*, Fig. 1, is let into the floor, in the centre of the hollow coin, and fastened with spikes, on which the gate turns. The arms are more firmly secured to the coin post by Ts and Ls, connected by bolts with screws. To the mitre post, the arms (except the lower one) are connected by a dove-tail tenon and key, reaching through the post. The upper and lower arms only, are secured to the mitre post with Ts and Ls. The end of the balance beam is secured to the mitre post by a strap of iron passing over it, and extending down on each side of the post, and connected by bolts and screws. This end of the beam is also banded, to prevent it from being split by the concussion of boats. The beam is fastened to the coin post to prevent it from rising by the high water. That part of the beam which lies over the gate is left square on the top, so that when the gates are shut, they form a foot bridge, which aids the lock tender in his duties. The gate is retained in its place by a collar around the coin post at the top; this is attached by keys to circular iron bars which are bolted to the coping.

During the time of a high flood in the Ohio river, five of these locks will be covered with water, so that it will be necessary to secure the gates from floating. In order to do this, it is proposed to put a permanent band around the top of the coin post, with the under side level with the coping, as seen in Fig. 2, at *a*. In the middle of the periphery of the hollow coin, a groove is cut to receive an iron bar *b*, four feet long; the lower end of this bar is inserted in the wall; at the top is a head or projection, which covers the band and prevents the gates from rising.



PLAN of the LOCKS at CINCINNATI.



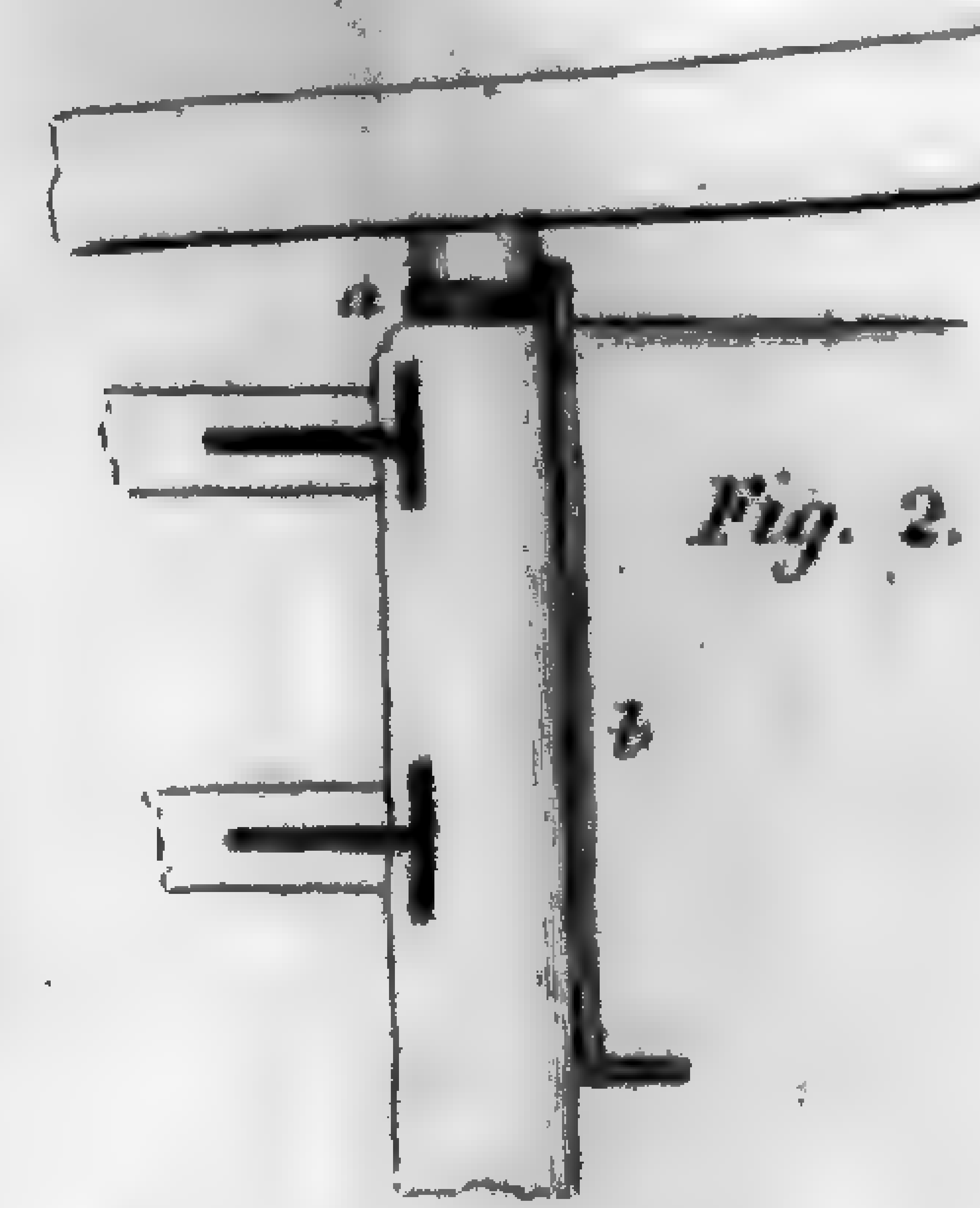


Fig. 2.

Fig. 1.

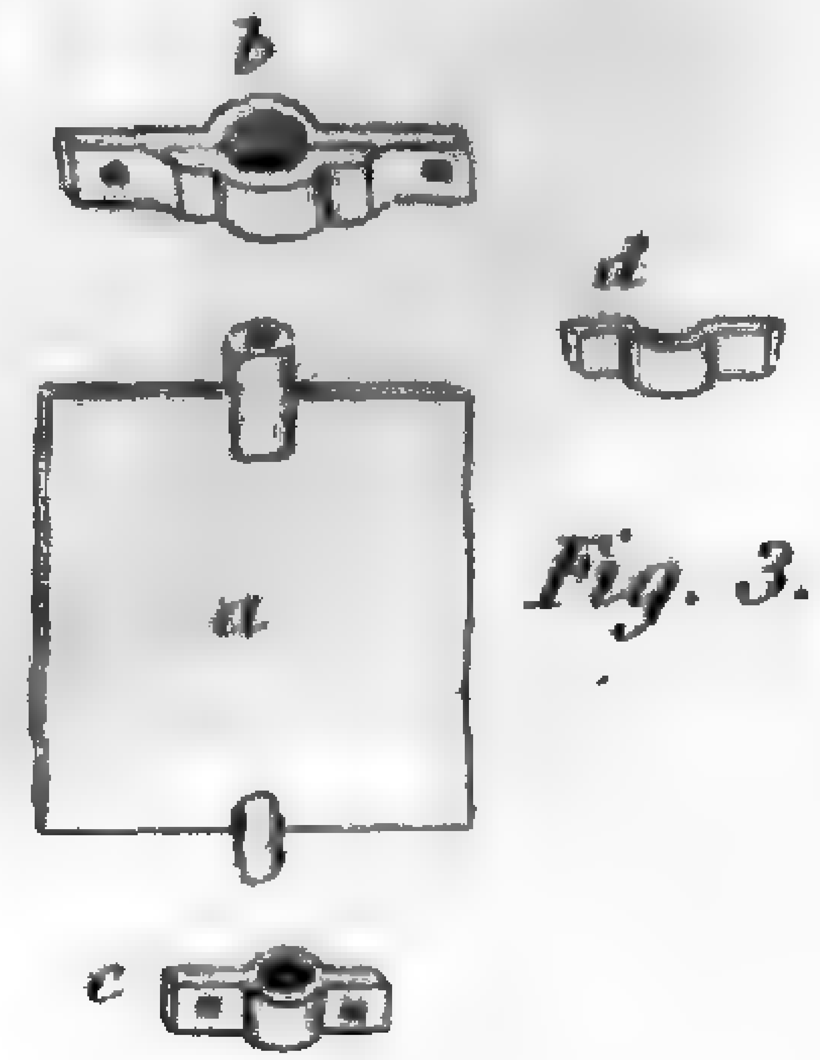


Fig. 3.

King's patent cast iron paddle gates are used for filling and discharging the lock. They are inserted in the lock gates adjoining the coin post, between the two lower arms. The form of this gate is represented in Fig. 3;—*a*, is the blade of the gate; *b* and *c*, are the fixtures which are attached to the arms of the lock gate, and in which the paddle gate turns. A short post is placed between the lower arms at the breadth of the paddle gate from the coin post. The paddle gate is hung on the upper side of the lock gate, so that when open, the blade will not project on the lower side. Into the socket in the top of the paddle gate, a large rod is inserted, which extends above the balance beam, and on the top is placed a wrench by which the gates are turned. At *d*, a portion of figure *b* is represented separate, which can be detached, and the paddle gate inserted, or removed as occasion may require.

Cincinnati, January 21, 1833.

Art. VIII.—*On the methods of describing various curves for Arches;* by J. Thomson, Civil Engineer, Nashville, Tenn.

TO THE EDITOR.

Sir.—The following observations on the methods of tracing various curves for arches, are submitted for publication in the American Journal, with the hope that they may be found useful to mechanics, by saving the time and labor of tedious calculation.

In regard to the method of describing oval arches, the communication of Mr. Miller, in Vol. XXII, No. 2, of this Journal, contains much useful information; yet the merely practical mechanic, unacquainted with algebraical calculations, is still uninformed in regard to the method of finding the point D, (fig. 1) or the distance CD, the determination of which is the only difficulty he will encounter. The distance CD, in that communication, is only expressed in indefinite parts, and not by means of a quantity derived from the ratio of AC to CB.

In order to find CD, *divide the difference of the rise and half span of the arch by the following decimal numbers.*

For five centers, divide by 0.794.
For seven centers, " " 0.771.
For nine centers, " " 0.758.
For eleven centers, " " 0.749.

The method of finding these divisors will be given hereafter. It may be observed that the last divisor is nearly $=0.75$, hence when eleven centers are used, multiply the above difference of rise and half span by 4, and divide by 3, the result will be the distance CD. Having found CD, make CH=3CD. Take one from the number of centers to be used, and half the remainder will be the number of parts into which CH and CD are to be divided; CH into *equal* parts, and CD into *unequal* parts, increasing from D as 1, 2, 3, &c. Join these points of division, as in the figure, by straight lines, whose intersections will give the centers H, G, F, &c. Thus, when nine centers are used, as in the figure, CH is divided into four equal parts, and CD into the same number of unequal parts, increasing as 1, 2, 3, 4, from the point D.

To find the above divisors, put $CD=y$, $AD=x$ and the given quantities $AC=a$, and $BC=d$. Now when the number of centers is given, the broken line HD is equal to CD multiplied by a constant quantity; put this constant quantity $=c$, then $HD=cy$, and since the broken line AH must be equal to BH, we have

$$x+cy=d+3y, \text{ whence}$$
$$x=d+y(3-c), \text{ and since}$$
$$AC=AD+CD,$$
$$a=y+d+y(3-c), \text{ hence}$$
$$y=\frac{a-d}{4-c}=CD.$$

In order to apply this general equation, c must be calculated for the required number of centers. For five centers, take CD=any assumed quantity, say three; then by trigonometry we find the sum of the lines that constitute $HD=9.619$, hence $c=\frac{HD}{CD}=3.206$. In the same way we find for seven centers, $c=3.229$, and for nine centers $c=3.242$, and for eleven centers $c=3.251$. Hence we have for

$$\text{Five centers, } CD=\frac{a-d}{0.794}.$$

$$\text{Seven centers, } CD=\frac{a-d}{0.771}.$$

$$\text{Nine centers, CD}=\frac{a-d}{0.758}.$$

$$\text{Eleven centers, CD}=\frac{a-d}{0.749}.$$

Since it is thus almost as easy to trace an oval arch with nine or eleven centers as with three, the description of this arch by means of three centers ought always to be avoided, as it is not only disagreeable to the eye, but it is deficient in strength, in consequence of the sudden change of curvature resulting from this mode of description.

Perhaps no curve unites beauty and strength in a greater degree than the cycloid. The arch, equilibrated by a horizontal road-way, is remarkable for strength, but it is deficient in beauty. The elliptic arch is perhaps the most graceful, but when the rise is small, compared with the span, it will not admit of great pressure with safety at the crown. The cycloidal arch, with the same rise and span with an elliptic arch, is more curved at the crown than the latter, and hence it will sustain a greater weight at that point, such as a heavy load passing over it. We are not at liberty, however, to choose the ratio between the rise and span of this arch, these being always to each other as the diameter of a circle to the circumference.

The mechanical construction of the cycloid is very easy. The following method I have not seen noticed in any work on Mechanics. Having fixed upon the dimension of the half span AC, (fig. 2.) take the rise BC such, that AC will be to BC as half the circumference of a circle to the diameter, the lines FH and AE being parallel to each other and perpendicular to AC, and make CH=CB. Let the describing line taken equal to BH or twice BC, be extended from H to A, and brought to a proper tension by means of the point or pin D. The curve AB is then described with the centers D and H. This curve will be an approximation to the cycloid. Fix a number of centers (the more the better) along the curve AB, and with these centers describe the curve BE, which will be a cycloid as near as can be obtained by any mechanical means. If, instead of a single point, D, three or four points be taken as centers between H and A, so arranged as to be nearly in a cycloidal curve, and keeping at the same time the line ADH at its proper tension, the resulting curve AB will itself be a very near approximation to the cycloid; but not much greater sensible accuracy can be attained in the second curve BE, than when a single point D is first assumed.

The above method of tracing this kind of arch is derived from the principle, that when any curve or broken line ADH is assumed between the parallel lines AE and FH, the successive developments or involutes AB, BE, &c. between the same parallels, constantly approach to, and finally terminate in a cycloid. These involutes converge so rapidly to the form of this curve, that when the above method is adopted, the second involute BE may always be assumed in practice as the required curve.

One advantage that might be mentioned, in tracing curves for arches with a variable radius, is that we may always obtain the height of the road-way above any point in the arch, such that it may be equilibrated by the superincumbent weight. Thus, let DE (fig. 3,) represent a road-way passing over the arch AB, let BC= radius of curvature at the vertex, AF=radius of curvature at the point A, DB=height of road-way at the crown, then we have

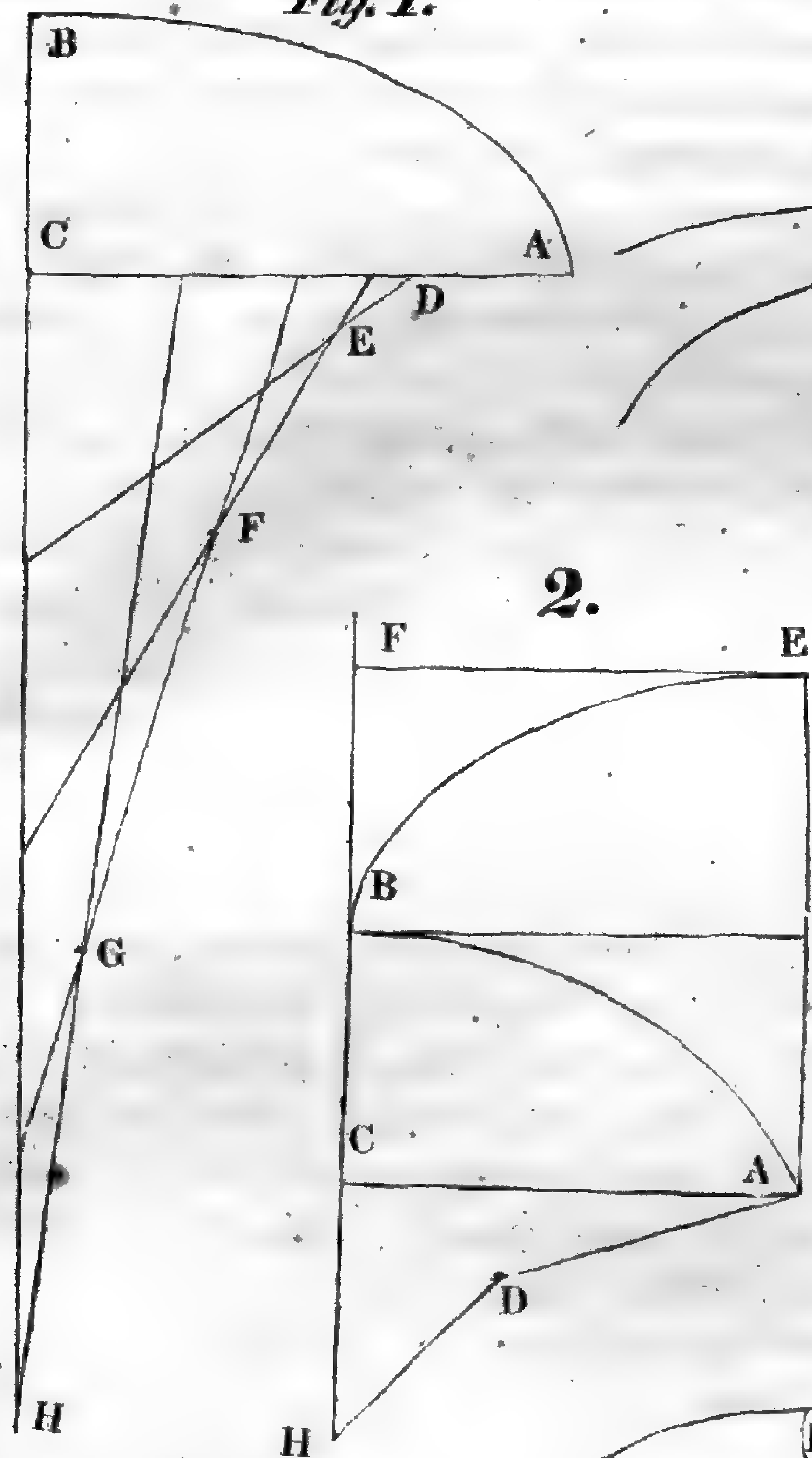
$$AE=\frac{DB\times BC}{AF\times(\cos AHB)^3}.$$

An arch that will require a gentle elevation of road-way at the crown, in order to produce equilibration, may be described by the following method. Let AD, (fig. 4,) represent the span of the arch, BC the rise; describe an arc CG of a circle on DC as a diameter; extend the describing line from A to G where it is a tangent to the circle; the line being fixed at G, describe the half arch AB with centers arranged along the curve CG, and in the same manner describe the half arch BD with centers on CE. If the span AD be =100, AG will be =70.7, and hence the rise BC will be 40. It will be found from the above equation that this arch will be nearly equilibrated by a road-way of the form of LHK, gradually rising at the crown of the arch, when HB is taken equal to about one fourth of the rise.

A very graceful arch may be described (fig. 5,) by centers arranged along circles tangent to the span and axis of the arch, at the points D, E, and A, E. This arch will also admit with safety a horizontal road-way. The span of this arch will be to the rise as $2r$ to $\frac{1}{4}c-r$, r being the radius of a circle, and c the circumference, or the ratio will be as 1 to 0.2854. The use however, of arches of this description is limited to cases where we are at liberty to adopt the constant ratio that necessarily exists between their rise and span.

Fig. 1.

2.



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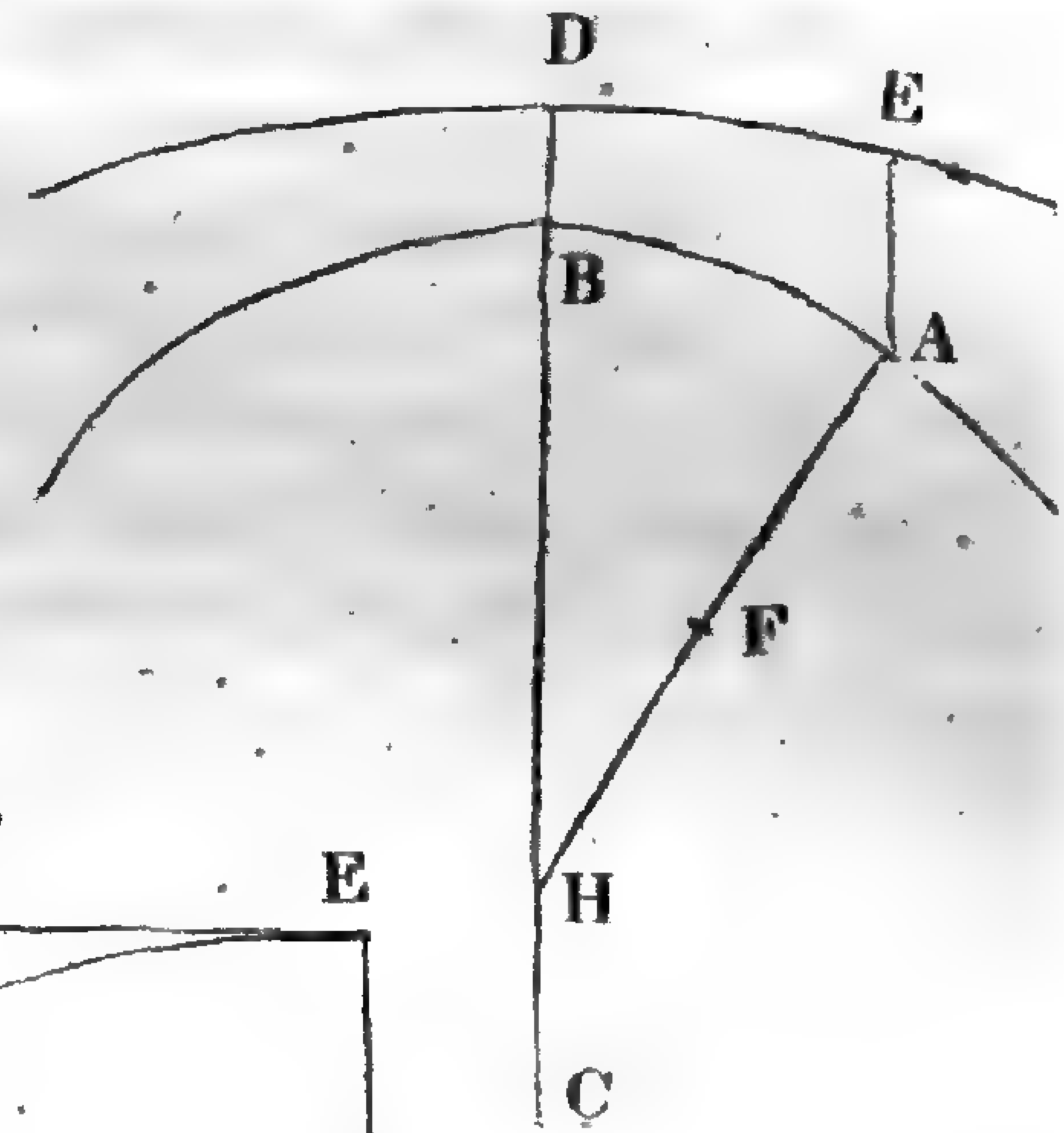

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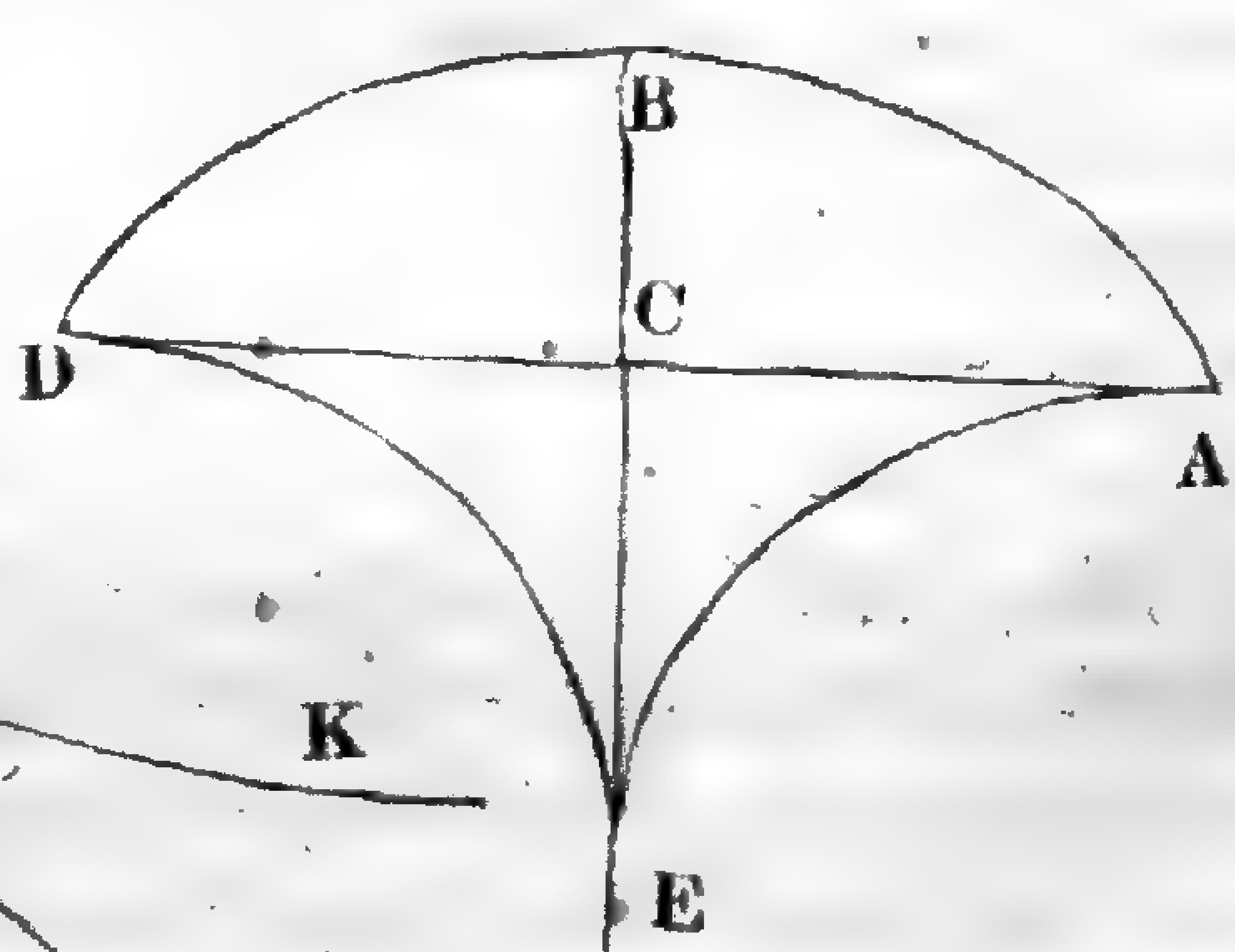

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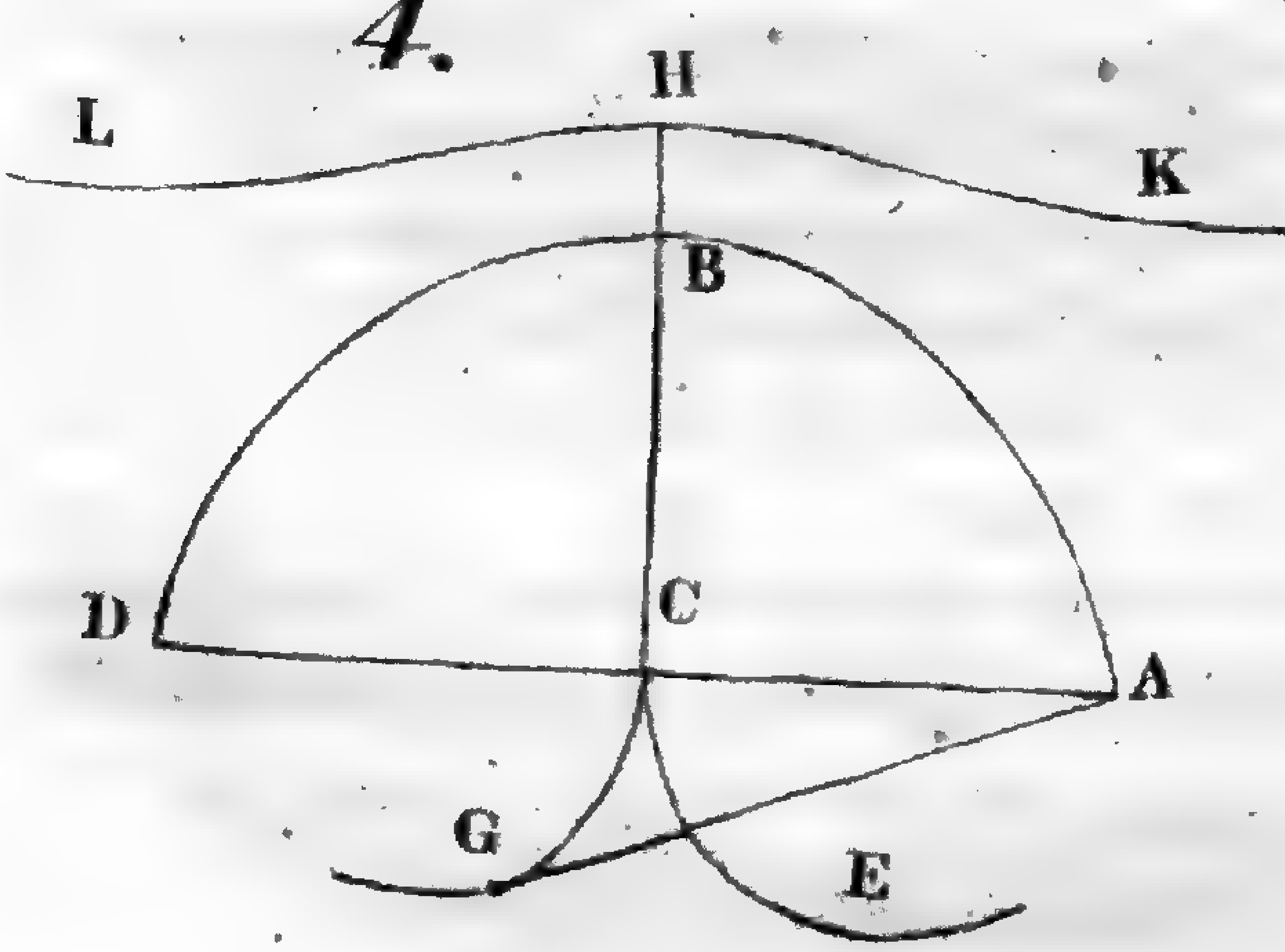


Art. IX.—*A new mode of developing Magnetic Galvanism, by which may be obtained, shocks, vivid sparks and galvanic currents from the Horse-shoe Magnet;* by John P. Emmet, Prof. of Chemistry in the University of Virginia.

The magnetic apparatus contrived by Nobili and Antinori, and by which they were enabled to obtain sparks from the horse-shoe magnet, has become so familiar to the scientific reader, in consequence of the experiments of Saxton, Faraday and Ritchie, that it is deemed unnecessary to describe it more particularly, upon the present occasion, than is required in order to understand the difference between its construction and that which I have found to be far superior for the exhibition of galvanic phenomena.

Nobili's instrument as described in the Annales de Chimie, &c.* consists of a coil of silk-bound copper wire, around the middle part of the keeper and so confined by a spool or brass plates, as to pass readily between the poles of a horse-shoe magnet. The *ends* of this coil are turned outwards in opposite directions, and so arranged as to press with elasticity, upon the contiguous poles of the magnet, when the keeper is on, without touching, *at any time*, the latter part of the apparatus. Fig. 1 will convey a sufficiently precise idea of this arrangement. The sparks are observed to pass between the ends of the coil, and the contiguous magnetic poles, whenever the keeper is suddenly pulled off, or restored to its place, but if I mistake not, have never been noticed to occur between the keeper and magnet.

It is easy to perceive that this mode of developing the galvanic fluid, is not calculated to go much beyond the immediate object which it accomplished, namely the production of sparks, because *both ends* of the copper coil being nearly at the same time in contact with the magnet, the galvanic current becomes instantaneously neutralized by circulating *through the magnet, as a conductor.* Nor is it a very advantageous form for the exhibition of sparks, since a complete failure, in this respect, invariably occurs, whenever both the ends of the coil leave the poles of the magnet, or touch them, simultaneously; or when, from the constant and violent pulling at the keeper, one wire becomes too short to reach the magnet.

With a view of obviating these disadvantages and increasing the *rapidity* of magnetic induction in the keeper, I made the following arrangement.

* December, 1831.

Fig. 1.

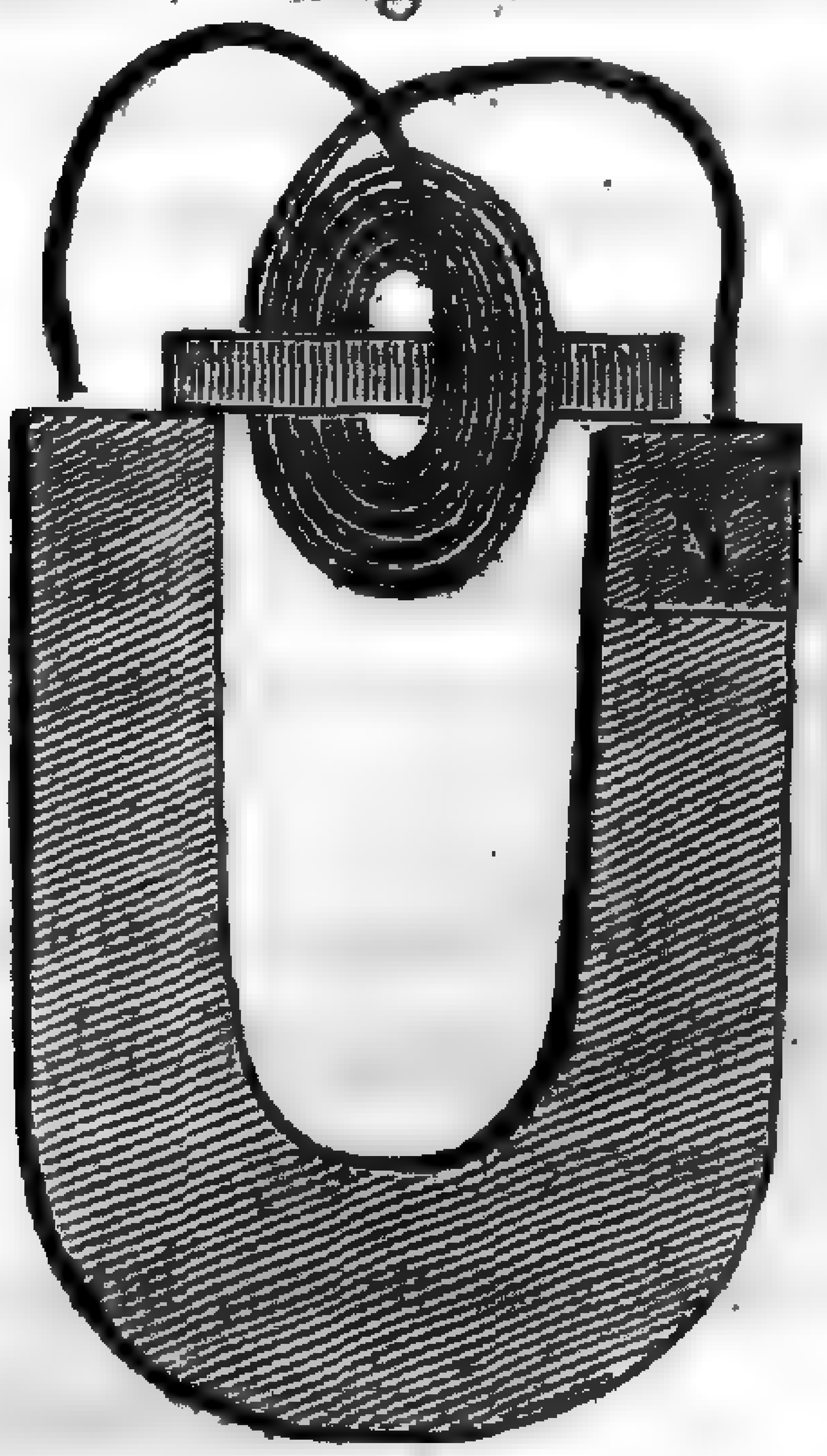


Fig. 3.

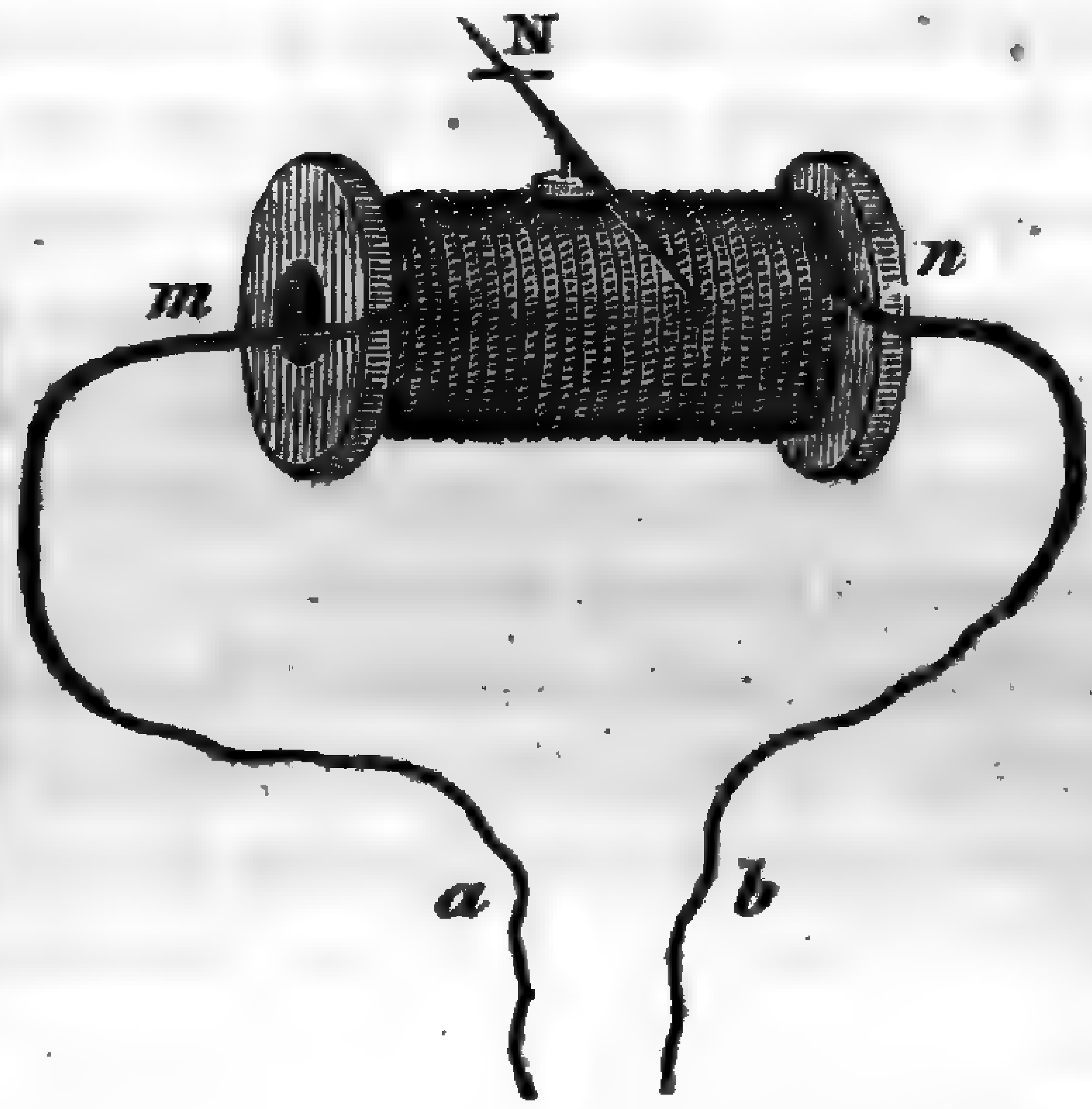
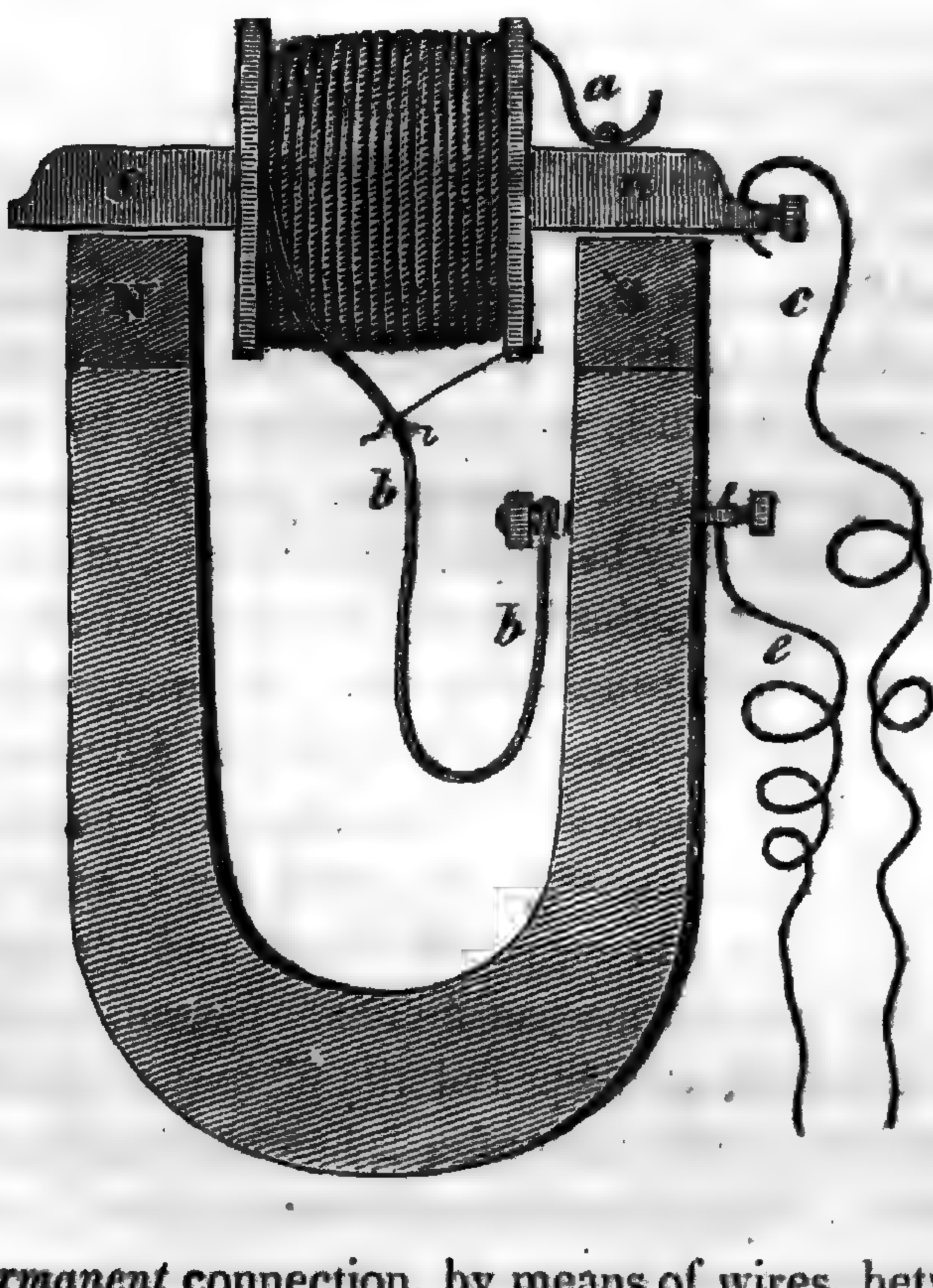


Fig. 2.



1st. A *permanent* connection, by means of wires, between one end (Fig. 2. *a*) of the copper coil and the keeper and between the other end, *b*, and the magnet. The silk-bound wire was wound round the middle of the keeper *s*, *n*, covered with silk, and confined between two brass circular plates, faced on the inside with silk (in order to prevent any communication between the centre and outer portion of the coil). These plates were perforated at the centres, so as to allow the keeper to pass through, and then fastened by pins on the outside. The end of the coil (*b b*), connected with the magnet, must, in no case, touch the keeper or the brass plates fastened to it, and, in the figure, it is represented as preserving this intermediate position by means of a string. It is equally necessary that no metallic communication should exist permanently between the magnet and the keeper, except through the coil.

2nd. Wires, *c* and *e*, are firmly fastened to the keeper and magnet, respectively. They serve as conductors of the galvanic fluid, for the purpose of giving shocks, affecting the galvanometer, &c.

3rd. The keeper to *touch* the magnetic poles as usual, but instead of being pulled, which is at all times an inconvenient process, is to be pushed smoothly but quickly downwards off the magnet. This movement is very easy, and, when well performed, increases astonishingly the *induced* magnetism of the keeper, and, consequently, the galvanic impulse, as is shown by the brilliant scintillations, and the vivid flashes of light, shock, &c. when the conducting wires *c* and *e* are taken into the mouth.

The magnet, made use of, consisted of seven plates and could not easily sustain more than fifteen pounds. The poles were not much over an inch apart, which is a great disadvantage, by preventing the use of a sufficiently large coil. The poles, it may be observed, should be ground down until they become very smooth and lie, accurately, in the same plane. As to the keeper, the best form seems to be that which enables it to adhere most firmly to the magnet (a result promoted by the smoothness of surface), for all the galvanic phenomena seems to be in direct proportion to the degree of adhesion. A flat bar of soft iron, about one quarter of an inch thick, and applied at its edge, was found to answer remarkably well and seemed to receive most rapidly, the induced magnetism, as it passed over the magnet. Contrary to expectation a keeper of the highest tempered steel was found to answer very well, even after it had obtained permanent and powerful polarity. With a coil of about thirty yards, the instrument, here described, gave sparks, shocks, flashes, in the eyes, the galvanic taste to the conducting wires, and some other results, but the observations, which follow, were made with, about one hundred and ten yards of fine copper coil. Five times the quantity could, it is obvious, be as easily managed and, by friction over a magnetic surface of twenty plates, would produce very powerful effects.

Sparks.—These always occur between the keeper and magnet or between the wires *c* and *e* when they are brought close enough to each other, but if the latter *touch*, no sparks can be produced between the keeper and magnet as in this case, a *continuous* metallic circuit exists by means of the coil and the wires. Gold and silver foils, placed between the keeper and magnet or hung loosely between the wires *c* and *e*, exhibit their characteristically colored light, and tinder may be ignited by holding it *beneath* the magnet when the keeper is passing off. The color of the sparks, is variable, sometimes brilliant white and at others copper red. The number, magnitude and brilliancy of the sparks, are exceedingly increased by this arrangement of the instrument. Upon several occasions, owing, apparently, to the combustion of shreds from the keeper, I have produced sparks nearly an inch long. No loud snap or noise accompanies them and it seems probable therefore, that they are purely galvanic, yet when the metallic foils are placed between the magnet and keeper and the latter pulled off, an indistinct crackling noise may, almost always, be heard.

The brilliancy of the light between the magnet and keeper, will be always greater, by preventing these parts from communicating at any other surfaces than those of the poles. The brass plates, in particular, should be varnished, or covered with silk on the outside, whenever, from the narrowness of the magnet and the quantity of included coil, the chances of contact become frequent. The following simple expedient, will enable the galvanic light to become apparent to a class. Place a piece of very fine wire, (such, for example, as the wire upon the finest guitar string,) so as to lie upon the upper part of the keeper and at the same time, press against the face of the magnet, secure its *contact* by the thumb and draw down the keeper swiftly. The end of the wire, being the last part in contact with the magnet, will give out a brush of brilliant sparks, closely resembling those obtained by rubbing together the conducting wires of an active battery. If for the elastic wire, we substitute metallic foils, and arrange them similarly, the sparks will be very brilliant and exhibit the characteristic colors.

Shock.—This may be felt in the fingers, by touching the magnet with the left hand and sliding the keeper off with the other; it is almost always perceived in the fingers resting on the magnet. The wires *c* and *e* must, of course, be kept apart. The most disagreeable and sudden shocks, are experienced by putting these wires into the mouth, and they are invariably accompanied by strong flashes of light and an acid taste. The increase of effect, owing to the rapid sliding off of the keeper, may, in this way, be rendered very apparent, for the shock, at times, equals that produced by a powerful galvanic battery. A sheet of paper interposed between the keeper and magnet, diminishes the effect, much more than a metallic plate of greater thickness.

The magnet, by its connection with the coil, acts a far more important part than as a conductor for the fluid. For the purpose of giving slight shocks and the galvanic taste, this connection, it is true, may be destroyed by separating the wire *b* from the magnet—all that is necessary is to put the ends, *b* and *a*, of the coil, into the mouth and to slide off the keeper. These wires will even impart the *acid taste* by simply *rocking* the keeper upon the poles of the magnet, yet no sparks appear between these parts until the connection between *b* and the magnet is restored, and, at the same time, the most obvious increase of shock, flashes of light, &c. will be experienced. It is not a little remarkable, however, that this connection between the coil and magnet, *wholly destroys* the strong galvanic taste of the connecting wires, occasioned by *rocking* the keeper upon the magnet.

Direction and force of the galvanic current, as indicated by the galvanometer.—One can scarcely refrain, after having experienced the effects described in this communication, from entertaining the conviction, that the magnet, thus remarkable for its development of galvanism without the intervention or aid of *chemical action*, will ere long furnish the philosopher with a powerful and novel instrument of analysis; yet, it must be confessed, that its action upon the galvanometer is quite insignificant, when compared with the smallest sized elementary battery, exposed to weak acids. The galvanometer employed, was an inferior one, consisting of a single needle and only seven coils of stout copper wire, yet it obeyed readily the impulse given by plates of zinc and copper, not larger than an inch in diameter. My first experiments were made with a coil of about thirty yards on the keeper, and, although I distinctly felt the shock, at different times, *through the galvanometer*, I never could perceive more than a tremulous motion of the needle. By substituting, for this latter instrument, a large spool, (fig. 3,) filled with silk-bound copper wire, (about one hundred yards,) the two ends turning out and connected with the coil on the keeper, by means of the wires *a*, *b*, I was enabled to trace, distinctly, the galvanic current developed by the magnetic power.

This simple arrangement furnished a very delicate galvanometer, by placing the spool so as to range, in length, east and west, and a pocket needle upon the upper part of the coil. Upon connecting it with a small galvanic battery, the ends *m* and *n* of the spool became north or south, according to the direction of the current, and the temporary polarity, thus developed, was uniformly so powerful, that the needle, in this form, and in that of the common galvanometer, must be regarded as actually under the influence of a magnet whose poles, being at right angles, occasion the deviation. The current from the magnet is not interrupted by passing through red hot wires. Under these circumstances, both sparks and shocks may be readily obtained.

When the coil on the keeper amounted to one hundred yards in length, the common galvanometer was sufficiently affected by the magnetic apparatus, to furnish definite results, but never indicated a greater declination than ten degrees. The *galvanic current* is apparently directed by that of the *induced magnetism* of the keeper, the positive one always moving in opposition to the north magnetism. This will account for the following fact.

When the magnet is stationary, the pulling or sliding off, produces a current *opposite* to that resulting from the replacement of the keeper. Hence arises the difficulty of effecting an accumulation of galvanic power. Indeed, the difference between galvanism, as generated by the battery, and that developed by the magnet, seems to depend less upon intensity, at the commencement, than upon the continuity of impulse and subsequent accumulation. The magnet only produces a momentary effect, and this is succeeded by a *counter current*, when the keeper is restored.

The galvanic battery, on the contrary, generates these impulses so rapidly as to create and sustain, in the coil of the galvanometer, a strong magnetic polarity, which occasions the prompt declination of the needle. The battery, moreover, has an equivalent, for want of magnitude, in the increase of chemical action. Hence, the merest metallic points may be made sufficient to cause the needle to fly from its meridian. The action of fused nitrate of ammonia upon zinc is equal to that of the strongest acids, as I particularly noticed in a former communication, and by melting this salt in a platinum crucible, connected with one wire of the galvanometer, I found, that when slightly touched by the smallest fragment of zinc, also connected with the galvanometer, the most powerful influence was exerted upon the needle: indeed, this seemed to be a more energetic galvanic battery, for the surface, than any of the usual ones for which acid baths are employed.

Any arrangement which would prevent the *inversion* of the galvanic current, when the keeper is restored to the magnet, as well as the loss of force, arising from the communication between these parts, would, no doubt, lead promptly to the decomposition of water, and of saline substances, and to a more conspicuous effect upon the galvanometer. So unsatisfactory were the results obtained, as to the decomposition of saline fluids, that I do not deem it important to mention the evidence in favor of my success, and I shall, therefore, conclude the subject by offering a few observations upon the galvanic currents.

The relation existing between magnetism and galvanism must be of the most intimate character, since it can now be shown, that one may appear either as the cause or effect of the other. Thus, the common galvanic arrangement gives rise to magnetism throughout the circuit, in the battery as well as connecting wires, and the magnetic apparatus, described in this communication, as unequivocally proves that the galvanic power may proceed from a simple magnetic current. The observation of Faraday, that one of these forces, while circulating, occasions another, of a different kind, to move in the opposite direction, seems to be confirmed by these magnetic experiments.

Thus, (fig. 2,) when the keeper, *s n*, is made suddenly to approach the poles of the magnet, its *induced* northern polarity is repelled to the southern pole, S, of the magnet, and the galvanometer, at the same time, indicates a current of *positive* galvanism, flowing in the direction of *n s*, or opposite to that which the induced magnetism had taken. As soon, however, as the keeper touches the magnet, although its polarity is not disturbed, there is no further *circulation*, and, almost at the same moment, the galvanic fluid ceases to move. If we suppose the existence of two magnetic and two galvanic forces, the same explanation will apply; the negative fluid then being regarded as moving in opposition to the direction which the south magnetism takes; the middle portion of the spool being, perhaps, neutral.

Rocking the keeper upon the magnet, as already described, produces a constant, though small, deviation of the needle, and, with a sufficiently powerful apparatus, would, perhaps, effect chemical decomposition.

The remarkable want of action of magnetic galvanism upon this instrument depends, I think, upon the following circumstance, which I do not remember to have seen noticed by any writer upon galvanism. Whenever a *coil* is made part of the galvanic circuit, there will be a loss of power upon the galvanometer needle. I have not had time to investigate whether the galvanic force is actually diminished, or whether the interposition of coil, in sufficient quantity, could be made to arrest the progress of chemical decomposition, but the effect upon the needle is obvious, and it seems, therefore, highly probable *that the coil around the keeper*, so necessary for the development of galvanism, is yet the true cause of the want of power of the fluid over the *magnetic needle.* It is obvious, from the common electro-magnetic experiments, however, that a coil has great influence in imparting *magnetism* to iron, inclosed within it, and the idea occurred to me that the latter could be made to represent the lost or diminished galvanism of the magnet, by placing the iron close enough to the needle. Trial amply confirmed my conjecture and enabled me to construct a peculiarly delicate galvanometer for this variety of galvanic fluid. The arrangement is simple. A fine wire of soft iron, and equal, in length, to the magnetic needle, is to be closely bound with a coil of covered copper wire, from end to end, and the extremities of the coil made to unite with the circuit wires from the magnet and keeper. This coil of bound iron wire is to be placed at *right angles* to the needle, and as close to it as the coils of the common galvanometer. Gently sliding off the keeper always occasions a deviation, but where the motion is performed briskly, an instantaneous declination of 90° and a permanent one of 80° will always follow. It is obvious that the iron wire becomes polar by the passage of the galvanic fluid through the investing coil, and so prompt is the effect, that it is difficult to prevent the needle from describing a quarter circle. Its indications are, of course, *contrary* to those of the common galvanometer since the iron wire takes the opposite polarity from that portion of the coil nearest to it. The wire may be made to receive a change of poles by simply reversing the keeper or magnet, or by putting the keeper, without any other change of position, forcibly upon the magnet. The latter is almost always the least effectual mode.

It may be regarded as objectionable to this galvanometer, that the iron wire retains its polarity so long. I have observed it to hold for a day, and I suspect it has a power but little short of steel, which, perhaps, it derives from the close approximation of its coil. But its power of holding magnetism depends upon its being undisturbed, and we may, at any time, remove it all, by simply pressing the wire so as to bend it gently backwards and forwards at its center. Upon testing this instrument with a galvanic battery, I found that it was not so delicate as the common one when the bath consists of pump water or weak saline solutions, but its value in pointing out the galvanic currents, generated by the magnet, is not diminished by this circumstance, since the common galvanometer is scarcely affected, and, if the coil upon the keeper be the cause of this defect, it is highly probable that extending it will not add to its power over the needle.

The magnetic apparatus occasions prompt declination of the needle, by the assistance of this wire, where the ends of the conductors are separated from each other eighteen inches, and plunged into acidulated water. If such strong magnetism can be impressed upon soft iron by this arrangement, it is obvious that a galvanometer of infinite delicacy might be constructed by bending fine iron wire, closely bound by a continuous coil, into the form of the coils in the common galvanometer, and increasing their number. This mode would also, I think, furnish the most powerful temporary magnetism by giving the *horse shoe form* to the wires, and after having united their respective coils, so as to make the whole continuous, and bound the wires firmly together to grind down their ends until they formed smooth polar surfaces.

Art. X.—*On the Orthography of Hebrew words in the Roman character;* by Prof. J. W. Gibbs, Yale College.

Every person conversant with Hebrew literature, must have observed the inadequate and fluctuating mode of representing Hebrew words in the Roman character generally adopted; and every one who has occasion to write on that language, must have felt the want of a more perfect and uniform system of notation.* The object of the present essay is to offer some hints towards the attainment of such a system.

The problem, here proposed for solution, may be rendered more definite by stating,

1. That it respects the pointed Hebrew text, as it is left us by the Masorites, and as it is exhibited to the eye, modified only by such principles as may be clearly deduced from the Masoretic system itself;

2. That it aims to exhibit all the leading features of the Masoretic punctuation, and to give to each character of importance a distinct and uniform representation; and

3. That the Roman letters chosen to represent the Hebrew, are to give the true sound, with as little ambiguity as possible to those of any nation who use the Roman alphabet.

General principles of the proposed system.

I. In Hebrew the consonants only are written on the line, the vowels being written under, over, or in the consonants. This striking peculiarity which extends to all the Shemitish languages, may be exhibited by using Roman letters for the Hebrew consonants and Italic letters for the Hebrew vowels.

II. The six aspirates ב, ג, ד, כ, פ, ת, sometime have a Dăghĕsh inserted in them, in which case they lose their aspiration. Otherwise they are aspirated. This prominent trait in the Masoretic punctuation may be uniformly represented, by appending an h to these

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* The evils and embarrassments arising from a varying and imperfect orthography have been ably described by Sir William Jones in his *Dissertation on the Orthography of Asiatick Words.* Compare J. Pickering's *Essay on a uniform Orthography for the Indian Languages in North America.*

letters severally when aspirated, and omitting it when they are unaspirated.

The sounds represented by bh, gh, dh, kh, ph, and th, are equally simple with those represented by b, g, d, k, p, and t. Of course, these combinations of letters do not express the composition of the sounds. Indeed the French, in expressing several of them, make use, with equal propriety, of an s or z, instead of an h; yet in favor of our mode of representation it may be said, (1.) that these letters, by the common consent of grammarians, are called *aspirates;* (2.) that the Greek ϑ, φ, and χ, actually arise from combining τ, π, and κ, severally, with the spiritus asper, and are expressed in Latin by th, ph, and ch (=kh); (3.) that gh is also used by the Irish for this purpose, and that the others bh and dh are formed analogically; and (4.) that this mode of representation has been adopted in part by many grammarians and in full by Professor Stuart.

III. The letters, א, ה, ו, and י, frequently quiesce, i, e, lose their sound in that of the preceding vowel point. In order to exhibit this peculiarity, it is proposed to omit the quiescent letter, and to place a circumflex mark, as a sign of prolongation, over the preceding vowel.

This course has been adopted by De Sacy in reference to the quiescent letters in Arabic, which he terms *letters of prolongation.* See his Gram. Arabe, tome i. p. 27, 33, 63.

IV. Letters which are otiant, i. e. absolutely mute, may be entirely omitted.

V. א moveable and ע have sounds which cannot be represented by Roman letters. Yet they differ so essentially from quiescent and otiant letters, that it is necessary to represent them in some way. The Roman a and Roman o have been selected as the most appropriate signs, for reasons which will appear hereafter.

VI. To distinguish letters which have nearly the same sound, כ may be represented by k and ק by ḳ, שׂ by s and ס by ṣ, ת by t and ט by ṭ.

By this dot we indicate that another character is used in the original Hebrew, but not at all the difference of sound. This plan has been adopted, in analogous cases, by Richardson in his Persian and Arabic Dictionary.

VII. The long vowels, except when followed by a quiescent, may be marked with (¯); when followed by a quiescent, with a pointed circumflex (ˆ).

VIII. The short vowels, except when followed by a quiescent, may be marked with (˘); when followed by a quiescent, with a curved circumflex (˜).

IX. The half vowels may be written in a smaller character and above the line. This method has been adopted by Gesenius and Stuart.

X. The tonic accent, when on the ultimate syllable, may be omitted; when on the penult, it may be expressed by (´) written immediately after the accented syllable.

XI. The euphonic accent may be expressed by (`).

XII. Măkkēph may be expressed by two parallel lines (=).

XIII. Sillûk may be expressed by a period (.); the other pause accents by a colon (:); disjunctives of the second class by a semicolon (;); and disjunctives of the third class by a comma (,). Conjunctives need not be expressed.*

Remarks on the several letters and vowel points.

Aălĕph.

א, according to the Masoretic punctuation, is either moveable, quiescent, or otiant.

The force of א *moveable,* consisted, like the spiritus lenis (') of the Greeks, in a gentle emission of the breath from the throat, or rather lungs, and differed from ה, or the spiritus asper (ʽ), in being more feeble. It was like the impulse given to the voice when we attempt to pronounce *deed* in two syllables *de-ed,* or *corner,* as if divided thus, *corn-er,* and may be compared with h in the French word *homme,* or the Eng. *hour.* In this way it served to divide syllables, as יִשְׁאַל yish-aăl, not yĭ-shăl. This is the *consonant* power of א, and was probably its original or primary power.

The force of א *quiescent,* depended on the vowel point which preceded. This was generally a, but sometimes other vowels. This is the *vowel* power of א, and was probably a secondary use of this letter.

When א had neither the force of a consonant, nor of a vowel, it was said to be *in otio,* and was then absolutely destitute of sound.

* For this classification of the accents, see Prof. Stuart's Hebrew Grammar, 3d and 4th editions.

The Shemitish Aālĕph, then, if we may judge from the Masoretic punctuation, was both a consonant and a vowel. The corresponding Alpha of the ancient Greeks, and a of the modern European languages, have retained only the vowel sound.

To represent the sound of א moveable, we will adopt the Roman a, (1.) because א, when quiescent, usually quiesces in a; and (2.) because the Roman a is ultimately derived from the Hebrew Aālĕph. Hence we merely restore to the Roman a its original consonant power.*

Bêth.

ב appears to have had two sounds, according as it was written with or without a Dāghĕsh. ב (without a Dāghĕsh) was aspirated and sounded like the Eng. v. בּ (with a Dāghĕsh) was unaspirated and sounded like b. The Greek Beta is pronounced by the modern Greeks as the Eng. v. So b in Spanish between two vowels. The Roman b, in the other European languages, has only its usual sound. The Russians retain both sounds.

The character v, however, as the representation of ב aspirated, is liable to some ambiguity, being pronounced by the Germans like f. We will represent it by bh, (1.) because bh or v has the same relation to b, that ph or f has to p; and (2.) because in this way we adopt an uniform mode of representation for all the aspirates.

Gîmĕl.

ג had two sounds, according as it was written with or without a Dāghĕsh. ג (without a Dāghĕsh) was aspirated and pronounced probably like the Irish gh. גּ (with a Dāghĕsh) was unaspirated and sounded like g hard.

The fate of this letter among the different nations has been somewhat singular. In Syriac, it seems, as in Hebrew, to have been sometimes aspirated and sometimes not. In Arabic and Persian it is usually pronounced like dzh (Eng. j); but in Egypt and some other provinces it is pronounced like g hard. In modern Greek it is sounded before a, o, u, like g hard; but before ε, ι, and the diphthongs having their sound, like the Eng. y. In Russian it partakes of a guttural sound. In French and Portuguese, it is sounded before a,

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* The necessity of representing א moveable in some way has led Professor Stuart to make use of the Hebrew character itself, which ill comports with the other letters. See his Heb. Gram. 2d, 3d, and 4th editions.

o, u, like g hard; but before e, i, y, like zh. In Italian and English it is sounded before a, o, u, like g hard; but before e, i, like dzh, (Eng. j). In Spanish before a, o, u, like g hard; but before e, i, with a peculiar guttural sound. In German, Swedish, and Danish, usually like g hard, but sometimes nearly like y, and g final with a peculiar guttural sound. In Dutch, usually with a guttural sound. The soft sound of g has fluctuated, then, between dzh, zh, y, and a peculiar guttural sound.

Amid this variety in the sound of g, it is most probable that the Gímĕl aspirated in Hebrew had a flat guttural sound, bearing the same relation to g hard, that the sharp guttural sound kh does to k. This sound the Irish are said to express by gh before a, o, u; and probably the Germans, Dutch, and Spanish, express nearly the same by their guttural sound of g.

We will represent ג aspirated by gh, (1.) because this combination of letters is so used by the Irish; (2.) because this flat guttural sound has the same relation to g hard, that the sharp guttural sound represented by kh has to k; and (3.) because in this way we adopt an uniform mode of representation for all the aspirates.

Dālĕth.

ד had two sounds, according as it was written with or without a Dāghĕsh. ד (without a Dāghĕsh) was aspirated and sounded like Eng. th in *thine*. דּ (with a Dāghĕsh) was unaspirated and sounded like d. The modern Greeks give to this letter invariably the former sound, and the nations using the Roman character, invariably the latter.

We will represent ד aspirated by dh, (1.) because the sound of th in *thine* has the same relation to the sound of d that the sound of th in *thin* has to t; and (2.) because in this way we adopt an uniform mode of representation for all the aspirates.

Hê.

ה moveable is naturally represented by h.

ה quiescent usually quiesces in a, but sometimes in other vowels. It is treated like the other quiescents.

ה otiant is entirely suppressed.

Wāw.

ו moveable had the sound of the French ou in *oui*, or of the Eng. w in *we*, and is best represented by w. This is much nearer, than the sound of the Eng. v, to the vowel power of ו.

ו quiescent, quiesced in o and u, and is treated like the other quiescents.

The consonant power of ו (w) was probably more ancient, as in the case of א, than its vowel power (u).

Zăyĭn.

ז had the sound of the Eng. z, and is best represented by that character.

Hhéth.

ח is admitted by all to have been a strongly aspirated h, and is best represented by hh.

Têt.

ט is represented by ṭ (with a dot under it) to distinguish it from Tāw which is represented by t. The difference of sound cannot be determined.

Yódh.

י moveable was sounded like the Eng. y, and is best represented by that character.

י quiescent usually quiesced in e or i, and is treated like the other quiescents.

י otiant is entirely suppressed.

The consonant power of י (y) was probably more ancient, as in the case of א, than the vowel power (i).

Kăph.

כ had two sounds, according as it was written with or without a Dāghĕsh. כ (without a Dāghĕsh) was aspirated and had a guttural sound like the Greek χ or the German ch. כּ (with a Dāghĕsh) was unaspirated and sounded like k.

כ aspirated we will represent by kh, (1.) because in this way we adopt an uniform mode of representation for all the aspirates; and (2.) because this mode has already been adopted by De Sacy and Stuart.

Lāmĕdh, Mém, Nûn.

ל, מ, נ, present no difficulty as to their sound or the mode of representing them.

Sāmĕkh.

ס is represented by ṣ (with a dot under it) to distinguish it from Sîn which is represented by s. How these letters differed in sound is not agreed. According to Gesenius, Sĭn may have been an intermediate sound between Sāmĕkh and Shĭn. In Syriac and Arabic for the two characters only one exists, and the ancient Greeks and Romans adopted only one character.

Oăyĭn.

The sound of ע is peculiar to the Shemitish languages. The ancient Greeks had no occasion for the sound, and adopted the character to represent the vowel o. We will represent the Hebrew ע by the Roman o, because this character is ultimately derived from the Shemitish ע, and by so doing we merely restore to o its original consonant power.*

Kóph.

ק is represented by ḳ (with a dot under it) to distinguish it from Kăph which is represented by k. How these letters differed in sound is not agreed. Some suppose Kăph to have been sounded as if followed by y, as in Eng. *kind*, when pronounced *kyind*. One of these letters was rejected by the Greeks, but both were received into the Roman alphabet as k and q. We express the difference by a dot, as in the case of Sĭn and Sāmĕkh. The use of c and k, or of k and q, would lead to ambiguity, or to the supposition that we mean to designate the difference between these sounds, which we do not.

Pé.

פ had two sounds, according as it was written with or without a Dāghĕsh. פ (without a Dāghĕsh) was aspirated and sounded like ph or f. פּ (with a Dāghĕsh) was unaspirated and sounded like p.

We will represent פ unaspirated by ph rather than f, (1.) because this combination of letters is already extensively used for this purpose; and (2.) because in this way we adopt an uniform mode of representation for all the aspirates.

Tsādé, Résh.

צ is naturally represented by ts, and ר by r.

Sĭn, Shĭn.

שׂ is naturally represented by ṡ, and שׁ by s.

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* The necessity of representing ע in some way, has led Antonius ab Aquila, to employ a, De Sacy in some cases (ʿ), and Professor Stuart to use the Hebrew character itself. See De Sacy, Gram. Arabe, tome i. pp. 34, 62. Stuart's Heb. Gram. 2d, 3d, and 4th editions.

Tāw.

ת had two sounds, according as it was written with or without a Dāghĕsh. ת (without a Dāghĕsh) was unaspirated and sounded like Eng. th in *thin.* תּ (with a Dāghĕsh) was aspirated and sounded like t.

ת aspirated we will represent by th, (1.) because this combination of letters is already extensively used for this sound; and (2.) because in this way we adopt an uniform mode of representation for all the aspirates.

Kāmĕts.

The sound of (ָ) was like the open or Italian a, or the English a in *father*. This is the pronunciation of the Spanish Jews. The Jews of Tiberias, however, in ancient times, gave it a sound nearly approaching that of o. So the German and Polish Jews of the present day. But this pronunciation is thought by the learned to be incorrect, although both the figure and name of the vowel originated from it.

Kāmĕts being a long vowel, we shall represent its sound, when pure, by ā, as דָּבָר dābhār; when impure, by â, as מָצָא mātsâ, גָּלָה gālâ.*

Tsērî.

The sound of (ֵ) was like the continental e, or the English e in *vein, they*, which is the same as the English a in *fate.*

Tsērî being a long vowel, we shall represent its sound, when pure, by ē, as לֵבָב, lēbhābh; when impure, by ê, as בֵּין, bên, לֵאמֹר, lêmōr, גְּלֵה, g'lê.

Hhîrĕk gādhôl.

The sound of (ִ) was like the French i, or the English i in *machine.*

Hhîrĕk gādhôl being a long vowel, we shall represent its sound, when pure, by ī, as אַדִּרִים, aăddīrīm; when impure, by î, as דִּין, dîn, רִאשׁוֹן, rîshôn.

Hhôlĕm.

The sound of (ֹ) was that of o in *rover.*

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* It will be seen that our mode of representation does not determine, in all cases, the quiescent which is suppressed. This I regard, in most cases, as an unimportant circumstance.

Hhólĕm being a long vowel, we shall represent its sound, when pure, by ō, as יִקְטֹל, yĭktōl; when impure, by ô, as קוֹל, kôl, בֹּאר, bôr, גָּלֹה, gālô.

Shûrĕk.

The sound of Shûrĕk was like the Eng. u in *rule*.

Shûrĕk being a long vowel, we shall represent its sound, when pure, by ū, as קָטֻל, kātūl;* when impure, by û, as קָטוּל, kātûl.

Păttăhh.

The sound of (ַ) was like the Eng. a in *bat*.

Păttăhh being usually short, we shall represent its sound, when pure, by ă, as בַּיִת, băyĭth; when impure and long, by â,† as לִקְרַאת, likrâth.

S'ghôl.

The sound of (ֶ) was like the Eng. e in *men*.

S'ghôl being usually short, we shall represent its sound, when pure, by ĕ, as מֶלֶךְ, mĕlĕk; when impure and long, by ê,† as גֵּי, gê, תִּמְצֶאנָה, tĭmtsênâ, גּוֹלֶה, gôlê.

Hhîrĕk kātôn.

(ִ) is pronounced like the Eng. i in *pin*. We shall represent it by ĭ, as מִקְנֶה, mĭknê.

Kāmĕts Hhātûph.

(ָ) is always short and pronounced like the Eng. o in *son*. We represent it by ŏ, as חָכְמָה, hhŏkhmâ.

Kĭbbûts.

The sound of (ֻ) was like the Eng. u in *gull*.

Kĭbbûts being usually short, we shall represent its sound, when pure, by ŭ, as כֻּלּוֹ, kŭllô; when impure and long, by û,† as פֻּארָה, pûrâ.

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* Shûrĕk pure, it will be seen, is the same as what Prof. Stuart calls Kĭbbûts vicarious.

† The printers are necessitated, in these cases, to use the pointed instead of the curved circumflex. The latter is to be preferred.

Sh^{e}wâ.

(ְ) was a very short e, like the French e mute. We represent it by ^{e} written above the line, as קְטוֹל, k^{e}tôl.

Hhātĕph Păttăhh.

(ֲ) was a very short Păttăhh. We represent it by ^{a} written above the line, as זְהַב, z^{a}hăbh.

Hhātĕph S^{e}ghôl.

(ֱ) was a very short S^{e}ghôl. We represent it by ^{e} written above the line, as אֱלִי, a^{e}lê.

Hhātĕph Kāmĕts.

(ֳ) was a very short Kāmĕts. We shall represent it by ^{o} written above the line, as חֳלִי, hh^{o}lî.

Păttăhh Furtive.

(ַ) under a final guttural, was pronounced like a very short Păttăhh before the guttural. We represent it by ^{a} written above the line and before the final guttural, as רוּחַ, rû^{a}hh.

Tabular view of the Consonants.

Aă′lĕph	אָלֶף	א	a	Lā′mĕdh	לָמֶד	ל	l
Bêth	בֵּית	ב	bh	Mēm	מֵם	מ	m
		בּ	b	Nûn	נוּן	נ	n
Gî′mĕl	גִּימֶל	ג	gh	Sā′mĕkh	סָמֶךְ	ס	s
		גּ	g	Oă′yĭn	עַיִן	ע	o
Dā′lĕth	דָּלֶת	ד	dh	Pê	פֵּא	פ	ph
		דּ	d			פּ	p
Hê	הֵא	ה	h	Tsādhê	צָדֵי	צ	ts
Wāw	וָו	ו	w	Kôph	קוֹף	ק	k
Ză′yĭn	זַיִן	ז	z	Rêsh	רֵישׁ	ר	r
Hhêth	חֵית	ח	hh	Sîn	שִׂין	שׂ	s
Têt	טֵית	ט	t	Shîn	שִׁין	שׁ	sh
Yôdh	יוֹד	י	y	Tāw	תָּו	ת	th
Kăph	כַּף	כ	kh			תּ	t
		כּ	k				

Art. XI.—*On the Transition Rocks of the Cataraqui; by* Capt. R. H. Bonnycastle, R. En.

(Continued from Vol. XX, p. 74.)

This is the second instance wherein a new mineral has been discovered on our interesting tour over so limited a locality, and we therefore pursue our journey onward with redoubled zeal.

Coasting the border of the lake, which is now entering upon a new character and rapidly changing its great expanse of water into the thousand intricate channels of the mighty St. Lawrence, we walk, for about a quarter of a mile, or perhaps somewhat less, to the eastward, over a shore heaped with large boulders, and protected by these from the further destruction of the limestone layers, which basset out in wall-like ledges overhead, from ten to twenty feet in height, occasionally covered and hid by debris and vegetable soil, in which the juniper, the silver birch, and other stunted plants, have a precarious existence, yielding their tender limbs to the rough spray and lashings of the stormy lake.

The boulders are so thickly strown over this shore, that it is difficult to creep along it, even in calm seasons, and when the lake is high, or much vexed, almost impracticable. Suddenly, however, the bank shelves off in green sward, and a ravine or dell opens, through which meanders a streamlet, whose source is at a short distance, in the limestone rocks above; its clear and cold waters trickling from a mere cleft, and then bounding away to the lake below. This is one of the many remarkable springs, peculiar to the limestone of the Cataraqui, yielding, in the hottest weather, a chilly cold water, which tastes as though it had been iced. After quitting the soft stone quarry, I passed by another, immediately under the great well, which actually flows out of a mere chink, not an inch above the ordinary level of the lake, to receive whose wholesome beverage, so different from that of the sapid Ontario, I have hollowed out a little votive basin. Clear it of the weedy slime which so rapidly covers it, ye future travellers, and consecrate its virtues to geology!

But to return to the valley. This valley is worthy of a prolonged visit. It is small, and scarcely deserves the name given to it; but it is highly interesting, as forming a demarcation between the transition limestone and the first great visible elevation of the sienite of the Cataraqui. The stream issues forth from the calcareous beds, and coursing down the dell, over limestone, suddenly meets a low rampart of the sienite, which forms the shore of the lake. It then winds, nearly at right angles to its original course, and fairly cuts its way through the sienite, the severe frosts of winter and its own action having evidently worn it out a passage by the large fissures, most of which, in this rock, trend from north east to south west.

On the Kingston side of the valley, the limestone crops out, every where, through the soil, to an elevation of above one hundred feet, whilst, on the opposite bank, the sienite, at a short distance, throws up its wave-like rounded masses to an equal elevation, but is cut off in a precipitous wall and bank, by another sharp and deeper valley, forming the upper end of the cove.

Just before we arrive at the valley of the spring, and just before the banks begin to descend, another alternation of the hard and soft stone occurs; a small quarry, or perhaps only a slide, showing, about fifteen feet above the lake, a very thick bed of the hard stone, covering a moderate layer of the softer kind.

At the termination of the gently shelving bank of limestone, a new beach suddenly succeeds to the boulder-strewn shore; this beach is composed principally of flat limestone shingles, mixed with a few that are siliceous. We now come to the tongue of land, forming one side of the banks of the stream; here, on the point, we first see the sienite assuming its usual form and standing out in barren majesty, covered only by the lichens of ages, and shelving gently down into the lake, under whose waters it is lost. It is worthy of note, that here the beach is composed of calcareous shingle, and the rock itself, under water, is almost hidden by a great deposit of the same materials, which become finer and finer, and are mixed with siliceous gravel.

Adjoining the lakes, the sienite is broken by the frost, into cuboidal masses or boulders, and here we see very plainly, the usual fissured surface, having its lines of opening, from north east to south west, crossed irregularly by vast rents. Wherever the boulders or fissured fragments have been recently made, the bright deep vivid flesh color of the sienite is beautifully displayed.

The top of this tongue is fissured also, and heaved up into a mantle-shaped mass, on which the north east and south west grooves so common to this rock are very apparent, and very deep and smooth. Ascending farther up the hill, the limestone is evidently superimposed upon the sienite; but this is not very visible, as the rocks are covered with soil and turf.

We now pass over the streamlet, whose ceaseless currents appear to have deeply grooved the rock along the line of fissures by which they find a vent, and every winter disrupts the solid sienite, more and more, until at last its walls will yield the stream a straiter course; and, it is on this spot that we arrive at an interesting place, which merits a little scenic description.

After travelling over sienite in the first instance, sandstone in the second, and limestone in the third, we were struck with the singular freaks of nature which they presented; but it remained for us to cross a mere runnel, to enter upon a scene still more singular than any we have hitherto met with, either as regards its geological or its picturesque associations.

Standing on the summit of the bank, which hems in the farther side of the stream, we see, to the right, the apparently boundless expanse of water, forming the first of the inland seas of Canada; before us, a rugged islet, wherein the rocks are strangely intermingled; beyond that, a river four miles broad, forming the beginning of the real St. Lawrence, and bounded only by a long and fertile island, whose lands, rising to a moderate height, seven miles in breadth, conceal another broad channel of the same mighty river. To our left, ravines cut through the solid sienite, and over a low cape, a long glittering line of waters shows us the forms of several beautiful islets, which are the commencement of the Thousand Islands of that river, whose name here was Iroquois,—a name, now as much forgotten, as are the warlike dead who slumber on its banks. The strange sight of enormous steam vessels, and of still greater ships of war, at nearly a thousand miles from the main ocean, framed to navigate a Mediterranean of fresh water, adds to the grandeur and interest of the prospect; but the geologist turns with no less delight to the stranger prospect of the scene, which meets his eyes in winding round this little bank, and which we thus endeavor feebly to portray and to explain.

This first view of the sienite in the limestone, in proceeding from Point Henry towards Haldimand Cove, shows the entrance of the valley where the banks gradually decline; the deep flesh colored and almost brick red spots* being those portions of the sienite which are bared, some of them jutting out a little, others being quite even with

* Designated on the two cuts by the letter *s*.

the limestone, with which they were once conjoined; on the left, is part of the beach of calcareous and siliceous shingle, and on the right is a peculiarly large rounded mass of sienite, on which the observer may sit, resting one hand behind him on the limestone, whilst his feet are on the same rock.

The variolous aspect of this conjoined rock is fully as distinct and vivid as that of the otherwise imperfect sketch we have given above, and immediately strikes the most listless observer.

The transition limestone here alters its nature into a porphyritic rock, as the tables are composed of the usual dark calcareous matter, thickly studded, throughout their masses, with nodules and strings of quartz, which, on a polished surface, have a bluish lustre and are very beautiful. I have had some of the rock blasted on the beach, near this place, where there is a most interesting mingling of the rocks in every variety of form, which we could suppose a state of jelly or of fusion could create, and I have found the quartz penetrating the calcareous matter, in every direction, as if shot into it; amidst this mass, a few crystals of pale feldspar appear, but not numerous enough to give a decided character to the mixture. The feldspar indeed, as before noticed, appears to have a decided antipathy to the lime, as the sienite nodules which are interspersed, have, generally, a protecting coat of quartz around them, whilst the feldspar, of a bright red, remains undisturbed.

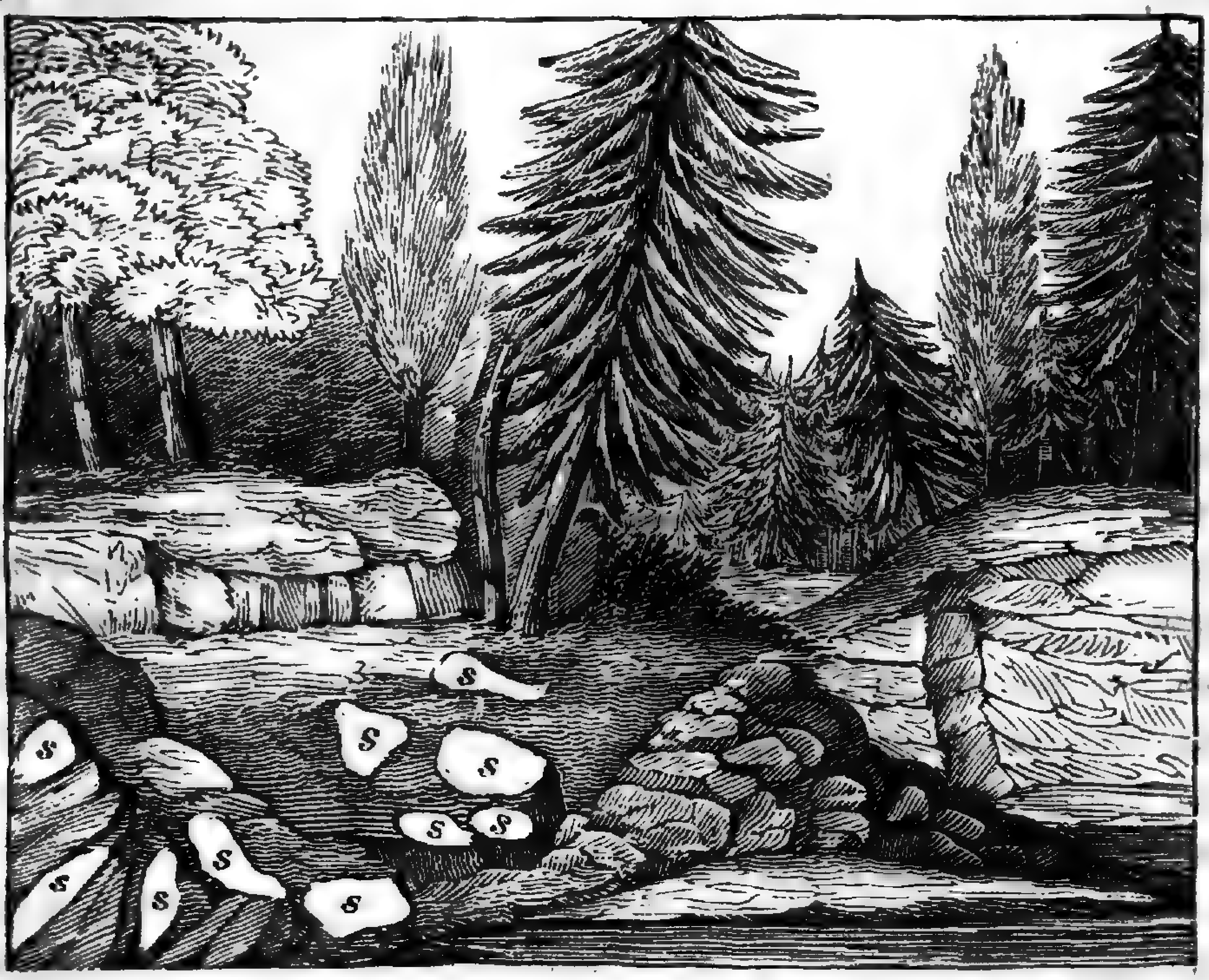
The sienite now mounts upwards into a series of undulating summits, until it attains to its greatest elevation, where its bold top, of a bright red color, bares an extensive bosom of smoothed rocks to the sun. Towards the land side, this surface is easy of access, and from the quartzose particles of the rock having resisted the storms of ages to a greater degree than the feldspar, it is at all times safe to walk over, as it is very smooth only in the long parallel channels running N. W. and S. E. by which it is so peculiarly marked. On this surface, the eye soon distinguishes a number of holes or indentations which appear as though they had been at one time the receptacles of crystals of some size, and seem not unlike those cells in which, in the sandstone, organic remains formerly reposed. The sienite is, moreover, split by the sun and frosts into extensive fissures, and where the rocks occur next to the lake, many of them have toppled down, leaving below them bold walls and a steep slope of debris and soil. These mixed with trees of the fir tribe, and of the ordinary deciduous indigenæ, form the side, a gloomy dell which running to the north east, bounds the sienite rock in this quarter, and also terminates the cove.

From the first rivulet, as above mentioned, it is somewhat difficult, excepting where there is ice, to proceed along the shore, towards this spot, as the bank is in general steep, and the beach is overspread with huge fragments of the sienite and with boulders; the occasional jutting out of the limestone may, however, be observed and for a quarter of a mile, we obtain, very frequently, the most conclusive evidence that the two rocks are in contact and form a junction.

Looking up the dell which opens from the cove, a curious scene again presents itself; to the left hand the sienite towers upward, its steep slope being covered, occasionally, by soil thickly overgrown with trees, and presents vast blocks and ranges of the disrupted rock, with occasional glimpses of the limestone.

On the right is a quarry, opened in some very thick and fine beds of the limestone, the two rocks forming the two sides of a narrow dell, and here the limestone, having been well denuded by the miners, its ancient bassets show themselves completely, their fissured and aged walls being thickly covered with a complete rough casting of minute siliceous fragments which appear, in many instances, scarcely to have penetrated the stone, here of a lighter color than usual, and extremely hard and splintery, and to which, wherever they only incrust it, they so inflexibly adhere, as not to be easily separated.

The drawing annexed is a slight sketch of this scene, which is rendered still more memorable, from the curious discovery made in consequence of the operations carried on, in an extensive quarry.



A remarkable regularity in the shape and appearance of some of the thick beds of the Cataraqui formation, which are near the water mark of Lake Ontario, had been observed for some time; but it remained for Mr. John Finch to discover and point out the singular fact that several of these beds were regularly divided into prismatic forms, by a species of huge crystallization, resembling that exhibited by basalt, but always in a horizontal position.

That gentleman, being at Kingston, and employed on a course of mineralogical lectures, naturally employed his leisure time in examining the country, and during his walks in the immediate vicinity of the town, was much surprised to find, in two or three places on the banks of the lake, that the calcareous beds near the water mark, were, to a great extent, regularly formed into almost interminable horizontal columns of an hexangular or octagonal shape, not jointed or connected by a cup and socket, as those of basalt often are, but irregularly, disunited only by occasional rents, evidently the result of the action of time, or of unequal coherency.

It would take up too large a space to describe all the appearances and localities of this new freak of nature at Kingston, the evidences of which, although highly clear and satisfactory, are so uncommon that some geologists who have seen them, are unwilling to attribute them to any other cause than weathering. Having had the opportunity of seeing them almost daily, and in many points of view not contemplated by those who entertain doubts concerning them, I am, perhaps, better acquainted than they, with their *form and pressure*, and as, in the great improvements and additions now making to Kingston, they will shortly be swallowed up or lost from our view, I shall, in my next communication, give three drawings, made with requisite care, showing them in elevation, sideways, and in their bed or floor; and, leaving to better informed geologists the task of inventing a theory from them, I shall content myself with merely stating that the beds in which they are found are those which, at Haldimand Cove, are nearly or quite in conjunction with the sienite, and on the borders of the lake are uniformly bassets, jutting out over the great gulf which contains its waters, their thickness being usually not above two or at most three feet; and in the octagons, which are the most usual forms, as at Murney's Point, the upper and lower, as well as the vertical sides are straight and almost or quite equal, whilst the angular faces are slightly concave and much less in size. The drawings, however, will give a much more correct idea of the formation than language can afford. It is probable that it is much more extensive than what has been already noticed, for, in several instances, in consequence of the very extensive series of cracks and fissures running in an opposite direction to the regular partings of the prisms which the weather and the waters have created, it can scarcely be discovered, when the observer is walking over the large flat tables of limestone on the borders of the lake, whilst frequently even an attentive observer finds it necessary to look for some time at a basset before he can discover the regular forms, either in elevation or profile, owing to the rounding away of the angles from exposure; and, in other cases, as at Haldimand Cove, the crystallization is less perfect, and to detect it, requires much examination, even in newly exposed portions from the quarry. In other cases, again, it is as plain as could be wished, as, for instance, at Murney's Point and just beyond Stuart's Point, where stands the celebrated lover's tree, which bears the poet Moore's name, and where it is said that he composed two of the most beautiful of his songs.

I had drawn these sketches purposely for Mr. Finch, and hope, as he examined very minutely into the nature of this new variety of limestone, he will still describe it, particularly, as I was unable to send the drawings to him, owing to my having been absent from Kingston on a tour to Gaspé, Anticosti, and the Labrador coast, which I trust will, when this meets his eye, excuse me from any apparent negligence in complying with his wish.

This basaltiform limestone has, however, a quality which neither that gentleman nor other attentive mineralogists had anticipated, and which renders it the third new mineral, (if I may use that term,) discovered in the transition rocks of the Cataraqui. It is an excellent lithographic stone for all the common processes of that admirable art, and is now extensively employed in the surveyor general's office at York, under the management of Mr. S. O. Tazewell, who first adapted it to this use and invented the peculiar manner of applying it, which is somewhat different from that employed on the Manheim or Bath stone. This lithographic limestone is darker than the usual beds of the Cataraqui formation, and I have not seen any fossils in it; it is very compact and hard, and, if kept at a good temperature, bears the press better than the German stone.

Canada seems to abound with limestones suitable for all the processes of lithography; a white and very pure kind has been found on Anticosti. Mr. Tazewell discovered a cream colored and very beautiful variety in the rear of Belleville, a new and rapidly increasing town on the shores of Lake Ontario, between York and Kingston, and I have every reason to believe that the true lithographic stone exists near Lake St. Clair, of which, however, I trust I shall be able shortly to speak, with more decision than hand specimens can authorize me to do.

Want of time, at present, obliges me to close this paper, which will be continued with the description of the curious amalgamation, or rather intermixture, of the limestone and sienite, and of the singular discovery of fossil organic remains in the very parts of the rock which seem, as it were, to have melted into each other.

York, Upper Canada, Jan. 1, 1833.

Art. X.—*An analytical examination of Prof. Babbage's "Economy of Machinery and Manufactures."**

An octavo volume of 320 pages on the Economy of Machinery and Manufactures has recently appeared in England, which elucidates many valuable principles, and comprehends much instruction both for manufacturers and for men of science. This work is executed with the precision of a mind habituated to scientific research, under the severe guidance of the inductive philosophy, and is such a production as we might expect from Prof. Babbage, whose name is conspicuous on the list of modern English philosophers.

The intellectual light, which within the last half century, has beamed upon Europe with such unprecedented splendor, has developed the mysterious powers of nature to the penetrating eye of the scientific inquirer; the diffusion of knowledge has enabled the ingenious mechanic to apply these newly discovered powers to his own use; and although "in the history of each article of manufacture a series of failures have occurred, they disclose an incredible amount of patient thought, of repeated experiment, and of happy exertion of genius, which have, gradually, led the way to excellence." We now look with admiration and astonishment, at the results of the application of scientific principles to matter; where the great powers of nature are brought under the control of man, which in their turn, compel inanimate and unwieldy things to work with the dexterity of thinking beings—with a rapidity far surpassing human efforts—and with a degree of skill, which, at no remote period, would have been attributed to preternatural agency. Nor, are these surprising results beneficial only to the country where they have originated. "The luxurious natives of the east, and the rude inhabitants of Africa are indebted to the looms of England," and every country in Europe and America, participates in the products of the mechanic arts, as at present conducted in the United Kingdom. "The cotton† of India is conveyed by British ships

* Since this notice has been put into type we have learned that the interesting work of Prof. Babbage has been reprinted in Philadelphia by Carey & Lea.

† Bandanna handkerchiefs, made in Glasgow, have long ago superseded the genuine ones in China and India, where they originated—dishes and utensils of the London stamp were seen by Clapperton at the court of the Sultan Bello; and at Calicut, where calicoes originated, and whence they derived their name, the market is supplied with the article from England.

round half our planet to be woven by British skill, in the manufactories of Lancashire. It is again set in motion by British capital and transported to the very plains whereon it grew and is repurchased by the lords of the soil, which gave it birth, at a cheaper price than, with their coarser machinery, they can manufacture it for themselves."*

The explanation of principles, and the detail of processes contained in this work must be extremely interesting to the American manufacturer. He will discern the differences, which exist between his own circumstances and those, whose operations he would imitate, and whether all the materials, and modes of economy, and powers and facilities, which have insured success to the foreign manufacturer are within his own compass. He will be able to decide, whether many fair and alluring appearances, may not prove fallacious, from ignorance of the minute aids, and savings, essential to secure profit; and he will see how far deviations may be practicable, and how far the resources of our own country may yield him a peculiar advantage.

In every civilized country a considerable proportion of its population will be employed in agriculture. If it be a wide country with a fine soil, a favoring climate, and ready means for transportation and export, a majority will be agriculturists; if crowded with inhabitants, and possessing but a limited territory, every inducement will urge them to procure, by other modes of industry, that which they cannot obtain from their soil. In Great Britain, all the causes which lead to excellence in manufactures, are in no common degree, combined; for, although agriculture is still the foundation of her wealth, the guarantee of its perpetuity, the pillar of her commerce and manufactures—yet with a dense, and when compared with the other countries of Europe, an educated population, and *a stable government*, their enterprise and success in manufacturing industry have been unparalleled.

The following table will show the ratio of the manufacturing to the agricultural classes in England, Italy and France:

	Agriculturists.	Non-agriculturists.
"In Italy, - -	100	31
France, -	100	50
England, - -	100	200

and the proportion of non-agricultural to agricultural persons in Great Britain is, continually, increasing. In three different periods of ten years, during each of which the general population of the country has

* See p. 4, Economy of Machinery and Manufactures.

increased thirteen per cent., the increase in the five large manufacturing towns of Manchester, Glasgow, Liverpool, Nottingham, and Birmingham, in the whole period of thirty years, has been one hundred and twenty three per cent." How far the disproportion between the agricultural and manufacturing classes can be carried, with safety, either to individuals or to the state, is a problem, which must soon be solved by the future progress of their history in Great Britain.

It is remarked by M. Say, that "*the complete inviolability of property, whether by public or private attack, and the habitual exercise of attention and judgment to which her people are trained from the earliest years, are the predominating causes of the manufacturing prosperity of England.*"

To return to the work which is named at the head of this article; Mr. Babbage says, "the fact, that England can undersell other nations seems to be well established: and it appears to depend on the superior goodness and cheapness of those raw materials of machinery, the metals—on the excellence of the tools—and on the admirable arrangements of the domestic economy of the manufactories."

The object of the author is "to point out the effects and the advantages, which arise from the use of tools and machines; to classify their modes of action; and to trace both the causes and consequences of applying machinery to supersede the skill and power of the human arm."

The work is divided into two sections—the first treats of tools and machinery, illustrating, by examples, the principles which direct their use; the second, considers some questions of political economy relating to the subject of manufactures.

It is believed, that a brief analysis of so meritorious a work, will be eminently useful to the American artisan, and hardly less accept able to the man of science.

In tracing the advantages derived from machinery, Mr. Babbage says, that they seem to arise, principally, from three sources.

"1st. Addition to human power.

"2nd. The economy they produce of human time.

"3rd. The conversion of substances apparently worthless into valuable products.

"1st. *Of addition to human power.*

"Beside the forces derived from wind, water and steam, there are other sources of increase, by which the animal force of the individual is itself made to act with far greater than its unassisted powers.

"At each increase of knowledge, as well as on the contrivance of a new tool, human labor becomes abridged; the man who contrived rollers, invented a tool, by which his power was quintupled. The workman, who first suggested the employment of soap or grease, was immediately enabled to move, without exerting a greater effort, more than three times the weight he could before."

The advantage of mechanical assistance will appear from the following experiment related by M. Redelet, *sur l'Art de Bâtir.*

"1st. A block of squared stone, weight - - - - - 1080 lbs.

"2nd. In order to drag this stone along the floor of the quarry, roughly chiseled, it required a force equal to - - - - - - 758

"3rd. The same stone dragged over a floor of planks required - 652

"4th. The same stone placed on a platform of wood and dragged over a floor of planks, required - - - - - - - 606

"5th. After soaping the two surfaces of wood, which slid over each other, it required - - - - - - - - 182

"6th. The same stone was now placed upon rollers of three inches diameter, when it required to put it in motion, along the floor of the quarry, - - - - - - - - 34

"7th. To drag it by those rollers over a wooden floor, - - 28

"8th. When the stone was mounted on a wooden platform, and the same rollers placed between that and a plank floor, it required - 22

"From this experiment it results, that the force necessary to move a stone along the roughly chiseled floor of its quarry, is nearly two thirds of its weight—to move it along a wooden floor, three fifths; by wood upon wood, five ninths; if the wooden surfaces are soaped, one sixth; if rollers are used on the floor of the quarry, it requires one thirty second part of its weight; if rolled over wood, one fortieth; and if between wood, one fiftieth of its weight."

The erection of palaces and temples,* monuments and tombs, seems to have engaged the early attention of nations; and the mode of removing, from their native repositories, those immense blocks of stone which minister to the grandeur or piety of the builders, has, through ages, and to the present day, remained a subject of astonishment. The manner of applying the different degrees of force necessary to move those ponderous masses, and to elevate them to the summit of the pyramids, or of the temple of Belus, is beyond the limit of conjecture; their artificers must have possessed mechanical knowledge, of which their history contains no record.

An interesting discovery, which was made by Champollion, a few years since, in Egypt, of an ancient Egyptian drawing, may throw some light upon this subject. "A multitude of men appeared harnessed to a huge block of stone, on the top of which stood a single individual with his hands raised above his head, apparently in the act of clapping them, for the purpose of insuring the exertion of their combined force at the same moment of time."

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* See page 6, Economy of Machinery and Manufactures.

In later times, also, sound has been employed to enable men to unite their efforts at a given point. "In removing the vast mass of granite, weighing above twenty eight thousand pounds, on which the equestrian staute of Peter the Great is placed, at St. Petersburgh, a drummer was stationed on its summit to give the signal for the united efforts of the workmen."

"*The economy of human time*" is an advantage, second only to "*the addition to human power*," which machinery gives to manufacturers. The use of gunpowder in blasting rocks, and of the diamond in cutting glass, offers familiar examples of the economy of time. In the former, effects are produced in a short space of time, which could not be accomplished, even with the best tools, in many months.

An important improvement has been made in the art of using the diamond, which twenty years since, even after seven years' apprenticeship, many glaziers were but indifferently skilled in. "This arose from the difficulty of finding the precise angle at which the diamond cuts, and of guiding it at the proper angle, when found." In the improved tool, the gem is set in a small piece of squared brass, with its edge nearly parallel to one side of the square. A person, skilled in its use, files away one side of the brass until, by trial, he finds that the diamond will make a clean cut, when guided by keeping this edge against the ruler. Thus the merest tyro, at once applies the cutting edge at the proper angle.*

"The relative hardness of the diamond in different directions is a singular fact. An experienced workman ground one on a cast iron mill with diamond powder for three hours, without its being at all worn, but on changing its direction with reference to the grinding surface, the same edge was quickly ground down."

3rd. The advantage of machinery and manufacturing is, most strikingly, obvious, in *the saving of materials, apparently worthless.* Nothing can seem of less value than the worn out remnants of tin ware, the offals of animals and the sweepings of workshops, and yet such is the result of economy and science, that nothing is lost, but the products of little intrinsic value are made valuable by the skill of the manufacturer.

"Gold-beater's skins are made of animal offal. The hoofs and horny refuse of cattle are employed in the production of prussiate of potash, that beautiful yellow crystallized salt, which is exhibited in the shops of chemists. The worn out sauce pans, tin ware, and coal scuttles, when beyond the reach of the tinker's art, have not completed their useful course. Their less corroded parts are cut into strips, punched with

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* See page 9, Economy of Machinery and Manufactures.

small holes, and varnished with a coarse black varnish, for the use of the trunk maker, who protects the edges and angles of his boxes with them; the remainder are consigned to the manufacturing chemists, who employ them, in conjunction with pyroligneous acid, in making a black dye for the use of calico printers."

Of tools.—A tool is a ready assistance to the human hand, by which it is chiefly used. There are multitudes of things which it would be impossible to make, by the unaided efforts of the hands, but add to them the rudest instruments, and their power is enlarged; with improved machinery their power becomes still farther extended, and in their applications, various almost beyond the limits of calculation. By placing a tool in a frame, it becomes a machine, and the combination of many tools in a machine requires an accumulation of power proportioned to its weight, and the forces it is designed to communicate. The powers of wind and water have long been applied to mechanical purposes, generally in aid of animal exertion, although in some instances, they nearly supersede it. Steam, another fertile source of moving power, when regulated and directed to machinery, possesses singular advantages, and produces effects unattainable by other methods.

But it is not alone in the moving of tools and machinery in the work shop, that *economy* of power should be practised in order to secure profit. Every one who examines this subject must be surprised to find how much success, in every department of the arts, depends upon a due application of this principle. Mr. Babbage gives an example in point, relating to the expense of transport.

"When a mass of matter is to be removed, a certain amount of force must be expended, and upon the economy of this force, the price of transport will depend. For instance, the cotton of Java is conveyed in junks to the coast of China; but from the seed not being previously separated, three quarters of the weight thus carried is not cotton. This might, perhaps, be justified in Java by the want of machinery to separate the seed, or by the relative cost of the operation in the two countries. But the cotton, as packed by the Chinese, occupies three times the bulk of an equal quantity shipped by Europeans for their own markets. Thus the freight of a given quantity of cotton costs the Chinese nearly twelve times the price, to which, by a proper attention to mechanical methods, it might be reduced."

This statement suggests the immense value of the cotton gin, invented by the late Mr. Whitney, of New Haven, which may, in some degree, be compared with the steam engine, in the extent of its usefulness. Cotton is now so universally used for clothing, that whatever reduces its cost, is a benefit to the whole family of mankind. When it is estimated, that the seed, before it is separated from the cotton, makes three quarters of the weight of the article; and that it requires the hand labor of one person for an entire day to clean one pound fit for the manufacturer,* while the same individual, by the aid of the cotton gin, can clean one thousand pounds in the same space of time—language is scarcely adequate to convey a full idea of its value. Mr. Whitney says in his application to Congress in 1812, that his cotton gin "*as a labor saving machine would enable one man to perform the work of a thousand men.*"

"*Accumulating power.*"—Under this head, the author describes the fly wheel and the sledge hammer. The fly wheel, constructed with a heavy rim, has the weight near the circumference; and when moving with considerable velocity, produces powerful effects. It is usefully employed in increasing the force for rolling iron, perforating iron plates, &c. &c.

The power of the hammer consists in raising a weight and letting it fall, and increases in the ratio of its weight and the distance, through which it falls.

Regulating power.—"Uniformity and steadiness, in the rate at which machinery works, are essential to its effect and duration." The contrivance which governs the steam engine, controlling its fearful rapidity, producing uniformity and steadiness in its movements, is a beautiful example of *the regulating power.*

It is on the same principle, that the water power is regulated, which drives the spinning-jenny, raises timber at the dock-yard, and supplies fuel in particular furnaces.

"*Advantage of velocity.*"—"Whenever work is light, it becomes necessary, in order to save time, to increase velocity. The proportion between the velocity, with which men and animals move, is of considerable importance. It is also of great importance for the economy of labor, to adjust the weight of that part of the animal's body, which is moved, to the weight of the tool it urges, and the frequency of repetition of these efforts so as to produce the greatest effect."

Twisting the fibres of wool by the fingers would be a most tedious operation. In the common spinning wheel, velocity is increased by a simple contrivance, which is common to a multitude of machines, such, for example, as the machine for winding cotton balls, ribbons, &c. &c. But the economy resulting from the increase of velocity, is more striking in the larger and more important machines.†

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* Vide Memoir of Mr. Whitney, by Prof. D. Olmsted, p. 208, vol. xxi of this Journal.
† Economy, &c. p. 26.

In converting cast into wrought iron, it is of importance, that the mass of softened metal should receive the greatest possible number of strokes before it cools; but as the momentum of the hammer, derived merely from the space through which it falls, would consume much time, the velocity is increased by throwing the hammer up with a jerk, against a large beam, which acts as a powerful spring, and drives it down with such force and rapidity as to make double the number of blows in a given time. "The smaller tilt hammers are made to rebound with such velocity, that from three to five hundred strokes are made in a minute."

There is also, in *extending the time of the action of forces*, a very great advantage, e. g. the winding up of a clock, or watch, extends the action of the original force for hours and days. Small machines set in motion by springs, with a train of wheels, are employed in magnetic and electric experiments, to produce a rotatory motion of a metallic disk or other body, thus giving the experimenter the unimpeded use of his hands. The domestic smoke jack is a familiar illustration of this principle. A similar apparatus is sometimes applied to polish minerals, and in certain chemical processes, to agitate a solution.*

Machinery is also employed to save time in natural operations. An accelerating process in tanning was long a desideratum. In the old method, it required two years for the tanning principle to become so thoroughly combined with the animal fibre, as to make firm and durable leather.

"The improved process consists in placing the hides with a solution of tan in close vessels, and then exhausting the air. The consequence of this is to withdraw all the air contained in the pores of the hides, and to employ the pressure of the atmosphere to aid capillary attraction in forcing the tan into the interior of the skins. The effect of the additional force, thus brought into action, can be equal only to one atmosphere, but a further improvement has been made. The vessel containing the hides is, after exhaustion, filled up with a solution of tan: a small additional quantity is then injected with a forcing pump. By these means, any degree of pressure may be given, which the containing vessels are capable of supporting, and it has been found, that the thickest hides may thus be tanned in six weeks or two months."

In noticing the practical value of science to the arts, the beautiful and improved process of bleaching with chloride of lime, although more of a chemical than of a mechanical operation, can scarcely be passed in silence.

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* Economy of Machinery, p. 28.

"Amongst the natural processes, which are perpetually altering the surface of our globe, there are some which it would be desirable to accelerate. The wearing down of the rocks, which impede the rapids of navigable rivers, is one of this class. A very beautiful process for accomplishing this object has been employed in America. A boat is placed at the bottom of the rapid, and kept in its position by a long rope, which is firmly fixed on the bank of the river near the top. An axis having a wheel similar to the paddle wheel of a steam-boat fixed at each end of it, is placed across the boat, so that the two wheels and their connecting axis shall revolve rapidly, being driven by the force of the passing current. Let us now imagine several beams of wood, called stampers, shod with pointed iron, fixed at right angles on the ends of strong levers, projecting beyond the bow of the boat. The levers being at liberty to move up and down, the action of the stream upon the wheels will keep up a perpetual succession of blows. The sharp pointed shoe, striking upon the rock at the bottom, will continually detach small pieces, which the stream will immediately carry away. Thus, by the mere action of the river itself, a constant and most effectual system of pounding the rock at its bottom is established. A single workman, by the aid of a rudder, may direct the boat to any part of the stream; and when it is necessary to move up the stream, as the channel is cut, he can easily cause the boat to advance by means of a capstan.* When the object of this machinery has been accomplished and the channel is sufficiently deep, a slight alteration converts the apparatus to another purpose, almost equally advantageous. The stampers and projecting pieces on the axis are removed, and a barrel of wood or metal surrounding part of the axis, and capable at pleasure of being disconnected from the axis itself, is substituted. The rope, which hitherto fastened the boat, is now fixed to the barrel, which being attached to the axis, begins to turn, and winding the rope upon itself, the boat is gradually drawn up against the stream, and may be employed as a tug-boat for vessels which ascend the rapid. When the tug-boat reaches the summit, the barrel is released from the axis, and friction being applied to moderate its velocity, the boat is allowed to descend."

"The economy of applying the power of steam to overcome resistances, which it would require a far greater expense to surmount by animal power, is of frequent occurrence in large manufactories. The twisting of the largest cables, the rolling, hammering, and cutting of large masses of iron, the drawing of wires, all require enormous exertions of physical force, continued for considerable periods of time. When the force required is great, and the space through which it is to act is small, other means are adopted. The hydraulic press of Bramah, by the exertion of one man, can produce a pressure of 1500 atmospheres, and with such an instrument a hollow cylinder of wrought iron, three inches thick, has been burst. In rivetting the iron plates to form steam-engine boilers, it is necessary to produce as close a joint as possible. This is accomplished by using the rivets red hot: while they are in that state, the two plates of iron are rivetted together, and the contraction which the rivet undergoes in cooling draws them together, with a force which is only limited by the tenacity of the metal of which the rivet itself is made.

"It is not alone in the greater operation of the engineer or the manufacturer, that those vast powers, which man has called into action by the agency of steam, are fully developed. Wherever the individual operation, demanding little force for its own performance, is to be multiplied in almost endless repetition, commensurate power is required. It is the same "giant arm, which twists the largest cable, that spins

* This machine would be very convenient to open passages through the ice for steam boats.

from the cotton plant an almost gossamer thread." Obedient to the hand, which called into action its resistless powers, it contends with the ocean and the storm, and rides triumphant through dangers and difficulties unattempted by the older modes of navigation. It is the same engine, that in its more regulated action weaves the canvass, which it may one day supersede; or with almost fairy fingers, entwines the meshes of the most delicate fabric, that adorns the female form."

A great advantage is derived from machinery "in *Registering Operations.*" To count the endless numbers of coins struck in a press, or the turns of a wheel, is a wearisome occupation, consuming much time and labor. An instrument for registering is used in some establishments for calendering and embossing calicoes, where there are many hundreds of thousands of yards delivered weekly; and as the price paid for the process is small, the time spent in measuring them and taking the account would absorb the profit. The machine measures and registers the goods as they pass rapidly through the hands of the operator. Erroneous counting is also thus avoided.

The ingenious instrument called a *tell-tale*, connected with a clock, to ascertain the vigilance of a watchman, is a very useful piece of mechanism. It is so arranged, that if a man does not pull a string at a certain part of his round, his neglect is exposed by the machine.*

The advantage of machinery is also great in "*economising the materials employed.*"

"The earliest mode of cutting a tree into planks, was by the use of the hatchet or adze." It must first have been split into parts, and then hewn to its proper breadth and thickness. Much of the raw material was wasted by this process; probably more than half. The saw reverses the process, and in converting a tree into planks, it wastes but a small part. In order to economise still further, a machine consisting of a system of blades has been contrived for cutting veneer from the precious woods, in continuous shavings, thus rendering the whole timber available.

Another instance of the saving of materials is noticed by Mr. Babbage, in the improvements made within twenty years in the printing press. In the old methods, much ink was lost by forming a harden-

* See p. 40, Economy of Machinery, &c. Analogous, in some degree, to this, is a contrivance employed by the millers at the tide-mills in this country. A gate is so fixed in the mill-flue as to be raised by the tide to the precise point, where the water is sufficient to set the mill at work: this is connected with a wire, which is conducted from the mill to the miller's house, on the top of high posts. The jar upon the wire rings a bell, which summons the miller to his duty, at the moment when the tide serves.

ed crust on the edges of the block. The consumption of ink by the new system of machine printing, is to that by the balls, or old method, as four to nine, or rather less than half. There is a saving, also, in the disuse of "the set-off sheet," which, in the old mode, received every printed sheet, to guard it from being soiled, and to absorb the superfluous ink. In the best kind of printing, in the old method, it was necessary to change it once in twelve times, as it became too much soiled for further use. In the new, a blanket is employed as a substitute, and so little in amount is the superfluous ink, that it is changed only once in two thousand, and in common printing once in five thousand times.*

"The *accuracy* with which machinery executes its work, is one of its important advantages," but equally important is the saving of time; for improved tools increase the quantity of work performed in a given time. It would require a long time for a skilful workman with files and polishing substances to form an accurate cylinder of a piece of steel, but by the use of the lathe and the sliding rest, it is quickly and cheaply accomplished. The art of turning is one of the most beautiful processes, and, with the exception of copying, is perhaps one of the most accurate of mechanical operations: for example, if the top of a circular box is to be made to fit over the lower part, it may be done by gradually advancing the tool of the sliding rest until the proper degree of tightness between the box and the lid is ascertained. After this adjustment, if a thousand boxes are made, no additional care is required; the same identity pervades them all. Equally exact are all the arts of printing. The impressions to the most minute traces in the same block or copper-plate, have a similarity, which no labor could produce by hand.

The author's estimate of the value of copying in the arts, will be seen from the following extracts, which, although abridged, are principally in his own language.

A principle which pervades a large portion of all manufactures, and one upon which the cheapness of the articles produced seems greatly to depend, is *copying*, taken in its most extensive sense. Almost unlimited pains are, in some instances, bestowed on the original, from which a series of copies is to be produced; and the larger the number of these copies, the more care and pains can the manufacturer afford to lavish on the original. It may thus happen, that

* See p. 47, Economy of Machinery.

the instrument or tool actually producing the work, shall cost even five or ten thousand times the price of each individual specimen of its power.

Operations of copying are effected, by printing from cavities; by printing from surface; by casting; by moulding; by stamping; by punching; with elongation; and with altered dimensions.

The art of printing, in all its departments, is essentially an art of copying. Under its two great divisions, from hollow lines, as in copper-plate, and from surface, as in block printing, are comprised numerous arts. Printing from cavities comprises copper-plate and steel-plate engravings, music printing, calico printing from cylinders, and printing from perforated sheets of metal, or stencilling.

The second department, i. e. printing from surface, is of more frequent application in the arts, and comprehends printing from wooden blocks, from movable types, from stereotype, calico printing from blocks, printing oil cloths, letter copying, printing on china, lithograph and register printing.

Before proceeding to the consideration of any of the other modes of copying, the manner of forming the pattern or block for surface printing and lithograph, will be quoted in the words of the author.

"A block of box wood is the substance out of which the pattern is formed; the design being sketched upon it, the workman cuts away, with sharp tools, every part except the lines to be represented in the impression. This is the reverse of engraving on copper, on which every line to be represented is cut away. The ink, instead of filling the cavities cut in the wood, is spread upon the surface, and is thence transferred to the paper. In lithographic printing, the original is a drawing made on a stone of a slightly porous nature; the ink employed for tracing it, is made of such greasy materials, that when water is poured over the stone, it shall not wet the lines of the drawing. When a roller covered with printing ink, which is of an oily nature, is passed over the stone, previously wetted, the water prevents the ink from adhering to the uncovered portions; whilst the ink used in the drawing is of such a nature, that the printing ink adheres to it. In this state, if a sheet of paper be placed upon the stone, and passed under a press, the printing ink will be transferred to the paper, leaving the ink used in the drawing still adhering to the stone.

"A few years ago, one of the Paris newspapers was reprinted at Brussels, as soon as it arrived, by means of lithography. Whilst the ink is yet fresh this may be easily accomplished. It is only necessary to place one copy of the newspaper on a lithographic stone; and by means of great pressure, applied to it in a rolling press, a sufficient quantity of the ink will be transferred to the stone. By similar means the other side of the newspaper may be copied on another stone, and these stones will then furnish impressions in the usual way."

Of "copying by casting," an art so extensively useful, and yet so familiarly understood, no illustration need be quoted in this place, except one, which is so extremely new and curious, that it cannot fail to be interesting.

"A beautiful mode of representing small branches of the most delicate vegetable productions in bronze, has been employed by M. Chantrey. A small sprig of the fir tree, a branch of holly, a curled leaf of broccoli, a vine leaf and tendrils, or any other vegetable production, is suspended by one end, in a cylinder of paper, which is placed for support within a similarly formed tin case: the finest river silt, carefully separated from all the coarser particles and mixed with water, so as to have the consistency of cream, is poured into the paper cylinder, by small portions at a time, carefully shaking the plant a little each time, in order that every vein and curl in the leaf may be covered, and that no bubbles of air may be left. The plant and mould are now left to dry, and the yielding nature of the paper allows the loamy coating to shrink from the outside. When this is dry, it is surrounded by a coarser substance; and finally, we have the twig, with all its leaves, imbedded in a perfect mould. This mould is carefully dried, and then gradually heated to a red heat. At the ends of some of the leaves or shoots, wires have been left to afford air holes by their removal, and in this state of strong ignition, a stream of air is directed into the hole formed by the end of the branch. The consequence is, that the wood and leaves, which had been turned into charcoal by the fire, are now converted into carbonic acid by the current of air, and after some time the whole of the solid matter of which the plant consisted is completely removed, leaving a hollow mould, bearing on its interior all the minutest traces of its late vegetable occupant. When this process is completed, the mould being still kept at nearly a red heat, receives the fluid metal, which by its weight drives out, through the holes, any air, which, at that high temperature, may remain behind."*

Of "*copying by moulding*," many examples are cited by the author, illustrative of the methods and advantages of this branch of the arts, from the humble brick and tile, to the costly mouldings employed by the jewellers, and the curiously embossed work upon porcelain. Many of the splendid dwellings in our own metropolitan cities, are indebted to this art, for the beautiful cornices, which ornament their apartments.

"*Copying by stamping*," comprises the modes of coining and striking medals, making ornaments for military accoutrements, &c. &c.

It would exceed the limits of this paper to make further extracts from this part of the work, but the author treats, successively, of copying by punching, of wire drawing, of rose engine turning, of copying dies, of the pentegraph, and finally of copying by stereotype plates, which are themselves castings, made in moulds formed by movable types, "those obedient messengers of the most opposite thoughts and conflicting theories"—all showing that the principle of copying is an important auxiliary to cheapness and uniformity in the mechanic arts.

Having thus glanced at the principles, which impel and regulate mechanical operations, the author proceeds to consider the economy, which governs the application of machinery, and the polity, or in-

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* The author does not inform us in what way the mould may be made available for more than one casting.

terior detail of British manufactories, as being of equal, if not greater importance to the prosperity of commerce, and the welfare of the State, than even the perfection and extent of their manufactures. Although they have arrived, by the excellence of their machinery and the skill of their artisans, at a great degree of perfection, yet it is owing to this vigilant economy, that they can afford their products at so cheap a rate, as to command the markets of all the world, except such as are closed against them by a restrictive policy.

The first object of a manufacturer is, or ought to be, the perfection of his products—the second, so to manage his concerns as to afford them, at the cheapest possible price. By the first, he secures a market, and by the second, an extensive market, i. e. if the goods are of the best quality, they will secure purchasers, and if cheap, more purchasers can afford to buy and more goods will be sold. If then the seller makes a profit on capital, it will increase in the ratio of sales. The cheaper the article is, the larger will be its list of consumers, and the greater probability will there be of its becoming a necessary of life, of its not falling into disuse, and, consequently, of its affording a desirable and profitable employment.

Competition is another and compelling stimulus to produce goods with the least cost; for dear goods, of equal quality, will be driven from the market, and supplanted by the cheaper commodity.

So low is the rate of profit upon capital in the manufacturing interests of Great Britain, since the introduction of machinery, that a manufacturer has many points to ascertain, relative to the facilities of which he may avail himself, and the various modes of economy he can practice, before he can, prudently, invest capital in such an enterprise. In this country it would be still more essential, that he should learn whether the location is favorable, i. e. if he employs steam, whether fuel is near and plentiful—whether the metals for his machinery are at hand—whether the raw materials for his work are cheap and abundant—whether the part of the country, its temperature, its predominating dryness or humidity, are suited to the goods which he intends to produce—and whether a ready market, with cheap and easy modes of transportation, is at hand. These questions being settled, he has to regulate the interior details, where, if his mechanical operations are not conducted with the utmost skill, if every possible saving is not made, and the most rigorous economy enforced, his hopes will be disappointed, and his exertions will fail. So thoroughly has the system of economy been tested in every department of the arts—

so keenly has every invention and improvement, and saving been applied, that any oversight or neglect, will be followed by ruinous consequences.

It is a great and obvious advantage to iron workers to be near a colliery, and near a smelting furnace, where the iron, beginning from the ore, is carried from one furnace to another, and from one shop to another, until it comes out of the manufacturer's hands in its perfect forms, ready for the market. Thus similar facilities in any department of the arts reduce the cost to the producer.

Making goods *in large quantities* is another source of profit; as is working night and day, which is practised in some large manufactories.

Mr. Babbage gives the following fact, illustrative of the less cost of making large than small quantities.

"The Navy Board applied to Mr. Maudsley to make iron tanks for ships, which he was rather unwilling to do, considering it out of his line: however, he undertook one as a trial. The holes for the rivets were punched by hand punching with presses, and the sixteen hundred and eighty holes, which each tank required, cost 7*s*. The board, who required a large number, proposed, that he should supply forty tanks a week, for many months. The magnitude of the order made it worth while to commence manufacturer, and to make tools for the express business. He therefore made tools, by which the expense of punching the rivet holes, of each tank, was reduced from 7*s*. to 9*d*.: he supplied ninety eight tanks a week for six months, and the price charged for each was reduced from £17 to £15.

The influence of durability, of supply and demand, and of the *quality* of the article contracted for, further modifies the price of it to the consumer.

Price is, usually, measured by gold and silver; but they are subject to some variations, such as differences in the cost of the metals at different times, and the irregular distribution of specie. They are objected to as a standard of value, by the author, who suggests several modes of estimate, but they are elaborate and liable also to objections. A distinct understanding of the character of specie may be premised as a reason why it should be made the criterion of value in preference to "*an agricultural laborer's days work*," or any other unit recommended by the political economists. It is but a short time since the doctrine was current, that specie constituted individual and national wealth; and that returns for export in other shapes of property, was a national loss. The reason why it was thought of so sacred a character, was the fact of its representing the value of all other things, and its apparent control over every thing, enabling the possessor to obtain by it whatever he wished for. Its durable nature, and its scarcity led men to mistake the effect for the cause, and to deem it the standard of safety and happiness, as it was of *utility and value.* This latter is its true estimate. It is the criterion of value—and the medium, wherewith wants may be supplied, pleasures purchased, and property preserved. It represents houses, lands and ships without defect of title, or risk; it may be laid up as a future provision for the real wants of life, or the unreal fancies of the imagination, and will neither perish nor go out of fashion. It is in universal request—it sets in motion the labor saving machine, and sustains the manufactory, it procures with equal certainty, a blanket for a peasant or a diadem for a prince. This versatility of power led men to view it as possessing, inherently, those advantages which it only procures.* The fact, that it will procure them, constitutes its intrinsic value, and its utility stopping at that point where it is made a standard, it can never rise far above or fall much below its *par value.* It is this comparative immutability, which in all countries, makes it a standard of value less subject to change than any other.

The irregular distribution of specie is the principal cause of its variation. When it becomes scarce in any country, from the ordinary transactions of commerce, a small rise upon its nominal value, will occasion its speedy return to a market, whence it was withdrawn, until it declines to its par value.

Nor can its scarcity and high value in time of war, invalidate the argument. The high price, which "an agricultural laborer" might command on the plains of depopulated Poland, would equally affect the unit proposed as a standard by Mr. Malthus. In such cases, all standards are set aside—right and order lose their hold upon men—the foundations are upturned, and laws and the accepted opinions of long ages are then of no force. But as a standard for estimating values, allowing for the variations, none, it is believed, so convenient, or approximating so nearly to a permanent and fixed criterion, has yet been employed, as gold and silver coin.

Although the standard for comparing values, at distant times, may not be mathematically exact, yet it is evident, that there has been a great diminution in the cost of manufactured products, compared with former ages, as well as with more modern times. The wife of the Emperor Aurelian besought him to purchase for her a robe of purple silk, which he refused, because it would cost more than twice

* The precious metals have a high value from the use made of them in the arts, either of utility or ornament; but it is believed that at no time has the demand for them in the arts raised their value materially.

its weight in gold. About the same period, the Romans received cambrics from Elis, which were sold for "their full weight of gold."* But the limits of this notice forbid any further allusions to antiquity, although the history of the progress of manufactures would be one of extreme interest.

From several tables, of the accuracy of which Mr. Babbage has taken pains to assure himself, it appears, that the reduction in price since 1812 has been from forty to sixty, and, in some instances, eighty five per cent., on various articles. He remarks, that

"The extent to which manufacturing can be carried, and yet a profit be realized, is astonishing, and is proved by the following fact. Twenty years since, a brass knob for the locks of doors, was made at Birmingham, for 13*s.* 4*d.* per dozen. The same article is now manufactured, with the same weight of metal, and an equal or superior finish, for 1*s.* 9¼*d.* per dozen. One circumstance, which has produced this economy in the manufacture is, that the lathe, on which these knobs are finished, is turned by a steam engine; so that the workman, now relieved from that labor, can make them twenty times as fast as he did formerly."

Several causes have contributed to diminish prices, within the last half century. The most influential have undoubtedly been the invention of cheaper modes of manufacturing, arising from improved machinery, and division of labor; and also, on a less rate of profit on capital, however employed.†

Division of labor has eminently contributed to this result. In *the division of labor,* no time is lost in going from one process to another, or in changing and adjusting tools; a greater degree of dexterity is acquired by constant attention to one process, and the muscles, exercised in it, obtain a flexibility and a capacity for fatigue, which they could not, if continually changing their motions. A frequent repetition of the same process produces, also, a degree of excellence and rapidity otherwise unattainable. As an instance of this remarkable celerity, Mr. Babbage states, "that a clerk of the Bank of England signed his name, consisting of seven letters, including the initial of his christian name, five thousand three hundred times, during eleven working hours, and arranged the notes he had signed in parcels of fifty each."

A further advantage arises from the employment of just such persons as are adapted to the different processes. For example, ten persons are occupied in manufacturing pins, and they are paid in the joint ratio of their skill and the time employed, from six shillings

* Annals of Commerce. † See p. 34, Economy of Machinery, &c.

to six pence per diem. Now it is obvious, that if a man, who is qualified to perform a more difficult process worth six shillings per day, spends a part of his time in a process which can be done by a child for six pence, he must either lose the difference of wages for the time so occupied, or the pins must be set at a higher price for his compensation.

From an analysis, given by Mr. Babbage, it appears, that it takes ten persons seven hours and a half to make a pound weight of pins, and that if one person, qualified to perform the most difficult parts, were to do the whole work, the pins must cost three times and three quarters as much as they do under the present system.

Division of labor has been carried to the greatest extent in watch-making. It was stated before a committee of the House of Commons, "that there are one hundred and two distinct branches of this art, and that the watch finisher, whose business it is to put together these scattered parts, is the only one of the one hundred and two persons, who can work in any other department than his own."

Another consequence of the economy arising from division of labor, has been *the establishment of large manufactories.* To consider the steps by which they become extended, may not be without interest. In any of the arts, labor not economically applied, will enhance the cost of the article, and if the material for the manufactured article, in the several stages of its progress, must be conveyed from one operator to another, it can be done at the least expense, when they are all working in one establishment. A demand for the article produced, causes the introduction of steam and other machinery, which greatly increases the quantity of the product. The proprietor having invested considerable capital in machinery, finds that he can increase his profits, by a small addition of floating capital, in working it night and day. Working the machines night and day, renders it necessary that a person should admit the workmen when they relieve each other, and his rest would be no more disturbed by admitting a large than a small number. The good performance and duration of machines depend much on repairing every "shake," or imperfection, or injury, as soon as it appears; and a workman accustomed to machine making, will adjust or make repairs better than any other, and by being resident on the spot, will reduce the expense of the wear and tear of the machinery. A single machine could not warrant so great an expense; therefore, the manufactory should contain enough of machines to employ the whole time of a machinist to keep them and the steam engine in order. One of the first effects of these arrangements is, that one workman can do four times as much work as he could do before, because the power of steam drives so much faster than human force. The manufactory, having become so much enlarged, and there being already attached to the establishment persons who are up all night and can attend to it constantly, and also engineers to make and repair machinery, the making of an apparatus for gas, to light the manufactory, introduces a new extension, which, by diminishing the expense of lighting and the risk of accidents by fire, reduces, yet farther, the cost of manufacturing. Long before a manufactory has reached this extent, it will have been found necessary to establish an accountant's department, with clerks and agents to purchase the raw materials and to sell the manufactured products. Thus, by the division of labor and the application of machinery, the greatest economy of power and skill prevails—the quantity of work is greatly augmented—and the result is, a great reduction in the cost of the article, which is brought to market.*

"The establishment of the Times newspaper in London, is an example of a manufactory on a large scale, in which the division of labor, both mental and bodily, is admirably illustrated, and in which, also, the effect of the domestic economy is well exemplified. It is scarcely imagined, by the thousands who read that paper in various quarters of the globe, what a scene of organized activity the manufactory presents, during the whole night, or what a quantity of talent and mechanical skill is put in action for their amusement and information.†

"Nearly a hundred persons are employed in this establishment; and during the session of Parliament, at least twelve reporters are constantly attending the Houses of Commons and Lords; each in his turn, after about an hour's work, retiring to translate into ordinary writing, the speech he has just heard and noted in short hand. In the mean time, fifty compositors are constantly at work, some of whom have already set up the beginning, whilst others are committing to type the yet undried manuscript of the continuation of a speech, whose middle portion is travelling to the office in the pocket of the hasty reporter, and whose eloquent conclusion is, perhaps, at that very moment, making the walls of St. Stephen's vibrate with the applause of its hearers.

"These congregated types, as fast as they are composed, are passed in portions to other hands; until at last, the scattered fragments of the debate, forming, when united with the ordinary matter eight and forty columns, reappear in order, on the platform of the printing press. The hand of man is now too slow for the demands of

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* Economy, &c. pp. 174 to 179.

† The author visited this most interesting establishment after midnight, during the progress of a very important debate. The place was illuminated with gas, and was as light as the day. There was neither noise, nor bustle. The visitors were received with a calm and polite attention, although at a moment of the greatest pressure. The tranquillity, which they so much admired, was the result of the most intense and regulated occupation.

his curiosity—but the power of steam comes to his assistance. Ink is rapidly supplied to the moving types by the most perfect mechanism; four attendants incessantly introduce the edges of large sheets of white paper to the junction of two great rollers, which seem to devour them with unsated appetite;—other rollers convey them to the type already inked, and having brought them into rapid and successive contact, redeliver them to four other assistants, completely printed, by an almost momentary touch. Thus, in one hour, four thousand sheets of paper are printed on one side; and an impression of twelve thousand copies, from above three hundred thousand movable pieces of metal, is produced for the public in six hours."

This imperfect analysis has already transcended our prescribed limits, but we cannot forbear from making one or two other quotations. The description of the slide of Alpnach, although not new, is very interesting, and may possibly lead to similar arrangements in some of our own mountain forests. We will add, also, the account of the bobbin-net manufacture, showing how cheaply an immense quantity of any article can be supplied by the application of power, guided by principles, such as have been enumerated and explained in the work we have been examining.

The slide of Alpnach is a surprising instance of a conquest gained over natural obstacles, by human enterprise, aided by mechanical skill.

The following description is quoted by Mr. Babbage from Dr. Brewster's Journal, in which it appeared in 1819, translated from Gilbert's Annalen.

"For many centuries the rugged flanks and the deep gorges of Mount Pilatus, in the Alps of Switzerland, were covered with impenetrable forests. Even the daring hunters were scarcely able to reach them, and the inhabitants of the valley had never conceived the idea of disturbing them with the axe. These immense forests were therefore permitted to grow and to perish, without being of the least utility to man, until a foreigner, conducted into their wild recesses in the pursuit of the chamois, was struck with wonder at the sight, and directed the attention of several Swiss gentlemen to the extent and superiority of the timber. The most intelligent and skilful individuals, however, considered it quite impracticable to avail themselves of such inaccessible stores. It was not until November, 1816, that M. Rupp and three Swiss gentlemen, entertaining more sanguine hopes, drew up a plan of a slide, founded on trigonometrical measurements. Having purchased a certain extent of the forests from the commune of Alpnach, they began the construction of the slide, and completed it in the spring of 1818.

"The slide of Alpnach is formed entirely of about two hundred and fifty thousand large pine trees, deprived of their bark, and united together in a very ingenious manner, without the aid of iron. It occupied one hundred and sixty workmen, during eighteen months, and cost nearly 100,000 franks, or £4,250. It is about three leagues or forty four thousand English feet long, and terminates in the Lake Lucerne. It has the form of a trough, about six feet broad, and from three to six feet deep. Its bottom is formed of three trees; the middle one of which has a groove cut in the direction of its length, for receiving small rills of water, which are conducted into it from various places for the purpose of diminishing the friction.

The whole slide is sustained by about two thousand supports: and in many places, it is attached, in a very ingenious manner, to the rugged precipices of granite.

"The direction of the slide is sometimes straight, sometimes zigzag, with an inclination of from ten to eighteen degrees. It is often carried along the sides of hills and the flanks of precipitous rocks, and sometimes over their summits. Occasionally it goes under ground, and at other times it is conducted over the deep gorges by scaffoldings one hundred and twenty feet in height.

"The boldness which characterizes this work, the sagacity displayed in all its arrangements, and the skill of the engineer, have excited the wonder of every person who has seen it. Before any step could be taken in its erection, it was necessary to cut several thousand trees to obtain a passage through the impenetrable thickets; and as the workmen advanced, men were posted at certain distances, in order to point out the road for their return, and to discover, in the gorges, the places where the piles of wood had been established. M. Rupp was obliged more than once to be suspended by cords, in order to descend precipices many hundred feet high. He had to contend with the prejudices of the peasantry, but nothing could diminish his invincible perseverance. They thought he had communication with the devil. He was charged with heresy, and every obstacle was thrown in the way of an enterprise, which they regarded absurd and impracticable. All these difficulties, however, were surmounted, and he had, at last, the satisfaction of observing the trees descend from the mountain, with the rapidity of lightning. The large pines, which were one hundred feet in length, and ten inches thick, at their smaller extremity, ran through the space of three leagues, or nearly nine miles, in two minutes and a half.

"The arrangements for this operation were extremely simple. From the lower end of the slide to the upper end, workmen were posted, at regular distances, and as soon as every thing was ready, the man at the lower end of the slide cried out to the one above him, "*lachez*," (let go.) The cry was repeated from one to another, and reached the top of the slide in three minutes. The workman at the top, then cried out to the one below him, "*il vient*," (it comes,) and the tree was instantly launched down the slide, preceded by the cry, which was repeated from post to post. As soon as the tree had reached the bottom and plunged into the lake, the cry of "*lachez*," was repeated as before, and a new tree was launched in a similar manner. By these means, a tree descended every five or six minutes, provided no accident happened to the slide, which sometimes took place, but which was instantly repaired when it did.

"In order to show the enormous force which the trees acquired, from the great velocity of their descent, M. Rupp made arrangements for causing some of the trees to spring from the slide. They penetrated, by their thickest extremities, no less than from eighteen to twenty four feet into the earth; and one of the trees having, by accident, struck against another, it instantly cleft it through its whole length, as if it had been struck with lightning.

"After the trees had descended the slide, they were collected into rafts upon the lake, and conducted to Lucerne. From thence they descended the Reuss, then the Aar to near Brugg, afterwards to Waldshut by the Rhine, then to Basle, and even to the sea, when necessary. In order that none of the small wood might be lost, M. Rupp established, in the forest, large manufactories for charcoal. He erected magazines for preserving it, and had barrels constructed for carrying it to market. In winter, when the slide was covered with snow, the barrels were made to descend on a kind of sledge. The wood which was not fit to be carbonized was heaped up and burnt, and the ashes packed up and carried away during the winter."

"Such is a brief account of a work undertaken by a single individual, and which has excited a very high degree of interest in every part of Europe.

"Professor Playfair, who visited this singular slide, states, that the usual time occupied in the descent of a tree was six minutes; but that in wet weather, it reached the lake in three minutes."

The manufacture of bobbin-net is carried to an almost incredible extent; and such have been the improvements in the machinery, since that article was invented, that it is difficult which most to admire, the lightness and beauty of the fabric, the rapidity with which it is made, or the low price at which it is sold. Mr. Babbage gives a short history of its progress, and says—

"The bobbin-net trade is, at present, both extensive and increasing; and as it may, probably, at some future time, claim a larger portion of public attention, it will be interesting to describe, briefly, its actual state.

"A lace frame, *at the present day*, on the most improved principle, manufacturing a piece of net, two yards wide, when worked night and day, will produce six hundred and twenty racks per week. A rack is two hundred and forty holes; and as in the machine, to which we refer, three racks are equal in length to one yard, it will produce twenty one thousand, four hundred and ninety three square yards of bobbin-net annually. Three men keep this machine, constantly, working; and they were paid by piece work, about 25*s*. each, per week, in 1830. Two boys, working only in the day time, can prepare the bobbins for this machine, and are paid from 2*s*. to 4*s*. per week, according to their skill. The total capital employed in the manufactories for preparing the cotton, in those for weaving bobbin-net, and in various processes, to which it is subject, is estimated at above £2,000,000, and the number of persons, who receive wages, at above two hundred thousand.

"The following condensed view of the state of this trade is quoted from a statement, made by Mr. Wm. Felkin, of Nottingham, in 1831.

"Amount of Sea Island cotton, annually used, is one million six hundred thousand pounds, value £120,000; this is manufactured into yarn, weighing one million pounds, value £500,000. There are also used twenty five thousand pounds of raw silk, which costs £30,000, and are doubled into twenty thousand pounds thrown, worth £40,000.

"Of this production about half is exported in the unembroidered state, and, principally, in the white; yet a large quantity is sent in the unbleached state, and is embroidered abroad; and much is figured in the white, on the continent. So that it is probable, that as much is figured abroad, as at home; and this principally, on account of wages being lower there than here. The foreign embroidery is chiefly done in Belgium, Saxony, and, until recently, in Poland. The exports are, in great part, to Hamburgh, for sale at home, and for the Leipzic and Frankfort fairs; to Antwerp and the rest of Belgium; to France, by contraband; to Italy; and to North and South America. Three eighths of the whole production are sold unembroidered at home, and the remaining one eighth is embroidered in this country.

"From this it appears, that in the operations of this trade, which had no existence twenty years ago, £120,000 of original cost of cotton becomes, when manufactured, of the ultimate value of £3,242,700 sterling."

Mr. Babbage has some very interesting speculations and many facts, on the position of large manufactories; on roads, canals, and rivers; on combinations among workmen, and combinations among masters, showing their, mutually, injurious tendency; on the exportation of machinery, and the emigration of workmen; on the application and duration of machinery, and on the effect of taxes, bounties, and monopolies upon manufactures. Each of these comprehend important principles; and the whole work is illustrated by tables, facts and reasoning, relative to the economy of machinery and manufactures.

An irresistible inference is deduced from the work, that *a knowledge of principles* is important to statesmen and legislators, equally with the philosophical student. While the latter unfolds the unknown combinations of matter, *detects their practical uses,* and contrives new associations, contributing to the perfection of the arts and the comforts of social life; the former should beware of impeding the progress, or of obstructing the prosperity of such important interests.

If, in the concluding pages, the author, departing from the world of utilities, where we have, with pleasure and instruction, accompanied his progress, indulges in visions of romance, and gravely views Iceland and Ischia, in the obscure perspective of remote ages, furnishing "steam power in exchange for the luxuries of happier climates;" and ships, under water, navigating and exploring the bottom of unknown seas, yet the master spirit soon subdues the spell—the balance is soon reädjusted in a mind, habitually, disciplined by the exact calculations of mechanical philosophy. Dismissing the delusive enthusiasm of poetical fancies, he sees, that "the sun of science has but penetrated the outer fold of nature's majestic robe." He contemplates the undeniable evidences of design, in all the wonders unveiled by modern learning, from the material portions of our planet—the life which animates, and the intellectual beings which adorn it—to the members and motions of those kindred systems, wandering, but not lost, "in the remoteness of space, where the eye gladdens by their forms of beauty, and the faculties expand by decyphering their laws."

Nor has science confined its benefits to the material world. It has enlarged the range of intellectual achievement; it has aided the faculty of reason, that choicest gift of life, in "subjugating the external world" to the use of man. It places before him incontestible evidence, that our own material globe—the countless host of radiant spheres, which traverse the boundless extent of space, that himself, the greatest mystery, the "master-piece of skill," all are the work of an Almighty Creator, who sustains and governs the universe by his own immutable laws.

ART. XI.—*Supplement to the "Synopsis of the Organic Remains of the Ferruginous Sand Formation of the United States;"* by S. G. MORTON, M. D.

(Continued from Vol. XXIII, p. 294.)

THE recent discovery of the Middle Tertiary, or London clay formation, in Alabama, completes the *Tertiary* series of the United States; and this series, as we have before seen, is based, as in Europe, on the Cretaceous* group. No member of the Oolitic series has yet been identified by fossils; and all our known formations above the Medial order, are embraced in the following diagram; for our so called New Red Sandstone and Oolitic strata can have no other than a hypothetical existence, until their organic characters are established.

Modern	Alluvial. Diluvial.	
Tertiary	Upper Tertiary, (Up. Marine.) Middle Tertiary, (London Clay.) Lower Tertiary, (Plastic Clay.)	
Secondary	Calcareous Strata. Ferruginous Sand.	Cretaceous group, or Ferruginous Sand series.

Although no known section exhibits all these strata in conjunction, yet more or less of them are constantly observed in proximity. It often happens that the ferruginous sand is covered only by alluvial deposits, or by diluvial gravels and sand: near Wilmington, N. C. it is immediately overlaid by the upper tertiary formation; at Bordentown, N. J. plastic clay forms the superincumbent mass; and if I may judge from the organic remains I have received from Alabama, the secondary beds are surmounted by a vast deposit of middle tertiary fossils, the analogues of those found in the *calcaire grossier* of Europe.

With respect to the basis on which the ferruginous sand rests, we as yet know nothing with certainty; for although these strata have been penetrated nearly one hundred feet at the Chesapeake and

* This term is now, with great propriety and by common consent, applied to the whole Chalk formation, and of course embraces our Ferruginous Sand.

Delaware Canal, they offer no answer to this question; nor, so far as I am informed, have any subjacent deposits of a different age, been any where detected on this continent.

If it should be hereafter proved that the northern part of our cretaceous group rests on primitive rock, it will be similarly circumstanced to the same formation in Sweden, where, according to Mr. Nilsson, the chalk is generally incumbent on gneiss. Again, in the Carpathian Mountains, the chalk and granite are in immediate contact.*

Mr. Conrad, who is now on a geological tour in the Southern states, has made some interesting observations near the town of Wilmington, N. C., which I shall give in his own words: "At this place I found the upper marine formation resting immediately on *secondary limestone*, precisely like that you have described as overlying the marl of New Jersey: it is in thin layers, and reposes on a hard rock, which is the equivalent of the marl itself, as it abounds in *Exogyra costata* and other characteristic fossils. The *calcareous strata* are said by intelligent persons here, to extend sixty miles up Cape Fear River, and from its mouth coastwise as far north as Cape Hatteras."

It seems, therefore, that the calcareous and arenaceous strata of the American cretaceous group, preserve, wherever they have been examined, the same relative position as the white chalk and ferruginous sand of Europe.

Mr. Conrad has also discovered an extensive basin of the calcareous deposit between Charleston and the Eutaw Springs, in South Carolina; and it will probably be found, especially in the Southern states, to constitute by far the largest portion of the series, which latter would, in consequence, be more appropriately designated as the *Cretaceous group.*

ORGANIC REMAINS.

CLAVAGELLA.

C. armata. (S. G. M.) Pl. IX, fig. 11.

Disk obtusely compressed, divided by an irregular fissure, and armed with four or five tubular spines; two or three other spines below the disk: bivalve, concentrically striated.

* De La Beche, Geolog. Manual, pp. 256, 262.

Found in New Jersey, and generically mentioned in the former part of this Synopsis.

PECTEN.

P. membranosus. (S. G. M.) Pl. X, fig. 4.

Convex, thin, with nearly an hundred delicate costæ, the alternate ones being smaller. Diameter three fourths of an inch.

Found by Mr. Conrad in the calcareous strata of South Carolina.

P. calvatus. (S. G. M.) Pl. X, fig. 3.

Orbicular, thin, smooth, with obsolete radiating lines. Diameter three fourths of an inch.

Occurs with the preceding species.

OSTREA.

O. torosa. (S. G. M.) Pl. X, fig. 1.

Elongated, with strong squamous longitudinal costæ. Length four and a half inches.

Occurs in the blue marls of New Jersey. This is species No. 3 of the former part of this Synopsis.

O. radians. (Conrad.) *Fossil Shells, Pl.* 13, *fig.* 1.

Oblong, compressed, lobed and flexuous on one side; ribs numerous, radiated.

From the calcareous strata of the Southern states.

O. sellæformis. (Conrad.) *Fossil Shells, Pl.* 13, *fig.* 2.

Oblong, convex, thick and ponderous, lobed; one side of the larger valve profoundly sinuous, and the opposite side gibbous.

This and the preceding species were described by Mr. Conrad as tertiary fossils; but the recent investigations of that geologist prove them to be characteristic of the calcareous secondary strata of the Southern states.

TEREBRATULA.

T. lachryma. (S. G. M.) Pl. X, fig. 11.

Ovato-triangular; beak produced, foramen large; both valves marked by delicate longitudinal striæ. Length half an inch.

From the calcareous strata of South Carolina.

T. Harlani. (S. G. M.)

Var. *discoidal.* Pl. IX, fig. 8.

This remarkable variety occurs with the ovoidal and rectilateral forms at Ralph's Mills, Burlington Co. N. J.

Var. *rectilateral.* Pl. IX, fig. 9.

The sides of this variety are often nearly parallel.

CONUS.

C. gyratus. (S. G. M.) Pl. X, fig. 13.

This fossil occurs in the calcareous strata of the Southern states but is rare.

BALANUS.

B. peregrinus. (S. G. M.) Pl. X, fig. 5.

Occurs in the calcareous strata.

SPATANGUS.

S. ungula. (S. G. M.) Pl. X, fig. 6.

Very compressed, with five excavated ambulacra; apex central.

A cast from the Deep cut of the Chesapeake and Delaware Canal.

Diameter one inch.

ECHINUS.

E. infulatus. (S. G. M.) Pl. X, fig. 7.

Five pairs of tubercles running from mouth to apex, as they approach the latter converging and becoming smaller: intermediately are four other rows of tubercles, commencing at the mouth and terminating just above the margin. Diameter three fourths of an inch. Calcareous strata of South Carolina.

CLYPEASTER.

C. geometricus. (S. G. M.) Pl. X, fig. 9.

Hemispherical; ambulacra elevated, formed of two pairs of lines, connected by transverse striæ: mouth stelliform, with five radiating ridges that cross the margin and meet the ambulacra. Delaware and Chesapeake Canal.

SCUTELLA.

S. crustuloïdes. (S. G. M.) Pl. X, fig. 8.

Sub-orbicular, thick, center elevated; ambulacra five, short, elliptical. Diameter three fourths of an inch. Obtained (together with all the calcareous species of this supplement) by my friend, Mr. T. A. Conrad, in the Southern states.

Explanation of Plates IX and X.

PLATE IX.

Fig. 1. Baculites compressus.
2. Teredo tibialis.
Fig. 3. Cardita decisa.
4. Gryphæa plicatella.

Fig. 5. Gryphæa vomer.
6. Ostrea falcata.
Var. nasuta.
7. Idem.
Var. mesenterica.

Fig. 8. Terebratula Harlani.
Var. discoidal.
9. Idem.
Var. rectilateral.
10. Pholas cithara.
11. Clavagella armata.

PLATE X.

Fig. 1. Ostrea torosa.
2. Ostrea urticosa.
3. Pecten calvatus.
4. Pecten membranosus.
5. Balanus peregrinus.
6. Spatangus ungula.
7. Echinus infulatus.

Fig. 8. Scutella crustuloïdes.
9. Clypeaster geometricus.
10. Cidaretes diatretum.
11. Terebratula lachryma.
12. Clypeaster florealis.
13. Conus gyratus.

Art. XII.—*Abstract of Meteorological Observations, taken at Marietta, Ohio, with notices of Floods, Fruits, and flights of Pigeons; by* S. P. Hildreth, *in the year* 1832. Lat. 39° 25′, North, Long. 4° 28′, West of Washington City.

Months.	Thermometer. Mean temperatures.	Maximum.	Minimum.	Range.	Warmest day.	Coldest day.	Fair days.	Cloudy day.	Rain. Inches.	Hundredths.	Prevailing winds.
January,	29.10	55	-9	64	14	26	12	19	4	50	W. & S.W.
February,	37.00	65	4	61	11	24	5	24	10	25	N. & N.W.—S.W. & S.E.
March,	43.25	74	8	66	9	18	22	9	1	33	N. & N.W.—S. & S.W.
April,	54.33	84	30	54	14	4	20	10	2	00	N. & N.E.—W.
May,	60.70	85	37	48	3	6	18	13	3	16	S.S.W. & S.E.
June,	68.00	88	44	44	13	20	21	9	2	85	S.W. & N.
July,	70.60	92	48	44	8	15	24	7	3	08	S.S.W. & N.
August,	69.33	88	45	43	14	25	20	11	7	92	S.W.—E. & S.E.
September,	63.00	86	43	43	18	26	24	6	2	08	S.S.W. & W.
October,	54.00	82	24	58	20	29	22	9	2	75	S.W.—N. & E.
November,	43.75	69	16	53	3	25	15	15	3	75	W. & S.W.
December,	36.00	60	7	53	31	22	13	18	4	66	W. & S.W
Mean, year,	52.42						216	150	48	33	

Mean temperature for the year, 52.42°, being nearly two degrees greater than last year, but still about two less than the average temperature of the seasons in this climate.

Pl. X.

[illegible] Lith. Phil.

Pl. IX.

MED Brown's Lith Phil^a

Total amount of rain and melted snow, 48.33 inches; two hundred and sixteen fair and one hundred and fifty cloudy days, being eleven more fair days than in the year 1831.

The mean temperature for the winter months is		34.00°
" " " "	spring "	52.76
" " " "	summer "	69.00
" " " "	autumn "	53.58

The winter being 8° warmer than that of 1831, and the summer $2\frac{1}{2}$° cooler.

The amount of snow in the winter of 1832–33 has been very small, not over two or three inches, and our rivers nearly free of ice.

Remarks.—The winter of 1831–32 was one of great severity. The cold being very intense over the whole of the United States. In the parallels north of 40°, the temperature was at several times 20° below zero, all through the valley of the Mississippi, from the banks of that river to the southern extremity of Lake Erie. At Marietta, a little south of this line, and lying a good many feet lower on the banks of the Ohio, the mercury sunk to 10° below zero.

Flood in the valley of the Ohio.—About the middle of February, the whole of the bottom lands on the Ohio, from its head waters to the mouth, were inundated by the greatest flood know since the settlement of the State. The earth was covered with snow more than a foot deep in the valleys, and three or four feet deep on the mountains and uplands at the heads of the river. The weather suddenly became warmer about the 10th of the month, with southerly winds attended with thunder and discharges of rain so copious that eight inches fell in the course of a week. The flood was at its height in Pittsburgh, Penn., early on the 11th day of the month, and at the falls of Ohio, on the 19th, averaging in its progress about one hundred miles to each twenty four hours. As the mighty flood rolled on its course, it received continual accessions from all the tributaries lying on its northern and southern borders. Each one of these, swelled by the continual rains, would in some regions be viewed as majestic rivers, rushing and foaming with impetuous haste to add their strength to that vast ocean of waters, which now swept over the fair valley of the Ohio, bearing on its bosom, the ruins of many a village and the productions of a thousand farms. The damage cannot be estimated at less than a million of dollars. The water was from five to six feet higher than any former flood since that of 1784, which was about the same height as this; but it took place at a period, before any settlements were made north of the river. It is stated by the early settlers about Wheeling, that, in the year 1772, there was a flood in the spring of that year, the waters of which were five feet higher than those of 1832. The evidences they give in proof are such as cannot be doubted, and will go far to rank this flood with the celebrated one of Deucalion, as rehearsed by the ancient Grecian poets, and which, if it should be repeated in these days, would sweep palace and cottage from their foundations, in every town, and hamlet on the shores of our beautiful river.

Fruits, &c.—The spring was very cold and backward, so that half that season was passed before the winter had fairly left us. Peach trees, where the cold had spared them, did not blossom until the middle of April, and apples not until the 25th, which is twenty days later than is common to this locality. It is with us pretty well established as a maxim, that "the colder the winter, the more backward the ensuing spring," and "the later the spring, the greater the certainty of a fine crop of fruit," as was demonstrated in the productions of the year 1832, and of other previous years, when after an intensely cold winter and backward spring, many kinds of fruit were very abundant, and, indeed, all kinds, excepting such as were killed in the bud by the severity of the cold. All the fruit-bearing forest trees brought forth in the greatest profusion; so that the quantities of acorns and nuts were scarcely ever equalled; the earth being literally covered with acorns, and the boughs of the trees bending and breaking with their loads of fruit. Hogs were well fattened without the aid of corn, and the "golden age," so much lamented by the poets, as lost, actually returned to all the inhabitants of the forests.

Flight and bivouac of pigeons.—The *Columba migratoria*, L., or wild pigeon, seems to have possessed early intelligence of this happy state of things, for our woods, since autumn, have been literally filled with countless multitudes of these interesting travellers. Through the whole winter, immense flocks are seen passing out in the morning to their feeding grounds, amongst the hills, in quest of acorns, and returning every evening to their grand camp, which, for this part of Ohio, is established on the head waters of the Little Hockhocking, in a broken and wilderness region, twenty five miles south westerly from Marietta. This camp covers a tract of more than three miles square. The timber trees, over the greater part of this extent, are nearly all destroyed. Trees of eighteen inches in diameter are broken down or turned out by the roots. The branches of others are broken off, leaving only the naked stem. From dusk until an hour or more after dark, immense flocks continually arrive, from every quarter of the heavens, and it requires the greatest care, on the part of those who visit the camp to kill or to capture the pigeons, to avoid the fall of the limbs and branches of the trees, which are continually dropping through the whole night. When, as the flocks arrive, a branch or a tree is filled, the pigeons still continue to accumulate upon the backs of each other, until the branch or the whole tree gives way, when they seek a new spot, to repeat the same thing. In the night, a great many are taken by hand from the low bushes, on which they alight, when forced from the higher trees. The earth is covered with their excrements to the depth of three or four inches, which would be, if within their reach, a source of wealth to the melon growers of Egypt; as they use the dung of doves, in preparing the earth for their finest melons. The encamping ground, being several miles from any settlement, wolves and foxes, visiting the spot to feast on the disabled and wounded pigeons, are very numerous here. I have the above facts from a man who visited the place at night, and, in a few hours, killed and brought away three hundred pigeons. In the morning, they leave the camp about sunrise—the rustling of their wings, as they depart, roaring like thunder, and filling the auditors with awe and astonishment. It is nearly three months since they began roosting in this place, and for the last two, the spot has been visited nearly every night, by the inhabitants for many miles around, and thousands of the pigeons have been killed. The abundance of nuts has caused them to be very fat, and excellent food. The situation is hilly, wild and sequestered, full of laurel thickets, and high projecting cliffs of sandstone rocks, under which the hunters kindle fires and spend the night, affording a picturesque scene for the pen of a Cooper or a Scott.

Marietta, Feb. 1, 1833.

P. S. *Strata connected with the salt of the West, named in the table in Dr. Hildreth's paper, p. 57.*—By a letter received from Dr. Hildreth, since the printing of his paper on the salt formation of the West, we learn, that the strata are composed chiefly of sandstone, schistus, and indurated clay of different colors; and that the argillite is called by the workmen *soapstone.*

Quere.—Are not the indurated saponaceous clays and similar slaty clays, called, in the popular language—soapstone?—*Ed.*

Although the eloquent account of the Passenger Pigeon, given by Wilson in his Ornithology, is well known; still, so much of it as relates to the flight, and to the roosting and breeding places of the pigeon, will form a very appropriate sequel to the notice of Dr. Hildreth, especially, as the two accounts are separated by an interval of more than twenty years, and we are thus enabled to see, how far time and the increasing population of the western states have influenced the state of facts.—Ed.

The most remarkable characteristic of these birds is their associating together, both in their migrations and also during the period of incubation, in such prodigious numbers as almost to surpass belief; and which has no parallel among any other of the feathered tribes, on the face of the earth, with which naturalists are acquainted.

These migrations appear to be undertaken rather in quest of food, than merely to avoid the cold of the climate; since we find them lingering in the northern regions around Hudson's Bay so late as December; and since their appearance is so casual and irregular; sometimes not visiting certain districts for several years in any considerable numbers, while at other times they are innumerable. I have witnessed these migrations in the Genessee country—often in Pennsylvania, and also in various parts of Virginia, with amazement; but all that I had then seen of them were mere straggling parties, when compared with the congregated millions which I have since beheld in our western forests, in the states of Ohio, Kentucky, and the Indiana territory. These fertile and extensive regions abound with the nutritious beech nut, which constitutes the chief food of the wild pigeon. In seasons when these nuts are abundant, corresponding multitudes of pigeons may be confidently expected. It sometimes happens that having consumed the whole produce of the beech trees in an extensive district, they discover another at the distance perhaps of sixty or eighty miles, to which they regularly repair every morning, and return as regularly in the course of the day, or in the evening, to their place of general rendezvous, or as it is usually called, the *roosting place.* These roosting places are always in the woods, and sometimes occupy a large extent of forest. When they have frequented one of these places for some time, the appearance it exhibits is surprising. The ground is covered to the depth of several inches with their dung; all the tender grass and underwood destroyed; the surface strewed with large limbs of trees broken down by the weight of the birds clustering one above another; and the trees themselves, for thousands of acres, killed as completely as if girdled with an axe. The marks of this desolation remain for many years on the spot; and numerous places could be pointed out where for several years after, scarce a single vegetable made its appearance.

When these roosts are first discovered, the inhabitants from considerable distances visit them in the night, with guns, clubs, long poles, pots of sulphur, and various other engines of destruction. In a few hours they fill many sacks, and load their horses with them. By the Indians a pigeon roost, or breeding place, is considered an important source of national profit and dependence for that season; and all their active ingenuity is exercised on the occasion. The *breeding place* differs from the former in its greater extent. In the western countries above mentioned, these are generally in beech woods, and often extend in nearly a straight line across the country for a great way. Not far from Shelbyville, in the state of Kentucky, about five years ago, there was one of these breeding places, which stretched through the woods in nearly a north and south direction; was several miles in breadth, and was said to be upwards of forty miles in extent! In this tract almost every tree was furnished with nests, wherever the branches could accommodate them. The pigeons made their first appearance there about the tenth of April, and left it altogether, with their young, before the twenty fifth of May.

As soon as the young were fully grown, and before they left the nests, numerous parties of the inhabitants, from all parts of the adjacent country, came with waggons, axes, beds, and cooking utensils, many of them accompanied by the greater part of their families, and encamped for several days at this immense nursery. Several of them informed me, that the noise in the woods was so great as to terrify their horses, and that it was difficult for one person to hear another speak without bawling in his ear. The ground was strewed with broken limbs of trees, eggs, and squab pigeons, which had been precipitated from above, and on which herds of hogs were fattening. Hawks, buzzards and eagles were sailing about in great numbers, and seizing the squabs from their nests at pleasure; while from twenty feet upwards to the tops of the trees, the view through the woods presented a perpetual tumult of crowding and fluttering multitudes of pigeons, their wings roaring like thunder; mingled with the frequent crash of falling timber; for now the axe-men were at work cutting down those trees that seemed to be most crowded with nests, and contrived to fell them in such a manner, that in their descent they might bring down several others; by which means the falling of one large tree sometimes produced two hundred squabs, little inferior in size to the old ones, and almost one mass of fat. On some single trees upwards of one hundred nests were found, each containing *one* young only, a circumstance in the history of this bird not generally known to naturalists. It was dangerous to walk under these flying and fluttering millions, from the frequent fall of large branches, broken down by the weight of the multitudes above, and which in their descent often destroyed numbers of the birds themselves; while the clothes of those engaged in traversing the woods were completely covered with the excrements of the pigeons.

These circumstances were related to me by many of the most respectable part of the community in that quarter; and were confirmed in part by what I myself witnessed. I passed for several miles through this same breeding place, where every tree was spotted with nests, the remains of those above described. In many instances I counted upwards of ninety nests on a single tree; but the pigeons had abandoned this place for another, sixty or eighty miles off towards Green river, where they were said at that time to be equally numerous. From the great numbers that were constantly passing over head to or from that quarter, I had no doubt of the truth of this statement. The mast had been chiefly consumed in Kentucky, and the pigeons, every morning a little before sunrise, set out for the Indiana territory, the nearest part of which was about sixty miles distant. Many of these returned before ten o'clock, and the great body generally appeared on their return a little after noon.

I had left the public road to visit the remains of the breeding place near Shelbyville, and was traversing the woods with my gun, on my way to Frankfort, when about one o'clock the pigeons, which I had observed flying the greater part of the morning northerly, began to return in such immense numbers as I never before had witnessed. Coming to an opening by the side of a creek called the Benson, where I had a more uninterrupted view, I was astonished at their appearance. They were flying with great steadiness and rapidity, at a height beyond gun shot, in several strata deep, and so close together that could shot have reached them, one discharge could not have failed of bringing down several individuals. From right to left far as the eye could reach, the breadth of this vast procession extended; seeming every where equally crowded. Curious to determine how long this appearance would continue, I took out my watch to note the time, and sat down to observe them. It was then half past one. I sat for more than an hour, but instead of a diminution of this prodigious procession, it seemed rather to increase both in numbers and rapidity; and, anxious to reach Frankfort before night, I rose and went on. About four o'clock in the afternoon I crossed the Kentucky river, at the town of Frankfort, at which time the living torrent above my head seemed as numerous and as extensive as ever. Long after this I observed them, in large bodies that continued to pass for six or eight minutes, and these again were followed by other detached bodies, all moving in the same south east direction till after six in the evening. The great breadth of front which this mighty multitude preserved would seem to intimate a corresponding breadth of their breeding place, which by several gentlemen who had lately passed through part of it, was stated to me at *several* miles. It was said to be in Green county, and that the young began to fly about the middle of March. On the seventeenth of April, forty nine miles beyond Danville, and not far from Green river, I crossed this same breeding place, where the nests for more than three miles spotted every tree; the leaves not being yet out, I had a fair prospect of them, and was really astonished at their numbers. A few bodies of pigeons lingered yet in different parts of the woods, the roaring of whose wings was heard in various quarters around me.

All accounts agree in stating, that each nest contains only one* squab. This is so extremely fat, that the Indians, and many of the whites, are accustomed to melt down the fat for domestic purposes as a substitute for butter and lard. At the time they leave the nest they are nearly as heavy as the old ones; but become much leaner after they are turned out to shift for themselves.

It is universally asserted in the western countries, that the pigeons, though they have only one young at a time, breed thrice and sometimes four times in the same season; the circumstances already mentioned render this highly probable. It is also worthy of observation, that this takes place during that period when acorns, beech nuts, &c. are scattered about in the greatest abundance and mellowed by the frost. But they are not confined to these alone; buck-

* The editor of the second edition of Wilson's Ornithology states, that he has been told that this bird lays *two* eggs.

wheat, hemp seed, Indian corn, holly berries, hack berries, whortle berries, and many others, furnish them with abundance at almost all seasons. The acorns of the live oak are also eagerly sought after by these birds, and rice has been frequently found in individuals killed many hundred miles to the northward of the nearest rice plantation. The vast quantity of mast which these multitudes consume is a serious loss to the bears, pigs, squirrels and other dependents on the fruits of the forest. I have taken from the crop of a single wild pigeon, a good handful of the kernels of beech nuts, intermixed with acorns and chesnuts. To form a rough estimate of the daily consumption of one of these immense flocks, let us first attempt to calculate the numbers of that above mentioned, as seen in passing between Frankfort and the Indiana territory. If we suppose this column to have been one mile in breadth, (and I believe it to have been much more,) and that it moved at the rate of one mile in a minute; four hours, the time it continued passing, would make its whole length two hundred and forty miles. Again, supposing that each square yard of this moving body comprehended three pigeons; the square yards in the whole space multiplied by three, would give two thousand two hundred and thirty millions, two hundred and seventy two thousand pigeons! An almost inconceivable multitude, and yet probably far below the actual amount. Computing each of these to consume half a pint of mast daily, the whole quantity at this rate would equal seventeen millions, four hundred and twenty four thousand bushels per day! Heaven has wisely and graciously given to these birds rapidity of flight and a disposition to range over vast uncultivated tracts of the earth; otherwise they must have perished in the districts where they resided, or devoured the whole productions of agriculture as well as those of the forests.

A few observations on the mode of flight of these birds must not be omitted. The appearance of large detached bodies of them in the air, and the various evolutions they display, are strikingly picturesque and interesting. In descending the Ohio by myself in the month of February, I often rested on my oars to contemplate their aerial manœuvres. A column, eight or ten miles in length, would appear from Kentucky, high in air, steering across to Indiana. The leaders of this great body would sometimes gradually vary their course, until it formed a large bend of more than a mile in diameter, those behind tracing the exact route of their predecessors. This would continue sometimes long after both extremities were beyond the reach of sight, so that the whole, with its glittery undulations, marked a space on the face of the heavens resembling the windings of a vast and majestic river. When this bend became very great, the birds, as if sensible of the unnecessary circuitous course they were taking, suddenly changed their direction, so that what was in column before became an immense front, straightening all its indentures, until it swept the heavens in one vast and infinitely extended line. Other lesser bodies also united with each other, as they happened to approach, with such ease and elegance of evolution, forming new figures, and varying these as they united or separated, that I was never tired of contemplating them. Sometimes a hawk would make a sweep on a particular part of the column, from a great height, when, almost as quick as lightning, that part shot downwards out of the common track; but soon rising again, continued advancing at the same height as before; this inflection was continued by those behind, who on arriving at this point dived down, almost perpendicularly, to a great depth, and rising followed the exact path of those that went before. As these vast bodies passed over the river near me, the surface of the water, which was before smooth as glass, appeared marked with innumerable dimples, occasioned by the dropping of their dung, resembling the commencement of a shower of large drops of rain or hail.

Happening to go ashore one charming afternoon, to purchase some milk at a house that stood near the river, and while talking with the people within doors, I was suddenly struck with astonishment at a loud rushing roar, succeeded by instant darkness, which, on the first moment, I took for a tornado about to overwhelm the house and every thing around in destruction. The people observing my surprise, coolly said, "It is only the pigeons;" and on running out I beheld a flock, thirty or forty yards in width, sweeping along very low, between the house and the mountain or height that formed the second bank of the river. These continued passing for more than a quarter of an hour, and at length varied their bearing so as to pass over the mountain, behind which they disappeared before the rear came up.

ART. XIII.—*Chemical Action and Decomposition of Water, produced by Electrical Induction. Communicated by* M. HACHETTE *to the Academy of Sciences, Oct.* 8, 1832. *Translated and condensed from the Annales de Chim. et de Phys., Sept.*, 1832; *by* OLIVER P. HUBBARD, Assistant in the Chemical Department in Yale College.

Mr. FARADAY remarks, in his memoir of Nov. 24, 1831, that he failed to produce chemical effects by the electrical currents of induction, and expresses the belief that they may be obtained by more powerful magnets than he used, and that future researches will identify the effects of the ordinary electrical currents and those of induction.

M. Pixii has verified this opinion by the following experiment; he mounted a horse shoe magnet upon the end of the shaft of a lathe and, by a treadle, caused it to revolve with its faces parallel to those of a piece of soft iron bent into the form of a horse shoe, and wound with a copper wire, covered with silk, the two ends of which communicated with two other metallic wires that passed through the bottom of a vessel filled with water, and each wire rose into a glass tube shaped like an inverted bell (cloche.) The water in the vase and in the tubes formed but one mass.

When the magnet turns, it acts by induction upon the soft magnetized iron, upon the silk bound wire, and upon the two wires placed in the tubes.

Water is decomposed at the extremities of the latter wires, and the two gases, oxygen and hydrogen, rise to the top of each tube.

This experiment proves, 1. that the simultaneous action of the positive and negative electricities is not necessary to the chemical decomposition of water, and 2. that an action, the intermission of which is only instantaneous, is sufficient to produce this decomposition.

These conclusions accord with previous observations made upon the decomposition of water by the Voltaic pile.

This decomposition takes place, although the moist or fluid elements of the pile differ in their conducting powers.

It is conceived, therefore, that the water opposes a force of inertia to the electrical action which tends to produce decomposition, and that to overcome this inertia, a current of electricity, uninterrupted to its source, must act upon the water a certain time before the fluid is decomposed. The electrical currents of induction appear to act like the constant electrical currents of the Voltaic pile, the metallic plates of which are separated by an imperfect fluid conductor. In this case, when the plates are separated by layers of starch, slightly moistened, dry piles are produced which act a long time and charge the condenser, and do not decompose water.

The electrical currents of these piles may be constant and still their tension be too much diminished to produce chemical action like the decomposition of water.

The magnet used by M. Pixii, for the decomposition of water, is formed by joining two others. Each of these supports alone twelve and a half kilog. (27.5 lbs.) and they weigh together four kilog. (8.8 lbs.)

The shaft of the lathe revolves at least six times in a second. The decomposition of the water is increased with the rapidity of the revolution of the magnet.

The piece of soft iron, wound with copper wire, is circular, and its diameter four centimetres, (1.57 inches,) height twenty centimetres, (7.87 inches,) bent into a horse shoe form, with parallel arms, distant eleven centimetres, (4.33 inches,) reckoned from the center of each circular end; the silk wire four hundred metres (437.5 yds.) long, and weighs two kilog. (4.41 lbs.)

2. *Of the Electro-Magnetic disc of M. Arago.*

M. A. has demonstrated, (memoir of March, 1825,) 1. that a metallic disc turning upon its axis, either above or below a magnetic needle, in the sphere of the magnetic action of the needle, causes it to deviate from its natural position: 2. that the deviation begins and ends with the rotary motion of the disc.

Mr. Faraday, (memoir before cited,) discovered that in this experiment the movable disc is electrified.

I have attempted to decompose water by electricity communicated to the disc. In the apparatus of M. Pixii just described, I substituted for the magnet a circular disc of copper, and for the wire-wound piece of soft iron, which is useless, a magnet. The ends of the wire of the multiplier were made to communicate with the circular disc, and to secure a perfect contact, each of the ends was terminated by a small plate of copper amalgamated with mercury, and one of the flat edges of the disc was also amalgamated.

The plates of the wire of the multiplier were secured before the poles of the fixed magnet, at the extremities of the diameter of the disc parallel to the straight line, (*a la droite,*) which joins the poles.

The plane of the disk is on a level with the poles of the magnet without touching them; the plates of copper resting against the flat edge of the disc farthest from the magnet, rub upon it while the disc turns, and the rotary motion is caused by a treadle. When the disc revolves about six times in a second, the needle of the multiplier deviates from its natural position at an angle of about 30°.

On joining the copper disk with another of iron of the same diameter, no change was perceived in the deviation. The experiment was repeated with a more powerful magnet, weighing twenty kilog. (44.11 lbs.) and sustaining one hundred kilog. (220.5 lbs.) but the tension of the electricity of the revolving disc was not increased. The diameter of the first disc was eleven centimetres, (4.3 inches,) that of the second seventeen centimetres, (6.7 inches.)

It appears that copper acts under the influence of a magnet, as a steel bar tempered and magnetized, under that of an electrical current—it is known that the current, whatever may be the power of the Voltaic battery, does not sensibly increase the force of a magnet of tempered steel.

Art. XIV.—*M. Ampere's communication to the Academy of Sciences upon an experiment of M. Pixii relative to a Current produced by the Rotation of a Magnet with an improved apparatus, Oct.* 29, 1832. *Translated from the Annales de Chim. et de Phys., Sept.*, 1832; *by* Oliver P. Hubbard, Assistant in the Chemical Department in Yale College.

M. Hachette has reported the experiments made with an apparatus constructed by M. Pixii, for producing an electrical current, by making a horse shoe magnet revolve, face to face, with a fixed horse shoe of soft iron, the latter being wound with a silk-bound copper wire; after having obtained vivid sparks with an apparatus, in which the magnet supported thirty livres, (33 lbs.) and the wire around it made five hundred turns, a magnet supporting more than one hundred kilog. (220.5 lbs.) and wound with a wire of one thousand metres, (1093.6 yds.) was used and the following effects were produced. 1. Vivid sparks: 2. Shocks of considerable force: 3. A numbness and involuntary movements of the fingers, when immersed in vessels of acidulated water with which the ends of the wires communicated: 4. A great divergence of the gold leaves in the condenser of Volta: 5. A rapid decomposition of water, previously mixed with a little sulphuric acid to increase its conducting power.

In these different experiments the current took place in the conducting wire in a different direction at each semi-revolution of the magnet; for instance in the decomposition of water, the oxygen was disengaged at first in one tube and the hydrogen in the other; at the next semi-revolution the hydrogen was evolved in the first, and the oxygen in the second; of course the two gases were mingled in each tube.

To obtain them separate, M. Pixii attached to this apparatus the bascule, which M. Ampere invented to change the currents in his electro-dynamic experiments. The bascule in this new apparatus supports a rod, upon which rests a semi-circle attached to the magnet, and which holds the bascule depressed on one side during a semi-revolution of the magnet, and during the next semi-revolution, the bascule becomes free, and is depressed on the other side by a spring.

On the first trial of this arrangement, the bascule plunged alternately into the troughs filled with mercury, like the bascules of M. Ampere; but when the movement became rapid, the mercury was so powerfully agitated as to leap out of the troughs.

M. Pixii obviated this inconvenience by substituting, for the mercury, small plates of copper, amalgamated upon the surface to render more perfect their contact with the points of the bascules which strike them alternately. By this ingenious arrangement, the electric current, in the part of the conducting wire beyond the bascule, takes place always in the same direction; whence it follows that oxygen alone is disengaged in one of the tubes and hydrogen in the other, and the two gases are obtained separate.

It is worthy of remark, that all the other circumstances remaining the same, the decomposition of the water becomes more rapid in this case than when the electric current is alternating; which is, probably, owing to the molecules of the water being previously and properly disposed for decomposition; whereas, when the current is alternating, it is necessary that they turn themselves at each semi-revolution of the magnet.

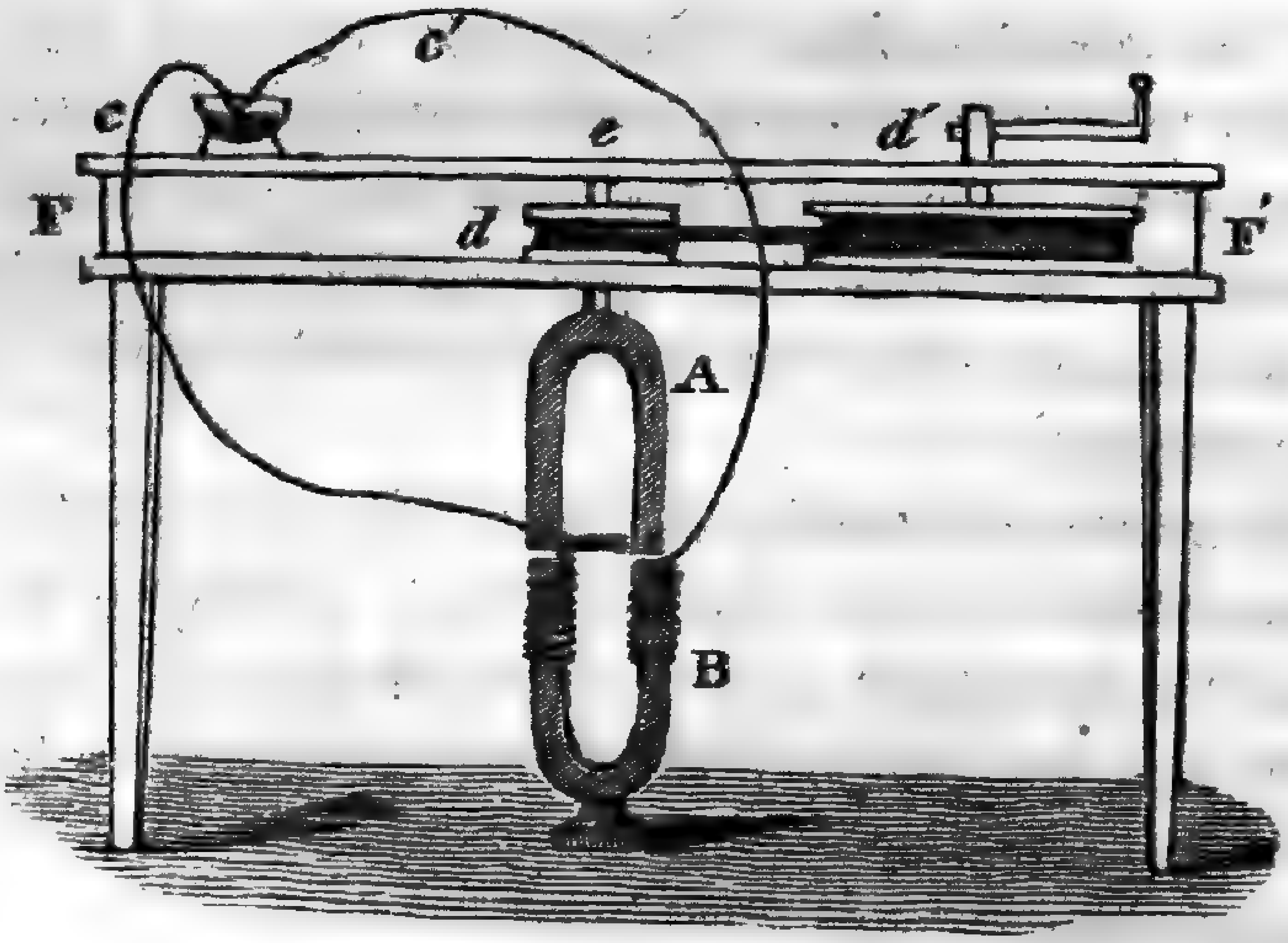
As to the sparks and shocks, and the action upon the leaves of the electroscope, they are alike produced by a current in the same direction and the alternating current, since all these phenomena result from an instantaneous action of electricity developed in the conducting wire, sufficient to charge the condenser as far as the tension of the current permits.

Prof. Emmet had not seen the articles, on electro-magnetism, contained in the nine last Nos. of the Ann. de Chim. et de Phys. to Sept. 1832, inclusive, when the proof of his paper passed through his hands.—Ed.

Notice of the Revolving Electric Magnet of M. Pixii, of Paris, in a letter from Dr. Charles T. Jackson, *to the Editor, dated New York, Dec.* 25, 1832.

As the preceding papers have no plates to illustrate the descriptions, we take the liberty to insert an extract from a letter of Dr. Jackson to the Editor, accompanied by a figure of an apparatus which we suppose to be, substantially, the same as that by which water was decomposed; the principal difference appears to have consisted in the greater strength of the magnet used to produce the chemical effects, and in the mode in which the rotation is produced.—Ed.

"While in Paris, I examined, with Mr. Pixii, a new instrument, lately invented by his son. It may be called a *Magnetico-electric machine.* As Mr. Pixii deposited a description of this machine at the Academy of Sciences, I have a right to give you some account of it. This machine is a curious invention destined to show the *identity of electricity and magnetism*, and may, perhaps, in the course of time, supersede the use of the common electric machine and galvanic pile. The annexed sketch will, perhaps, suffice to give you some notion of the construction of Pixii's machine. The one he exhibited was, however, of a different form from that figured here, but as Mr. P. proposed to mount one in this manner, I give it as I suppose he will construct one.



"A, a horse shoe magnet, composed of six pieces, capable of supporting fifty pounds weight. B, a horse shoe multiplicator of soft iron, wound with wire, covered with silk, at the extremities. These wires are prolonged as poles, *c*, *c'*, one of which is plunged into a cup of mercury, and the other brought close to the surface of the mercury. *d*, *d′*, wheels and a band to cause the magnet to rotate on its axis *e*. F, F′, table to support the machinery.

"The magnet should be armed with its connecting bar, which should come close to the extremities of the multiplicator without touching it. When the magnet is made to revolve and the extremity of the poles are approximated as above directed; there is a constant current of electricity, which becomes visible to the eye, a spark like a twinkling star being given off from the pole brought near the surface of the mercury. The spark is accompanied by an audible crackling sound, and is easily seen even by day light. I tried to take a shock from the wires but the intensity of the spark was not sufficiently great to produce any commotion. When one of the wires is placed on and the other under the tongue, there is a strong metallic taste, like that produced by pieces of silver and zinc placed in a similar manner when brought in contact.

"It would appear, then, that the quantity of electricity is great, but its intensity feeble. If we were able to produce a sufficiently strong magnet, there can be no doubt that this steady current of electricity, given off without any expense of acid or any diminution of intensity, might be of practical utility in the arts."

Experiments in the Laboratory of Yale College.—Sparks and Shocks from the Magnet.

Two magnets have been made, under my direction, by Messrs. Bradley & Merriman, of this place, (New Haven,) upon the plan of Prof. Emmet, as described in the present number of this Journal, p. 78.

These magnets consist, each, of nine plates, seven eighths of an inch wide, a little more than one eighth of an inch thick, and thirteen inches long, all united by a screw which perforates them. They are in the usual horse shoe form, and the space between the poles is three inches. They are capable of supporting over twenty pounds each. The armature or keeper, which is in the form of a flat bar, is six inches long, seven eighths of an inch wide, and three eighths of an inch thick. It perforates two wheels or disks of plate brass, each of three inches and a half diameter, and covered with silk on the inside and with shell lac varnish on the outside.

These disks, when the armature, or keeper is in them, exactly resemble wheels on an axletree; they are placed at the distance of three sixteenths of an inch from the poles of the magnet, when the keeper rests in such a position as to divide the distance equally.

Around the keeper, between the disks, are wound six hundred and twenty feet of copper wire covered with silk in one magnet, and four hundred and seventy five feet in the other.

The ends of the wire are connected, the one with the keeper, and the other with the inside of one of the poles of the magnet, and also two other wires proceed, the one from the keeper and the other from the outside of one pole of the magnet, in the manner of Mr. Emmet, except that thumb screws, are added to make the metallic connection more perfect. These magnets give small, but brilliant sparks when the keeper is slid horizontally off, especially when it is done with a sudden and rapid motion; in the dark, the spark was very vivid, and exhibited the party colored hues of lightning. The best sparks were obtained between the keeper and the poles of the magnet, and were observed at the moment when the connection was broken. The sparks from the points of the connecting wires were much more feeble. The shocks from these wires were felt distinctly in the finger joints, and were very decided and even painful, when the wires were connected with the tongue. Usually, the flash of light was not observed when the connection was made through the tongue only; with the stronger of these two magnets, however, this effect was observed; and when the wires of the weaker magnet were placed, one under the tongue and the other between the upper lip and gum, the flash was distinct; but it never failed with either, when one wire was laid on the tongue and the other was made to touch the eye ball. As it was not quite convenient to move a wire around the eye, a small disk of copper (as large as a twelve and a half cent piece,) was soldered to the remote end of one of the connecting wires; when, to the moistened eye ball of the closed eye, this disk was applied and the other wire touched to the tongue, at the moment when the keeper was slid off, a flash was perceived as brilliant as lightning, and the whole of that side of the face received a convulsive twitch. All these effects, the spark, the shock and the flashes of light, were perceived, without apparent diminution, when the discharging wires were made to take a circuit of one hundred and fifty feet, and the poles for discharge were made to meet in the middle of this distance, that is, seventy five feet from the magnet—the shocks through the fingers were very strong. *It is a battery, always charged, and whose energy is independent of chemical agency.*—Ed.

Electro-Galvanic Effects.

It may perhaps be worth mentioning, that in using the great galvanic magnet of Prof. Henry, which is excited by a small galvanic battery, and is nothing but soft unmagnetic iron,* wound around with insulated copper wire, a spark was perceived, this season, in the laboratory of Yale College, when the armature was forcibly drawn up to the horse shoe, at the instant of the immersion of the battery, and when the magnet easily took up one thousand and four hundred pounds, and even retained it until the battery was nearly out of the acid. It sustained, for a few minutes, from five to six hundred pounds when, after immersion, the acid was entirely withdrawn.

The deflagrator of Dr. Hare, (that with one hundred and sixty coils,) readily and vividly ignited charcoal at the distance of one hundred feet from the instrument, and when the two charcoal points formed the poles in the middle of a wire of three hundred feet circuit. At the same place, an unmagnetical needle, placed in a helix and connected with the poles at the moment of immersion, became instantly a powerful magnet.

Art. XV.—*Analysis of the water of Rio Vinagre; by* M. Boussingault. *Translated from the Annales de Chim. et de Phys. Sept.* 1832; *by* Oliver P. Hubbard, Assistant in the Chemical Department in Yale College.

The waters of the river Pasambio, near Popayan, are acid, and it is therefore called by the natives Rio Vinagre, or river of vinegar. It arises near the craters of the volcano of Puracé, at an elevation of about twelve thousand nine hundred feet. The torrent runs to the village of Puracé, in a subterranean channel, and at the Chorrera of St. Antonio, where alone it can be conveniently approached, it makes a beautiful cascade of three hundred feet, into a vast amphitheatre, cut in trachyte, and a few miles below, after receiving the torrent of the Anambio, it empties into the Cauca. From the village of Puracé, the visitor can, without much difficulty, descend to the foot of the Chorrera; but it is painful to remain, on account of the constant shower of acidulous water, which occasions in the eyes an insupportable prickling. Its width below the falls is seventy two feet; average depth, four inches; current, three feet per second.

The water of the Rio Vinagre is perfectly limpid; its density 1.0015; taste very acid and astringent, indicating an aluminous salt; reddens litmus speedily, even after being boiled a long time; with

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* For a full description see vol. xix of this Journal, and vol. ii of the Yale College Elements of Chemistry.

zinc filings, produces hydrogen gas. The reagents indicate sulphuric and hydrochloric (muriatic) acids, with lime and alumina, and traces of iron and magnesia.

Quantitative results of an analysis at Puracé, April, 1831.—422 grammes* of the water gave, with nitrate of silver, 2.01 grs. of chloride of silver, equivalent to 0.384 gr. hydrochloric acid. 422 grammes, treated by chloride of barium, gave 1.35 gr. sulphate barytes, containing 0.464 gr. sulphuric acid.

422 grammes, concentrated by evaporation, were treated with caustic ammonia, and gave a precipitate of alumina weighing 0.17 gr. which contained traces of iron and magnesia; from the fluid, deprived of the alumina, oxalate of ammonia precipitated lime; the oxalate of lime, changed into a carbonate, weighed 0.10 gr., containing 0.056 gr. lime; the liquid was now evaporated and the ammoniacal salts driven off, and there was a residuum of alkaline salts of soda; these were changed to a sulphate; the sulphate of soda weighed 0.13 gr., but in dissolving in water lost 0.01 gr. of silex, and was thus reduced to 0.12 gr., representing 0.05 gr. of soda.

The water of the Rio Vinagre contains, according to this analysis,

Sulphuric acid, - - - -	0.00110
Hydrochloric acid, - - -	.00091
Alumina, - - - - -	.00040
Lime, - - - - -	.00013
Soda, - - - - -	.00012
Silica, - - - - -	.00023
Oxides of iron and magnesia, traces.	

Or, supposing the alumina and lime to be combined with the sulphuric acid, the composition of the water may be given thus:

Sulphate of alumina, - - -	0.00131
Sulphate of lime, - - -	.00031
Chloride of sodium, - - -	.00022
Silica, - - - - -	.00023
Hydrochloric acid, - - -	.00081

But it is not only possible, but even probable, that the acidity of the water of the Pasambio is owing more to the sulphuric than to the hydrochloric acid, since free hydrochloric acid could not be found in the products of the volcano of Puracé, and I have discovered in the crater of the volcano of Pasto a great quantity of an acid sulphate of alumina, which communicates to the water an acid and astringent taste.

* The gramme is about 15¼ grs. Troy.

ART. XVI.—*Notice of the Dispensatory of the United States of America; by* GEORGE B. WOOD, M. D., Prof. of Materia Medica and Pharmacy in the Philadelphia College of Pharmacy, &c. &c., and FRANKLIN BACHE, M. D., Prof. of Chemistry in the Philad. Coll. of Pharmacy, &c. &c. Philadelphia: Grigg & Elliot. 1833. 8vo. pp. 1073.

AMONG the benefits, as well as the evidences, of a liberal attention to the arts and sciences in any nation, is the improvement of its materia medica. So urgent is the necessity of healing applications in the case of wounds, and of disordered functions of the system, that no people, however low in the scale of civilization, are to be found entirely destitute of the means of aiding nature in her efforts at restoration. The principal resort of savage tribes is the virtues of plants, whose peculiar qualities accident or untutored ingenuity has taught them to investigate. The amount of knowledge thus acquired by the inhabitants of our forests is a matter of proverbial remark. The popular impression, that Providence has provided an appropriate remedy for every disease, and that it depends only on the skill and industry of man to find it out, is probably cherished among the rude as well as the more refined portions of mankind; and that the distinction which those have gained who have been most successful in the acquisition of this knowledge, has served as a powerful stimulus to greater attainments in the medical virtues of substances derived from either of the three kingdoms of nature, there can be little doubt. To what extent this knowledge has been benefited by the researches of pure science, can be demonstrated only by a reference to the history of alchemy, and to the surprising discoveries which have rewarded the labors of those who have devoted themselves to an experimental acquaintance with the chemical laws of matter. Medicine, it is well known, is greatly indebted to the extravagant search after the universal solvent, the powder of projection and the elixir of life. And when, in the ardor of these vain dreams, any new compound was discovered, which upon trial was found to possess active powers upon the organs of digestion, the discoverer often broke forth, into extravagant manifestations of joy. No one can read the rhapsodies of Basil Valentine, in his "Triumphant Chariot of Antimony," or, as it was styled in the original German, "Triumph Wagen Antimonii," nor the eloquent raptures of Glauber, in Packe's folio account of his "sal mirabile," without a smile at the lofty tone and self congratulations of these enthusiasts; and yet, without a portion of enthusiasm, who would have braved the ridicule, and endured the toil and labor of these distinguished alchemists. When we consider, also, the immense amount of benefit which the world has derived from the depletive virtues of these compounds, who would venture to pronounce a sentence of condemnation on the extravagant anticipations of their discoverers?

But the multiplicity of active and valuable medicines with which modern chemistry has enriched the pharmacopœia, is a proof that health, as well as other physical comforts, is not to be left to the wayward influences of time and chance, but to be brought within the domain of sound and rational science.

Pharmacy, therefore, when it advances beyond the mere art of arranging and preparing its simple Galenicals, and aspires to the distinction of a science, must array itself in the garb of chemistry and conduct its operations agreeably to the genuine principles of inductive philosophy. It will then steadily march forward in the track of improvement, abandoning all empiricism, and rejoicing in the lights and ameliorations which scientific research confers upon it.

It is but recently that the Pharmacopœia became an object of attention to those who were qualified, by their attainments in chemistry, to divest it of its charlatanry, and to point out the numerous inconsistencies with which it abounded. The basis of a good, renovated treatise on the materia medica was laid by Lewis, who brought to bear upon the subjects on which he wrote, all the advantages which an accurate acquaintance with the science of his day, enabled him to apply. Much was left, however, in this extensive garden, for modern chemistry to weed out, and abundant room for the transplantation of new and valuable materials. Medical men, allied to the different schools of Europe, in proportion to their acquaintance with chemistry, perceive the fallacies of the books most in vogue, and as every country affords some specific contributions to the arts, it is by no means surprising that local peculiarities should become obvious in medical formularies. London, Edinburgh and Dublin has each its Dispensatory, and, on the continent of Europe, treatises on pharmacy, more or less extensive, are sufficiently numerous.

The state of medical and pharmaceutical knowledge in this country seemed loudly to call for a national work, that might justly serve as a standard amid the conflicting claims of European treatises, and the knowledge and experience of our chemists and physicians. A national medical convention accordingly met at Washington and provided for the publication of a pharmacopœia. This work was published in New York, in 1820, but it did not appear to attract general attention, or satisfy the demands of the profession. At the decennial meeting of the convention, held in Washington, in 1830, a revised edition of it was ordered, which was published in Philadelphia, in 1831.* Of the superior accuracy of this pharmacopœia over any other, published or republished in this country, there cannot, we think, be any doubt.

But a pharmacopœia, published under the authority of a board of physicians or licensed apothecaries, and limited as such works generally are to officinal titles, objects and preparations, is not sufficient to satisfy the mind of the student, (and what physician ceases to be a student with respect to the natural history, preparation, and various qualities, chemical and physical, of the multifarious substances which his profession calls for,) who aims at a clear and accurate comprehension of the materia medica. It is justly, therefore, stated by our authors, that the "national pharmacopœia requires an explanatory commentary, in order that its precepts may be fully appreciated and advantageously put in practice. On these accounts, (say they,) it is desirable that there should be a Dispensatory of the United States, which, while it embraces whatever is useful in European pharmacy, may accurately represent the art as it exists in this country, and give instruction adapted to our peculiar wants." The voice of every American physician will doubtless respond to this opinion, and no less freely to the sentiment of the authors, that "It appears due to our national character, that such a work should be in good faith an American work, newly prepared in all its parts, and not a mere edition of one of the European dispensatories, with here and there additions and alterations, which, though they may be useful in themselves, cannot be made to harmonize with the other materials, so as to give to the whole an appearance of unity, and certainly would not justify the assumption of a new and national title for the book."

With these enlightened views of the nature of the task before them, it is not to be presumed that they entered upon the determination to write a "United States Dispensatory," without a becoming sense of the fertility of their resources, and we have thus a sort of

* Vide Am. Jour. Vol. XXI, p. 177.

a priori pledge of their ability and fitness for the task. In short, no well grounded expectation could be formed of such a work, unless it were undertaken by persons at once skilled in the details of chemistry, and conversant with medical practice in the foremost circles of the profession. We therefore felt an assurance, when we found that this work had issued from the combined talents and industry of two of the professors of the Philadelphia College of Pharmacy, one of them known to be an accomplished chemist and the other of high standing as a practical physician, that it would not disappoint the hopes of the profession; and this assurance was by no means diminished by the acknowledgment of the authors, that they had received assistance from the president of the College, whose attainments and judgment, in all that relates to the business of a scientific apothecary, our pages (already referred to) bear testimony.

The Pharmacopœia of the United States has been adopted as the basis of the work before us, but in the selection and concoction of their materials, the authors have availed themselves of all the information obtainable, not only from the Dispensatories of the late Dr. Andrew Duncan and Dr. A. T. Thomson, each of them standard works in their respective countries, but from the best pharmaceutical works of the European continent. "The pharmacy of continental Europe," they observe, "is ground which has been almost untouched, and much information in relation to the natural history, commerce and management of our own drugs, has lain ungathered in the possession of individuals, or scattered in separate treatises and periodicals, not generally known and read." "The Pharmacopœias of London, Edinburgh and Dublin have been incorporated in all their essential parts. Their officinal titles are uniformly given, but always in subordination to those of the United States Pharmacopœia, when they express the same object; but in chief, when, as often happens, no corresponding medicine or preparation is recognised by our national standard." "Besides these officinal substances, some others have been described, which, either from the lingering remains of former reputation, or from recent reports in their favor, or from their important relation to medicines in general use, appear to have claims upon the attention of the physician and apothecary."

"In the description of each medicine, if derived immediately from the animal, vegetable or mineral kingdom, the attention of the authors has been directed to its natural history, the place of its growth or production, the method of collecting and preparing it for market, its commercial history, the state in which it reaches us, its sensible properties, its chemical composition and relations, the changes which it undergoes by time and exposure, its accidental or fraudulent adulterations, its medicinal properties and application, its economical uses, and the pharmaceutical treatment to which it is subjected. If a chemical preparation, the mode and principles of its manufacture are indicated, in addition to the other particulars. If a poison, and likely to be accidentally taken, or purposely employed as such, its peculiar toxicological effects, together with the mode of counteracting them, are indicated; and the best means of detecting its presence by reägents are explained."

We have deemed it right to let the authors speak for themselves, in relation to the plan of their work, by extracting thus largely from the preface. Such a plan could not be followed out without rendering the work necessarily of greater size, than any other book of this nature which has fallen under our notice. It is an octavo of one thousand and seventy three pages, and these of rather unusually large size. Dr. Duncan's (Edinburgh) Dispensatory contains, indeed, about fifty more pages, but the pages of the work under our review are nearly one third larger. The American work, moreover, consists entirely of a commentary on the officinal articles, except sixteen pages on pharmaceutical operations, introductory to the second part; whereas the British dispensatories are encumbered with an introduction to elementary chemistry, which it is probable few persons read, inasmuch as more ample or extended treatises on chemistry must be studied by those who aspire to a correct or intelligent understanding of the theory or practice of pharmacy.

The sixteen pages to which we have alluded, will be found to confer no small value on the work. They consist of lucid directions to the pharmaceutical student, on the best means of conducting his operations, and are quite a *multum in parvo* on the choice and management of apparatus, on collecting and drying plants, on the preservation of medicines, on weights and measures, and other analogous and useful matters. This addition to the book, we learn, from a note in the preface, is from Mr. Daniel B. Smith, the president of the College.

The authors have not departed, in the arrangement of their materials, from the course usually pursued in the best pharmacopœias and dispensatories. Under the head of Materia Medica, they have treated, in strictly alphabetical order, of medicines in the state only in which they are produced by nature, or have come into the hands of the apothecary. As a dispensatory is intended more for reference than for regular perusal, no classification of its materials could compensate for the absence of that facility which the alphabetical arrangement affords. This constitutes the first part of the work, and occupies about two thirds of the volume. The second part includes all medicines of established value which come under the denomination of *preparations.* These are, in like manner, treated of alphabetically, and the authors have, in every instance, preferred the names given to each medicine which is recognised by the Pharmacopœia of the United States; but they have also given, in subordination to these, the officinal titles of the best English pharmacopœias, and they have also, as in the excellent work of Dr. A. T. Thomson, given botanical descriptions of the plants from which the medicines treated of are derived.

In an appendix of sixteen pages, the authors have treated of the art of prescribing medicines, and have given a list of common extemporaneous prescriptions, with very useful tables of weights and of measures, both of capacity and length, (comparing the French with the English,) with tables of specific gravity, &c. and terminating with a comparison of thermometers.

But the relative merits of this new Dispensatory must unquestionably depend not so much on the arrangements which the authors have adopted, for in this respect they do not differ very materially from the best models which they had before them, but on the taste, judgment, and science displayed in its execution. A work of this kind, in order to claim a superiority over its predecessors, must take cognizance of the advancements of knowledge, not only in our own country, but in all parts of the world, and avail itself of that activity of chemical and medical research for which the present period has been so much distinguished.

It is well known that the German and French schools have latterly been most conspicuous in chemical discovery, and in its applications to pharmacy and the arts. The *Journal de Pharmacie* of the French metropolis, although impeded as most of the French journals have been by the political disturbances of that country, has been for some time one of the best vehicles of information extant. We have looked a little into this matter, in reference to the work before us, and have been gratified to find that the authors were duly aware of the importance of resorting to the discoveries of continental Europe, that their chemistry is principally derived from Berzelius and Thénard, and that they are familiar with the pharmaceutical skill of such men as Pelletier, Robiquet, Caventou, Majendie, and others whose industry and talents combined, have not been equalled in any part of the globe.

The following substances have been introduced into this Dispensatory, although not officinal in any British or American Pharmacopœcia. They are thus admitted on account of their growing imporand for other reasons that might be assigned; viz. oxalic acid, antimony, baryta, bassora gum, bromine, chloride of lime, carbon, cahinça, copper, bean of St. Ignatius, iron, ginseng, phosphorus, lead, potassium, salep, iodine, chloride of soda, &c. We are rather surprised in not finding in this list chloric ether, or chlorated alcohol, salicine, (incidentally mentioned, however, under salix,) ilicine, (from Ilex aquifolium,) gelatine, much used in the French hospitals, derived from bones, and other articles which might be named; but we are more disposed to credit the authors for their actual additions, than to censure them for their omissions. Their new Dispensatory, judging from a comparison of it with others that we have looked at, is to be taken entirely as a new composition, and as such it bears upon the face of it evidences of that taste which can only spring from an habitual and extensive acquaintance with the sciences, botanical, chemical, and therapeutical, on which a work of this nature must necessarily be based.

Did our space admit of it we should assign to this volume a more extensive analysis; and we cannot well dismiss it without adverting more fully to some of the articles which appear to contain the most valuable original matter. Under the head *Acidum Arseniosum* to which the authors have devoted eight pages, the reader will find a luminous statement of the chemical and medical history of this substance, in which is cited the experience of some of the highest medical authorities in this country. We insert the following extract as characteristic of the style and manner of the work.

"*Medical properties.*—The preparations of arsenic have been used both internally and externally. Internally their action is alterative and febrifuge; externally, for the most part, violently irritant. They have been considered as peculiarly applicable to the treatment of diseases of a periodical character. In commencing with their exhibition, the dose should at first be small, and afterwards gradually increased, its operation being carefully watched. When the specific effects of the medicine are produced, it must be immediately laid aside. These are a general disposition to œdema, especially of the face and eyelids, a feeling of stiffness in these parts, itching of the skin, tenderness of the mouth, loss of appetite, and uneasiness and sickness of the stomach. The peculiar swelling produced is called *Œdema Arsenicalis*. The principal preparations now in use, are the arsenious acid, the article under consideration, and the solution of arsenite of potassa, or Fowler's solution. The arsenite of potassa and sulphuret of arsenic are also occasionally employed.

"It may be a question whether the different arsenical preparations act precisely in the same way, when exhibited internally. It is the opinion of some, that the election need only be regulated by the convenience for exhibition. Dr. Physick, whose opinion is entitled to great respect, thinks otherwise; for, with regard to the arsenious acid, and the solution of arsenite of potassa, (Fowler's solution,) the result of his experience is, that they act differently, and cannot be substituted for one another.

"Some writers have entirely proscribed the use of the arsenical preparations in medicine. Among them, one of the most authoritative is Mr. Brande. He conceives the introduction of them into the pharmacopœias to be a great evil; as facilitating, by legalizing the medicinal use of the poison, its employment for self destruction and murder. At the same time, he believes that more harm than benefit has resulted from its administration.* We confess, however, that we do not share those opinions with Mr. Brande. Arsenic is confessedly a virulent poison, and is often employed for criminal purposes; but when it is considered how extensively it is used in the arts, it is questionable whether its exclusion from the materia medica would much reduce the facility of obtaining it. On the other hand, it may be asked are poisons more dangerous as medicines than other medicinal articles, if given in their appropriate doses? We should think not, although we are free to acknowledge, that dangerous mistakes in the dose are more apt to be made. If the views of Mr. Brande were carried out, they would lead to the discarding of the corrosive chloride of mercury, hydrocyanic acid, strychnia, and other articles from the materia medica; but we believe that no practitioner will be found willing to strike these substances from the list of remedies.

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* Man. of Pharm. p. 20.

"While we wish to retain arsenic as a potent remedy in the hands of the judicious practitioner, we should be glad to find the public authorities in the United States subjecting the sale of this poison to strict regulations, under heavy penalties for their infraction. Speaking of the practice in Europe, Berzelius remarks, "Le commerce de l'acide arsénieux est toujours soumis à une surveillance sévère, et l'achat n'en est permis qu'à ceux, qui ont donné des preuves légales qu'il leur est indispensable dans l'exercise de leur état. A l'exception de ces cas, l'acheteur et le vendeur sont soumis à une responsibilité très sévère."*

To this succeeds an account of the diseases in which arsenic has been exhibited with the greatest advantage,—its properties as a poison, the most appropriate antidotes, and the best means of detecting its presence. The authors avail themselves, among other authorities, of the late work of Dr. Christison, which we regard as the most worthy of confidence on this difficult point of chemical inquiry.

In their account of *Oxalic acid*, we have an elaborate statement of its preparation, its properties, physical, medical and toxicological, with the appropriate remedies. "From the composition of oxalic acid, as given above, (say the authors,) it is plain that this acid corresponds in composition to carbonic acid and oxide, taken together, and is, therefore, intermediate in the quantity of oxygen which it contains between this acid and oxide. Notwithstanding it contains less oxygen than carbonic acid, it is incomparably a stronger acid, which circumstance may be accounted for by supposing some peculiarity in the mode in which its constituents are combined. The composition of the acid not only corresponds with the united constituents of carbonic acid and oxide, but there is reason to believe that these two compounds are actually its proximate constituents; for, if it be treated with strong sulphuric acid, the whole of the water will be abstracted, and the elements of the dry oxalic acid will be instantly resolved into equal volumes of carbonic acid and carbonic oxide. Oxalic acid seems, therefore, to require one equivalent of water as a bond of union between its elements, without which they arrange themselves in a new binary order."

Water, one of the most important articles of the materia medica, is altogether omitted in the British pharmacopœias, but most properly introduced into that of the United States. Under the head of *Aqua*,

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* Traité de Chimie, II, 431. Paris, 1830.

our authors have inserted a well written and valuable account of the chemical and physical characters of pure water, the ingredients which usually deteriorate its qualities, the mode of detecting them, with a statement of the common distinct properties of spring, river, well, lake and marsh water, and, what is very judicious in a work of this kind, a brief account of the principal mineral waters of the United States, and of some of the most celebrated in Europe. The article terminates with some appropriate observations on the use of water as a bath.

The article *Hydrargyrum*, with the various preparations of mercury, occupies thirty three pages, and bears the marks of great care, skill and research.

In the account of *Alcohol*, which is full and accurate, it is very properly observed, that "physicians ought to be on their guard, not to prescribe alcoholic remedies in chronic diseases, whether alone or in the form of tinctures, for fear of begetting habits of intemperance in their patients. As an article of daily and dietetic use, alcoholic liquors produce the most deplorable consequences. Besides the moral degradation which they cause, their habitual use gives rise to dyspepsia, hypochondriasis, visceral obstructions, dropsy, paralysis, and not unfrequently mania."

Under *Iodinum*, which takes up five pages, the physician and apothecary will find a good account of a substance but recently introduced into the materia medica, and which already holds a valuable rank in the cure of glandular and other diseases.

The account of the Leech we deem to be so well drawn up, and furnishing withal an article so appropriate to a scientific journal, that we cannot deny ourselves the pleasure of inserting it entire, although at the risk of extending our notice of the present work beyond the limits usually assigned to the review of a new book.

Hirudo Medicinalis. Dub.

The Leech.

Sangsue, *Fr.;* Blutegel, *Germ.;* Mignatta, *Ital.;* Sanguijuela, *Span.*
Hirudo. *Class* 1, Annelides. *Order* 3, Abranchiatæ. *Family* 2, Asetigeræ. *Cuvier.*

The Leech belongs to that class of invertebrated articulated animals called *Annelides.* This class contains the worms with red blood, having soft retractile bodies, composed of numerous segments or rings, breathing generally by means of branchiæ, with a nervous system consisting in a double knotted cord, destitute of feet, and supplying their place by the contractile power of their segments or rings. The third order of this class, *Abranchiatæ*, comprehends those worms which have no apparent external organ of respiration. This order is again divided into two families, to the second of which, the *Asetigeræ*, or those not having setæ to enable them to crawl, the Leech belongs.

It is an aquatic worm, with a flattened body, tapering towards each end, and terminating in circular flattened discs, the hinder one being the larger of the two. It swims with a vertical undulating motion, and moves when out of the water, by means of these discs or suckers, fastening itself first by one and then by the other, and alternately stretching out and contracting its body. The mouth is placed in the centre of the anterior disc, and is furnished with three cartilaginous lens-shaped jaws at the entrance of the alimentary canal. These jaws are lined at their edges with fine sharp teeth, and meet so as to make a triangular incision in the flesh. The head is furnished with small raised points, supposed by some to be eyes. Respiration is carried on through small apertures ranged along the inferior surface. The nervous system consists of a chord extending the whole length, furnished with numerous ganglions. The intestinal canal is straight and terminates in the anus, near the posterior disc. Although hermaphrodite, leeches mutually impregnate each other. They are oviparous, and the eggs, varying from six to fifteen, are contained in a sort of spongy, slimy cocoon, from half an inch to an inch in diameter. These are deposited near the edge of the water, and hatched by the heat of the sun. The leech is torpid during the winter, and casts off, from time to time, a thick slimy coating from its skin. It can live a considerable time in sphagnous moss, or in moistened earth, and is frequently transported, in this manner, to great distances by the dealers.

Savigny has divided the genus Hirudo of Linnæus, into several genera. The true leech is the Sanguisuga of this author, and is characterized by its three lenticular jaws, each armed with two rows of teeth, and by having ten ocular points.

Several species are used for medicinal purposes, of which the most common are the gray and the green leech of Europe, both of which are varieties of the *Hirudo medicinalis* of Linnæus, and the *Hirudo decora* of this country.

1. Hirudo medicinalis. Linn. ed. Gmel. I. 3095.—*Sanguisuga officinalis*. Savigny. Moq. Tandon, Mon. Hir. p. 112, t. 5, f. 1. The *green leech*.—*Sanguisuga medicinalis*. Savigny. Moq. Tandon, Mon. Hir. p. 114, t. 5, f. 2. The *gray leech*.

Many of the best zoologists regard the *Sanguisuga officinalis* and *S. medicinalis* of Savigny, as mere varieties. They are both marked with six longitudinal dorsal ferruginous stripes, the four lateral ones being interrupted or tesselated with black spots. The color of the back varies from a blackish to a grayish-green. The belly in the first variety is of a yellowish-green color, free from spots, and bordered with longitudinal black stripes. In the second, it is of a green color, bordered and maculated with black. This leech varies from two to three or four inches in length. It inhabits marshes and running streams, and is found abundantly throughout Europe.

The great use made of leeches in the modern practice of medicine, has occasioned them to become a considerable article of commerce. They are collected in Spain, France, Italy and Germany, and exported in large numbers to London and Paris. They are also frequently brought to this country, as the practitioners in some of our large cities use only the foreign leech, although our own waters furnish an inexhaustible supply of this useful worm.

2. *Hirudo decora*. (*Say. Major Long's Second Expedition*, II. 268.) The medicinal leech of America has been described by Say, under the name of *Hirudo decora*, in the appendix of the Second Expedition of Major Long. Its back is of a deep pistachio green color, with three longitudinal rows of square spots. These spots are placed on every fifth ring, and are twenty two in number. The lateral rows of spots are black, and the middle range of a light brownish orange color. The belly is of the same color, variously and irregularly spotted with black. The American leech sometimes attains the length of four or five inches, although its usual length is from two to three. It does not make so large and deep an incision as the European leech, and draws less blood.

The use of the indigenous leech is nearly restricted to the city of Philadelphia. The practitioners of New York and Boston depend for their supplies upon foreign countries, and leeching is seldom resorted to in the southern or western states. Those which are used in Philadelphia, are generally brought from Bucks and Berks county, in Pennsylvania, and occasionally from other parts of the state. It is estimated that from two hundred to two hundred and fifty thousand are annually consumed.

The proper preservation of leeches is an object of importance to the practitioner, as they are liable to great and sudden mortality. They are usually kept in jars, in clear water, which should be changed twice or three times a week. The jar must be covered with a linen cloth, and placed in a situation not liable to sudden changes of temperature. They will live a long time, and continue active and healthy, without any other attention than that of frequently changing the water in which they are kept. M. Derheims has proposed the following excellent method of preserving them. In the bottom of a large basin, or trough of marble, he places a bed, six or seven inches deep, of a mixture of moss, turf, and fragments of wood. He strews pebbles above, so as to retain them in their place without compressing them too much, or preventing the water from freely penetratiug them. At one end of the trough, and about midway of its height, is placed a thin slab of marble or earthern ware, pierced with numerous holes, and covered with a bed of moss, which is compressed by a thick layer of pebbles. The reservoir being thus disposed, is half filled with water, so that the moss and pebbles on the shelf shall be kept constantly moist. The basin is protected from the light by a linen cover, stretched over it. By this arrangement, the natural habits of the leech are not counteracted. One of these habits, essential to its health, is that of drawing itself through the moss and roots, to clean its body from the slimy coat which forms on its skin, and is a principal cause of its disease and death.

Medical uses.—Leeches afford the least painful, and in many instances the most effectual means, for the local abstraction of blood. They are often applicable to parts which, either from their situation or their great tenderness when inflamed, do not admit of the use of cups; and in the cases of infants, are, under all circumstances, preferable to this instrument. They are indeed a powerful therapeutic agent, and give to the physician, in many instances, a control over disease which he could obtain in no other way. Their use is in a great measure restricted to the treatment of local inflammations; and, as a general rule, they should not be resorted to until the force of the circulation has been diminished by bleeding from the arm, or in the natural progress of the complaint.

In applying leeches to the skin, care should be taken to shave off the hair, if there be any, and to have the part well cleansed with soap and water, and afterwards with pure water. If the leech does not bite readily, the skin should be moistened with a little blood, or milk and water. Sometimes the leech is put into a large quill, open at both ends, and applied, with the head to the skin, until it fastens itself, when the quill is withdrawn. Leeches continue to draw blood until they are gorged, when they drop off. The quantity of blood which they will draw varies, according to the part to which they are applied, and the degree of inflammation existing in it. In the loose and vascular textures, they will abstract more than in those which are firm and compact, and more from an inflamed than a healthy part. As a general rule, our leechers apply six for every fluid ounce of blood. A single European leech will draw from half an ounce to an ounce. The quantity may often be much increased by bathing the wound with warm water. Leeches will continue to suck, after their tails are cut off, which is sometimes done, although it is a barbarous practice.

They may be separated from the skin at any time, by sprinkling a little salt upon them. After they drop off, the same application will make them disgorge the blood they have swallowed. Some leechers draw the leeches, from the tail to the head, through their fingers, and thus squeeze out the blood; after which, all that is necessary is to put them in clean water and change it frequently. Leeches which are gorged with blood, should be kept in a vessel by themselves, as they are more subject to disease, and often occasion a great mortality among the others. They should not be again used, until they have recovered their activity.

In cases where the bleeding from leech-bites continues longer than is desirable, it may be stopped by continued pressure, with the application of lint, or by touching the wounds with lunar caustic. It may sometimes be necessary, in the case of a deep bite, to sew the wound, which is readily done with a single stitch of the needle, that need not penetrate deeper than the cutis.

To this valuable account of the Leech, we would add, that it appears to be necessary to guard them against sudden changes in the electrical state of the atmosphere. That they are very susceptible of these changes, and are often destroyed by them, appears to be a well established fact, and from the experiments of M. Derheims of St. Omer, their death is occasioned by a coagulation of the blood by electricity. By placing the jar or vessel in which they are kept near a good conducting substance, their preservation from this source of danger might probably be secured.

The reader will find in the articles Cinchona, Rhubarb, Tartar Emetic, Calomel, Soap, Terebinthina, Wine, Colchicum, Elaterium, Quinia, and numerous others, similar evidences of originality, research, and sound judgment. Upon the whole, we consider the "Dispensatory of the United States of America" as deserving the title which it bears, as a valuable addition to the stock of American literature, and as worthy of a place in the library, not only of every physician and apothecary, of every lover of natural history, but of every one who aspires to some knowledge of the nature and character of those materials which, in skilful hands, are of so much importance in alleviating the pains and diseases which cast so deep a shade over the perspective of human existence.

Art. XVII.—*Notice of Prof. Dunglison's Human Physiology.* 2 vols. 8vo. Philadelphia: Carey & Lea, 1832.

The author of the above named work was one of the gentlemen, who, upon the establishment of the University of Virginia, were invited from abroad, to fill the professorial chairs in that liberally endowed institution. While resident in London, he was favorably known to the profession as the co-editor, with Dr. Copeland, of a respectable medical journal, the London Medical Repository; and in consequence of this knowledge, he was, at the suggestion of the late Professor Smith, complimented with the honorary degree of Doctor of Medicine, by the President and Fellows of Yale College. As the result of his labors, he has now favored the profession with a full and elaborate work on one of the most important and interesting branches of medical science. A particular examination of the doctrines of a work of this nature, would not exactly comport with the design of this Journal, but a few general remarks may not be unacceptable to a large class of its readers.

Systems of physiology have been written upon two plans, widely differing from each other. In one, the leading doctrines of the science are laid down, in a regular series, in the form of distinct propositions, beginning with the more simple and gradually advancing to those that are more abstruse. These propositions are accompanied by such facts or trains of reasoning as are sufficient, in the opinion of the author, to prove and illustrate them. In this way, physiology is made to bear the semblance of the more exact sciences; and were its doctrines susceptible of demonstration, this would be the only correct plan of placing it before the public. Unfortunately, however, such is the nature of this science, so obscure are many of the functions of the animal fabric, so minute are many of its parts and so mysteriously, in the present state of our knowledge, do they perform their important operations; and at the same time so prone is the human mind, over confident in its own powers, to erect general principles upon insufficient and insecure foundations, that many of the leading doctrines of physiology instead of being supported by demonstration are still matters of dispute; others maintain their credit rather by the authority derived from the name of their author, than by the strength of their supporting facts; and others still, are mere theoretical notions, with little either of fact or authority to uphold them.

This is essentially the plan of the justly esteemed work of Professor Blumenbach, the latest edition of which, translated into English and much enlarged, and brought down to the present time, by Dr. Elliotson, of London, contains a greater amount of truth, briefly yet plainly stated, with a smaller admixture of error, than any other similar treatise in the language. A reprint of this work in this country would be a valuable addition to its medical literature.

Under these circumstances many, perhaps most authors have adopted a different plan. This consists, for the most part, in a statement of all the known facts, or a selection of the most important of them, upon the several branches of the subject; in arranging them under heads corresponding with the systems of which the body is composed, and in deducing from them such doctrines, as in the author's view, they support. This plan, while it demands a minute and sometimes tedious detail of facts, and while it carries with it little of the air of a well arranged and established science, yet has many advantages. Especially, a more perfect opportunity is afforded to the reader, by the full display of facts, to judge of the soundness of the principles laid down, to correct those which are erroneous, and to form and establish others more correspondent to the truth. Even here, however, with all the facts before him, there is much to perplex the student of this interesting and important science. The mixture of truth and error, which he has not sufficient knowledge to distinguish and separate; the devious paths, struck out by ingenuity, leading to self display, rather than to simple truth, and sometimes the obvious sophistry employed to establish some favorite fallacy, embarrass and bewilder his mind. A work which should be free, in a great measure, from embarrassing circumstances of this kind, might be formed, by the united labor of learning, talent and industry, upon something like the following plan.

Many of the leading and most important doctrines in physiology, are firmly established, and are universally received as fundamental truths; such as the circulation of the blood, the sensibility, both common and peculiar, of the nerves, the power of alternate contraction and relaxation of the muscular fibre, and numerous others of a similar character. These should be fully and distinctly stated as established principles, and should be accompanied by the facts by which they are proved. There are many others, such as the doctrine of the vitality of the blood, the contractile power of the middle tunic of the arteries, the agency of a peculiar fluid in the stomach in the process of digestion, &c. which, although rendered highly probable by a multitude of supporting facts, are yet with difficulty reconcilable to others, and are therefore not universally received. These should be laid down, as a distinct class of principles; all the facts bearing upon them should be fully detailed, their truth or fallacy fairly canvassed, and whatever the opinion of the author concerning them may be, an impression should be left upon the mind of the reader, that, in the present state of the science, they are still unsettled, and therefore open for further investigation. Besides these, there is another large class of opinions, often the result of highly ingenious speculation, which yet are too slightly in accordance with known facts to challenge belief, and which still ought not to be passed over. These consist, for the greater part, of attempted explanations of the hitherto unintelligible processes of several parts of the animal body; such as speculations concerning the functions of the spleen, the lymphatic glands, ganglions of the nerves, &c. Such of these opinions as deserve notice at all, either from their ingenuity, or their semblance to truth, should be stated both to show the train of thought upon these subjects in which ingenious minds run, and as a connecting medium of all the known facts in relation to them.

The object of this plan is to place distinctly and severally before the mind of the inquirer into the doctrines of physiology, all that is known, all that is believed and all, of importance, that is conjectured concerning them, giving to each class its due weight and bearing. In this way much labor and perplexity would be saved to those who are entering upon the study of this important science. The great difficulty in executing a work upon this plan, in addition to the learning and talent which it would demand, would be, to preserve a sufficient degree of humility in the mind of one, competent by his learning and talents to execute it, to secure him from stating favorite hypotheses as strongly probable, and those which are only probable as established truths. Could a man be found, in whom were united the zeal, industry, and unconquerable love of truth of John Hunter, with a thorough education which he had not, such a work might be accomplished.

But to return to the Human Physiology of Dr. Dunglison. In a brief preface, the author states, that the "work was undertaken chiefly for the purpose of forming a text book for his students, in the University of Virginia;" and that "his object has been to offer a view of the existing state of the science, rather than to strike out into new, and perhaps devious paths." This object he has accomplished in a manner highly creditable to his character for learning, industry, and integrity. The principal favorable qualities of the work are the following.

In the first place, it is characterized by marks of great extent of research, and by variety of illustration. During the past century, and especially the latter half of it, the animal kingdom has been examined by thousands of highly gifted and industrious observers. These, in the progress of their labors, have peered into the minute recesses of the animal fabric, and have listened to the almost inaudible sounds given out by its secret workings, and have thus accumulated facts, formed opinions, and indulged in speculations, almost without number. These facts and opinions are scattered throughout the periodical and other similar works every where issuing from the press, or they are elaborated by their authors into distinct treatises, or are mingled with other and foreign matter in works upon other branches of natural science. From all these sources, Dr. Dunglison, with praiseworthy diligence, has collected every thing fitted for his purpose, and has arranged, in their proper order, the various materials which he found. Few facts or opinions of importance have been omitted, and the collection may be safely pronounced complete. At the same time, it is also, especially with regard to opinions, select; for he has judiciously omitted, or mentioned with becoming brevity, many of the thousand theories with which this branch of science has been encumbered by ignorance or incapacity. He has also examined the ancient authors with sufficient attention, and has transferred from them to his pages, much that is useful and interesting. The amount of labor necessary to make such a collection, can be duly estimated by those only who have, for many years, watched the progress of this science. In addition to the physiology, he has also given a brief anatomical description of the most important and interesting parts of the human body, illustrated by numerous engravings, inserted by the side of the letter press, sufficient to enable a person, slightly versed in anatomy, to understand the remarks which are made concerning their functions.

Another characteristic of the work is, the perfect fairness and integrity which is manifest upon every page. In this respect, it deserves high commendation. It is perfectly obvious, that the author intended to state every fact precisely as he found it, to place the arguments and the course of reasoning of others in the same light which they themselves would have done, and to give every fact, argument and opinion its due weight. This course, so different from that of the mere partizan author; of the unscrupulous or perhaps merely ardent advocate of a favorite opinion; and at the same time, so advantageous to the reader, saving, as it does, the necessity of referring to the original, in order to verify the statements which may be made, confers upon this work a large part of its value. The reader feels safe in relying upon it as authority, and the inquirer after truth refers to it with pleasure, feeling in no danger of inadvertent or intentional deception.

The style of the work is plain, without much attempt at ornament; perhaps somewhat diffuse, but always intelligible. The language rarely differs from that in common use by the best English authors. In both language and style, it is, at least, equal to the best class of American medical works. It is especially free from that admixture of foreign words and idiomatic expressions, which are unfortunately becoming so frequent among the junior members of the medical profession. The literature of medicine and its auxiliary branches, appears to be in danger of being overwhelmed by the torrent of new and unauthorized language let in upon it through the medium of imperfect translations from other languages, especially the French; of translations which, from the number of words turned into English only in their terminations, and of idioms not Anglicized at all, require, in order to understand them, almost as much knowledge of the language from which they are professedly translated, as the originals themselves. It is a subject of congratulation, that all error of this kind has been avoided by Dr. Dunglison, and that this, which will be for years a standard work in one branch of medical science will remain as a barrier against this inundation from abroad.

The critical reader will occasionally notice a word or phrase employed in an unusual sense; as, "laboring under perfect health," vol. ii, p. 158; and frequently the word *invoke*, as in the following, at p. 153, vol. ii, "some of which" *conjectures* "have been invoked by Sir Charles Bell;" and several others of a similar kind. Where there is so much that is correct, these will be easily passed over.

There are two omissions which many readers will regret. The first is, of all reference to the particular works where the facts and opinions quoted may be found; and the second, of a more complete and thoroughly digested index. These omissions are so common in the modern English and French works, that they are scarcely thought blameworthy; still the matters omitted are of so great convenience, the one to him who would examine the subject more thoroughly, and the other to the more casual inquirer, as to deserve a place in every work of merit.

A work like this, so abounding in important facts, so correct in its principles, and so free from errors arising from a prejudiced adherence to favorite opinions, will be cordially received and extensively consulted by the profession, and by all who are desirous of a knowledge of the functions of the human body; and those who are the best qualified to judge of its merits, will pronounce it, the best work of the kind in the English language.

Art. XVIII.—*Analysis of American Spathic Iron and Bronzite.*

A letter from Mr. Thomas G. Clemson, dated Paris, Nov. 28, 1832, to Mr. C. U. Shepard, contains the following notices:—

"1. The carbonate of iron, from Plymouth, Vermont, is composed as follows:

Carbonate of protoxide of iron, - -	7.428
Carbonate of magnesia, - - -	1.640
Carbonate of protoxide of manganese, -	0.656
Peroxide of iron, - - - -	0.030
Insoluble residue, - - - -	0.140
	9.894

"This ore is one of great value, and nothing prevents its being heated in the ordinary high furnace. The magnesia is rather abundant, and I perceived on the specimen small portions of sulphuret of iron. Nothing has a more deleterious effect upon iron than sulphur, and if it were present in considerable quantities, it would most certainly injure the qualities of the iron or steel produced, but this might be obviated by careful picking.

"2. Brown lamellar substance, labelled Bronzite, from Amity,* N. J. Alone, it is infusible before the blowpipe; with carbonate of soda, a transparent white pearl; the same reaction with borax. When reduced to an impalpable powder, it is attacked by acetic, nitric, muriatic and sulphuric acids.

"The analysis was made by means of muriatic acid and ammoniacal salts.

"The silica having been separated by evaporation, the alumina, iron, and a small portion of magnesia, were precipitated by ammonia, added to an acid solution of the substance. The lime was obtained by oxalate of ammonia, and the muriate of magnesia was evaporated to dryness and decomposed by sulphuric acid.

"The following are the results:

		Oxygen.	
Water, - - -	0.036	0.0319	1
Silica, - - -	0.170	0.0882	8
Alumina, - - -	0,376	0.1755	
Magnesia, - - -	0.243	0.0939	4
Lime, - - -	0.107	0.0299	
Protoxide of iron, -	0.050	0.0113	
	0.982		

By uniting the silica and alumina, and the bases magnesia, lime and oxide of iron, we have the formula $4(mg.C.f.)(S.al)^2+aq$, which represents a bi-silicio aluminate of isomorphous bases."

Mr. Clemson expresses the opinion, that the so called Bronzite is a new species; and proposes for it the trivial name of Seybertite, after the distinguished American analyst, Mr. Henry Seybert.

* We have received a duplicate of this analysis, through Dr. R. Harlan of Philadelphia, in a letter from that gentleman from Mr. Clemson, dated Paris, Nov. 28, 1882.

MISCELLANIES.

DOMESTIC AND FOREIGN.

1. *Vegetable origin of Anthracite.*

TO THE EDITOR.

Cambridge, Mass. Feb. 23, 1833.

Dear Sir—Geologists are now convinced that the common bituminous coal, so abundant in the eastern continent and in some parts of North America, owes its origin to vegetable depositions. The frequent discovery of partially mineralized wood, and of impressions obviously vegetable, presents, on this point, a mass of incontrovertible testimony. But I believe that many eminent geologists are not satisfied to refer the anthracite formation to the same origin. To this reference they have found an objection, which to them seems insuperable, in the vast quantity of this useful mineral. But is this objection really insuperable? Does it not proceed from a limited view of the operations of nature, from a disinclination to allow sufficient time for the execution of her stupendous designs? Many errors in geological science are justly attributable to an erroneous or limited estimate of time; and yet the eloquent chronicles of inanimate nature, tell us of changes in the constitution of the globe which we inhabit, for the accomplishment of which ages must have been requisite. How many years must have rolled away, after the disruption of the original rock, before the sandstone formation attained its present degree of compactness. Those, therefore, who deny that the anthracite is of vegetable origin, must bring forward some other objection than the want of time; and if they found their objections upon the extent and depth of this formation, we urge the analogy of the bituminous coal, and thus sustain the vegetable origin of the anthracite. It cannot be denied, that the power which could create mineral carbon, could also create vegetable carbon, and afterwards, by some great convulsion, subject it to an irresistible consolidating force. Indeed, to me it seems more in unison with the other arrangements of providence, that the vegetables which beautified the face of the earth, for the happiness of one race of beings, should afterwards, when those races had passed away, be stored up for the use of other successive generations of men. But the object of my communication to you at this time, is not to engage in the discussion of the question whether anthracite coal is of vegetable origin, except so far as may be necessary in the exhibition of the testimony which I am able to produce in support of that opinion. Mr. Bakewell, in his Introduction to

Geology, asserts, that no vegetable impressions have ever been discovered in the anthracite, and I believe that most geologists are of the same opinion. I have been so fortunate as to obtain from a small quantity of Schuylkill coal, six specimens proving that trees were at least present when the coal was formed, if vegetable matter is not its *materiel.* The best specimen presents the longitudinal section of a piece of wood, ten inches long and two inches broad. Another specimen exhibits a similar section six inches long. A third contains a bit of wood one inch square and one tenth of an inch in thickness, and this piece could be easily detached. Another specimen exhibits a section of wood, from four to five inches long, and about three inches in width. The grain of this piece resembles that of the oak. A fifth contains a section four inches by three. The sixth is the counterpart of the fifth; the two pieces, being the parts of a larger specimen, the cleft of the coal dividing the wood equally and similarly, leaving a portion in each division. These specimens exhibit not impressions merely, but real wood, resembling charcoal, although softer. In examining coal, I have often found indentations, which, by the aid of imagination, could be magnified into vegetable impressions; but I never before found real wood. About the specimens which I now possess, there can be but two suppositions. Either this wood was introduced, in some incomprehensible mode, into the heart of the solid mass of the coal, or else it is a remnant, not wholly consolidated, of the material from which the coal was formed. I believe that the latter supposition is more philosophical, and consequently more reasonable, than the former. Very respectfully, sir,

Your obedient servant, James Madison Bunker.

The specimens of Mr. Bunker fully confirm his statements, as regards the existence of large masses of ligneous fibre in the anthracite of Pennsylvania. The structure is very palpable, and much resembles that of the curled maple. Under the blowpipe, it burns more readily than the anthracite—does not, like that, decrepitate, and it exhales, at the same time, a peculiar odor. Every one has observed the appearance, on a small scale, of fibrous charcoal in the Pennsylvania anthracite, and the specimens now before us have evidently resulted from the mineralization (more or less complete) of large portions of wood.—Ed.

2. *Lehigh Coal and Navigation Company.*—Some of the most important interests of this company, as they stood in 1830, formed the subject of an article in Vol. XIX of this Journal, p. 8. We are

happy to observe, that this great region, (Mauch Chunk and its vicinity, on the Lehigh,) continues to be successfully explored, and particularly that the vast treasures of coal at the new mines at Room Run fully justify the statements made respecting them in the article quoted above.

Some serious difficulties and delays have been encountered, particularly upon the Delaware Canal; but all difficulties will ultimately yield to the intelligent perseverance and resources of the company; one hundred and fifty tons of coal are contracted to be delivered, from the Lehigh Mines, on board the boats, the ensuing season: four hundred thousand could be delivered in a season, with the application of no more force than was applied last year during a part of the time.

3. *Atmospheric pressure.*—I caused to be made, a very strong bell glass, nine inches in diameter, and low and flat, for the purpose of congealing water, by its own evaporation, in the manner of Prof. Leslie. It was tried upon the plate of one of M. Pixii's glass barreled air pumps, from Paris. At the moment, Mr. O. P. Hubbard, assistant in the chemical department of Yale College, and myself, and also a young man who was working the pump, were stooping and intently inspecting the experiment, and our faces were almost in contact with the bell, when it was instantaneously crushed by the pressure of the atmosphere, with a loud report from the collapse. The fragments of glass were innumerable, and some of them impalpable; some of the larger were driven into the glass plate of the pump, causing deep wounds, which it was necessary to remove by a new and thorough grinding, and, even in that way, they were not entirely obliterated. Still, neither of us was even scratched by the glass, for the obvious reason that the force was all exerted downward and inward.

4. *Siliceous glass formed from burning hay.*—Extract of a letter dated Watertown, Conn., March, 1833, from Mr. Chester Dutton, to Mr. Samuel W. S. Dutton of the Senior Class in Yale College.

"There was a quantity of siliceous glass formed from a stack of hay burned about a year since, within twelve rods of my father's house. Having never been observed before, it gave rise to various conjectures as to its origin. In the American Journal of Science and Arts, Vol. XIX, p. 395, I found a notice of siliceous glass formed from hay, by lightning, copied from Dr. Brewster's Edinburgh Journal. From the style of the notice, I should infer that it is a rare occurrence, and on that account interesting. The stack of which this was formed was a large one, and it burned with violence; the hay was all herds-grass, which you know has much silex in its epidermis."

Mr. Dutton was so kind as to hand to us specimens of this glass. It is of a light grey color, porous, vesicular, and inflated like scoriæ of furnaces and glass-houses, and like the upper scum of lava; its lustre is highly vitreous; it is tasteless, and very harsh between the teeth; it scratches window glass with great energy, and has every appearance of having undergone a perfect fusion, doubtless by the aid of the alkali and salts contained in the hay. The resemblance between it and that described in this Journal, in the case cited by Mr. Dutton, is very striking, and, as the statement is supported by credible testimony, there can be no reasonable doubt as to its origin.

5. *New England Asylum for the Blind.*—Dr. Howe, the celebrated historian and active friend of the Greek revolution, is at the head of this interesting institution, and we have read with pleasure and instruction, a discourse of his in relation to this subject. It is replete with important and gratifying facts respecting similar institutions in Europe, and affords the best ground of confidence, that success will attend the New England asylum, especially in such a community as Boston, and under the able and zealous direction of Dr. Howe. We were particularly impressed with the mechanical facilities afforded to the blind, by the sense of touch, which enables them to read by means of letters raised by stamping the paper, and even maps and diagrams are in the same way rendered intelligible.

It would appear, from the exhibition recently made at Salem, Mass., by pupils of this institution, that their attainments in reading, writing, arithmetic, geography, music, and various mechanical arts were of a high order, and called forth, in their favor, not only benevolent feeling and admiration, but very liberal pecuniary aid.

6. *Philosophical apparatus.*—The earlier cultivators of physical science in this country, encountered great inconvenience from the want of apparatus, and much expense and delay resulted, from their being obliged to send to London or Paris for almost every article.

Professors and teachers, who are still on the stage, can answer for the truth of this statement. Now, however, the case is happily reversed. Ingenious artists and good collections of apparatus are found in most of our cities, and many of our native artists are able to construct new instruments to order, and with accuracy, neatness, and dispatch. Still, it is desirable that the stock of talent, skill and *materiel* in this department should be increased, and we trust that the very respectable men already established in this line, will welcome to this country one who has long been celebrated in his own.

Mr. John Millington, civil engineer and machinist, and late professor of Mechanics in the Royal Institution, and of Natural Philosophy in Guy Hospital, London, has established himself at No. 207, Pine street, Philadelphia. The collection of apparatus and substances, specimens and various means of experiment, research and illustration, enumerated in the printed sheet of Mr. Millington, includes almost every thing that is needed, both by those who teach and by those who learn.

Mr. M. is also a practical machinist, architect and manufacturer, and proposes to furnish models, machines, substances, instruments, instructions, and every thing needed for a successful prosecution of the practical arts as well as of science. We trust that this country is wide enough both for him, and his coadjutors in the same important pursuits, and that all of them will find encouragement to continue and enlarge their establishments. We have formed a very favorable opinion of Mr. Millington from his papers in the English Quarterly Journal of Science.

7. *Notice of the Crotalus durissus, (L.,) as found in Carroll county, Geo., where it is called the Diamond Rattlesnake.*

TO THE EDITOR.

Dear Sir—This reptile is an inhabitant of the grey or sandy land covered by the long leaf pine and an under growth of grass and ferns.

It has its popular name of diamond rattlesnake from the manner in which two stripes, crossing from the point of his nose, extend back over his whole body, the intersections of which give the mathematical figure of the diamond or rhomboid. The lines are smallest where the diameter of the body is least, and on the largest part do not exceed the fourth of an inch in width. The body of the snake is of a light brown or copper color; the stripes are a light yellow, and at each extremity the color is darkest.

This rattlesnake is the largest reptile in this part of America. It is often eight feet long—skins of the largest size, when stripped from the body, have held three pecks of sand. Three, of great size, were killed during the past summer on the waters of the little Talapoosa; one of them had fifteen shells to his rattle. The Rev. Mr.

Haygood and Mr. Lyles examined the bones of the head of one, after they became exposed, from decay of the flesh. There were five fangs on each side of the jaw, above and below, making twenty teeth, which were more than an inch in length and nearly of the same size. When the jaws of the reptile are closed, the fangs, (as is the fact generally with venomous snakes,) fold like the claws of the feline animals. Dreadful as this rattlesnake may appear, there is no instance known *here* of any human being having been bitten by one of this species. Being usually found fat, and very large for the length, they are conequently sluggish and indisposed to attack, although, when aroused, their aspect is terrible.

The very broad head of this serpent, often four inches wide and the great number of large and long teeth make him altogether the most formidable snake in appearance, and probably he is the most fatal in North America. Yours respectfully,

JACOB PECK.

January, 1833.

This snake is described by Linnæus, and called by him *Crotalus durissus*. Descriptions of it may also be found in Rees's Cyclopædia, art. *Crotalus*;—Encyc. Amer. art. *Rattlesnake*;—Cuvier's An. King. (Am. ed.) vol. ii, p. 67, and Shaw's Zoology, vol. iii, pt. 2, p. 333. The last named account is accompanied by a drawing.—*Com.*

8. *Delaware Academy of Natural Sciences, and the Address of Dr. Henry Gibbons, at Wilmington.*—We are happy to observe the proofs of a high regard to mental culture, which this discourse exhibits; and we learn with pleasure that the Wilmington Academy exhibits, in its hall, a valuable collection in natural history, and especially in mineralogy. These collections are stated to be increasing, and that "a growing disposition, favorable to the cultivation of science, is manifested, more especially by the younger portion of the citizens of Wilmington." The disquisition of Dr. Gibbons is replete with interesting facts, relating to science, literature and morals; it finds its way equally to the head and the heart, leaving them both under the happiest influences. We have rarely read a more interesting discourse, pronounced on such an occasion.

9. *Proposal for establishing a seminary for education in Liberia.* A benevolent correspondent has addressed to the Editor a letter upon

the subject mentioned in the caption. Although it may not be strictly within the plan of this Journal, still if viewed as a moral experiment upon man, regarding a portion of his race, which, in the later centuries, and more especially since the discovery of America, has been oppressed and afflicted, almost beyond the examples of former ages, this project certainly ought not to be excluded from our pages. That the negro has a rational mind, is sufficient to entitle him to the consideration of the benevolent and philanthropic in all countries, and especially in those that claim the Christian name.

We do not think it necessary to discuss, with our correspondent, the various questions connected with the physical peculiarities of the negro. We would at once throw the *onus probandi* upon those who maintain, that he is a distinct and inferior variety of man: even if that were, which never can be proved, it would be equally necessary to admit numerous other subdivisions in the human race, since there are, even in Africa itself, many diversities almost equally striking, as in the case of the negro. It is much more simple, and we believe not less philosophical, to believe, that God has made of one blood all nations that dwell upon the face of the earth.

The colony in Liberia is an object of high intellectual and moral interest; and we hesitate not to say, that it has now arrived at such a degree of maturity, and presents such proofs of permanency, that it is high time to institute there, for the education of Africans, a seminary of a higher order than common schools. Its mode and form must be determined, by deliberate and wise consultation, among the friends of Africa and Africans in this country; with the advice and consent of the most enlightened and virtuous, and public-spirited citizens of Liberia itself. We are persuaded, that if an effort were extensively made, in this country, to obtain funds for the specific object of creating a liberal seminary of education in Liberia, it would, if prosecuted with vigor and perseverance, be successful, and we cannot doubt, that such a seminary, wisely constituted and directed, would prove a blessing, of incalculable value, to the infant colony of Liberia, and to Africa itself.

We do not, therefore, feel that we are departing from the design of this Journal, in proposing, in accordance with the wishes of our correspondent, that efforts be made, as soon as a plan can be satisfactorily devised and proper agents obtained, to raise funds for establishing in the colony of Liberia, in Africa, a liberal seminary for the education of African youth.

10. *The New Universal Gazetteer, by Edwin Williams*, is a small and valuable volume. Perhaps there is not another of its size which contains so much information, so well, and so concisely expressed. Mr. Williams is remarkable for condensing facts and descriptions into the smallest compass, without being abrupt, and for a terse style, appropriate to works of this kind. The type is clear, although small, and, as a book of reference, it is particularly convenient for its portable size.

The statistical tables, comprising thirty pages at the end of the volume, are interesting and useful. They contain the latest censuses of the United States, Great Britain, France and Ireland, and refer also to the tonnage, imports and exports, the colleges, post-roads, rail-roads and canals of the United States; also Martucci's population of China, comparative heights of mountains, lengths of rivers, and sizes of lakes, the number of Indians in the different states and territories, with many other valuable particulars.

Mr. Williams has just published "The Book of the Constitution," containing various important documents and resolutions respecting the true character and powers of the general government.

11. *Flint's History and Geography of the Valley of the Mississippi, &c.* 2d edition: Cincinnati, 1832.—The author, Rev. Timothy Flint, is already favorably known, by a previous edition of this work, and by other works relating especially to the "great valley of the west."

An emigrant himself, he is identified with all the varied interests which constitute the rapidly increasing prosperity of this noble and interesting section of the United States; and being one of its most favored sons, he has contributed his best services to develop its resources, to extend investigation, and to diffuse a knowledge of interesting facts.

With a mind filled, almost to enthusiasm, with his subject, familiar with facts, accurate in his observations, and intelligent and independent in his deductions, he is peculiarly fitted to appreciate and record the great moral and physical transformations which are now in progress in the west.

Having been an observer of man and nature, in every part of this great valley, and an eye-witness of most of the scenes he describes, they are depicted with faithfulness, and a freshness and fervor seldom found in works of this kind, and we doubt not the anticipations of the author of the happy influence of his book upon the intimate relations of the east and west will be fully realized.

An extract from the preface will show the reasons which prompted him to the work, and his claims as a historian. "He had devoted the best portion of twelve years to exploring the western country. He had remained, one or more seasons, in each of its great divisions. He had been familiar with Cincinnati, St. Louis and New Orleans, the points most central to the information and resources of their respective divisions, and had resided in each of those capitals. He had traversed this great valley in all its chief directions, in an employment which had necessarily brought him in contact with all classes of its people and all its aspects of society. He had had abundant communications with its scholars and distinguished men, and as an earnest lover of nature, he had contemplated her in the West, in her original dress and in all her phases. On foot and alone, he had wandered beside the long and devious rivers. He had been between two and three hundred days on the Mississippi and its tributary waters. He had published "Recollections" of these journeyings, which had been received by the public with great kindness. His chief efforts as an author had been directed to bringing the people of the west acquainted with one another, and with the beauty and resources of their own great country. He hopes it will not be deemed assumption for him to say, that he has done something towards bringing about an intimacy of good feelings between the elder sister, whose fair domain is the east country, the fresh breeze and the shores of the sea, and her younger sister, whose dotal portion is the western woods and the fertile shores of the western streams. A kind of affectionate feeling for the country where he has enjoyed and suffered all that the human heart can be supposed capable of feeling on this side of the grave, which contains his children, his charities, and all those ties which call forth aspirations for its well being, after he shall be in the dust, enlisted his first purpose to commence this work. The general amenity of the aspect of this country, of its boundless woods and prairies, its long and devious streams, and its unparalleled advancement in population and improvement, filled his imagination. He had seen the country, in some sense, grow up under his eye. He saw the first steam-boat that descended the Mississippi. He had seen much of that transformation, as if of magic, which has converted the wilderness into fields and orchards. He has wished to transfer to others some of the impressions which have been wrought on his own mind, by witnessing those changes."

The first part of this work, (nearly two hundred pages,) contains a general view of the valley, comprising the face of the country, its minerals, climate and diseases, its botany and zoology, the natural history of its birds, reptiles and fish, its rivers, an interesting account of the aboriginal inhabitants, its population, the national and religious character of the western people drawn to the life, their pursuits, a succinct view of the civil history of the country, and a section on immigration, particularly useful to those who are about to try their fortunes in the west, and interesting to all who would be acquainted with the humble but incipient measures for the foundation of that future immense empire. A particular account is given of each state and territory, then of the Atlantic states and the remainder of the continent, with an appendix of various useful statistical tables.

This work, replete as it is with interesting matter, forms a valuable addition to our knowledge and literature, and is worthy of a place in the library of every American.

We observe, with pleasure, that it is highly esteemed in London, as appears by a flattering notice in the Weekly Atheneum for December, 1832.

12. *Indiana Historical Society.*—This society was founded December 11, 1830, and confirmed by act of the local legislature January 10, 1831.

The natural, civil, and political history of Indiana is its principal objects of attention, and it embraces useful knowledge generally.

Among the names of its officers, we observe those which are well known and greatly respected throughout the union. At its annual and semi-annual meetings, it is proposed that lectures or discourses be delivered on the following subjects:

1. The history of the Indian tribes within the State.

2. The civil and political history of the State from its earliest settlement.

3. The ancient remains and natural curiosities within the same.

4. Its Natural History, embracing its geology, mineralogy and botany, its soil, productions and climate, its animals, birds, fishes, &c.

The society resolved to communicate its constitution, &c. to other historical and learned societies, to the executive governments, and to distinguished individuals in other States, and they desire contributions in books, manuscripts, curiosities, &c. All communications are to be addressed to John H. Farnham, Corresponding Secretary, Salem, Windham County, Indiana.

Every friend of his country and of mankind will wish success to this infant institution which affords a happy presage of the character of the young and rising State in which it is situated. The society have published an important document signed by the Hon. Nathan Dane, of Beverly, Mass., showing what were the true foundations of the government of the United States, and of the free land titles of the States north of the Ohio, and also of their exemption from the curse of slavery.

The *people* of the United States formed their own government *before there were any States*, and Mr. Dane was chiefly instrumental in procuring the free land titles and in excluding slavery from the States and territory north of the Ohio.

13. *Explosion of bellows by inflammable gas.*

TO PROFESSOR SILLIMAN.

Sir—An explosion happened in this place, last week, in a smith's shop occasioned, as I suppose, by hydrogen gas. The circumstances of the disaster were related to me as follows:—The workmen had been in the practice of putting into the forge fire a small piece of hard wood, when leaving work, to obtain fire from in the morning; the evening before the explosion, they, as usual, put in a piece of *elm, wet* from being immersed in water, (as was their usual custom,) and covered the same with the cinders and ashes of the forge, probably half a bushel in all, and left it after *hooking up the bellows* with a harsp to the gallows on which the lever for working the same rests. In the morning, they found the *fire* and *covering undisturbed*, but the bellows, which were made of two inch plank, split to pieces, the leathers torn from them, gallows torn down which was fastened by two four inch spikes, and the brick work cracked and started at its base. The place for the tube of the bellows was of cast iron, six inches through, and the tube about twenty inches long, which remained uninjured; not the slightest appearance of fire, on any thing near, was to be found. As this is the first instance in which any thing of the kind has ever happened here, some were led to the conclusion, that it must have been done by gunpowder, which I think could not be the case, as there were no indications of it. Yours respectfully,

ANTHONY S. JONES.

Newburyport, February 3, 1833.

Remarks.—The occurrence stated by Mr. Jones, although by no means uncommon, was one of unusual violence; but, from the circumstances it appears to admit of a satisfactory explanation. The bellows, being hooked up to the cross beam, there was of course as large a cavity as possible, filled, at first, with common air. The wet wood, buried in hot ashes and cinders, necessarily emitted, during the whole time of its carbonization, a great deal of carburetted hydrogen gas, mixed with carbonic acid, and probably also with carbonic oxide. The pressure of the covering of ashes and cinders obstructed the escape of these gases into the air of the room, and forced a part of them into the bellows, and when the explosive proportion was attained, the mixed gases were kindled by the fire in the forge, just as a musket or cannon is discharged by fire applied at the touch hole.

The most powerful explosive proportions are one seventh or one eighth of the inflammable gas to six sevenths or seven eighths of common air, and this proportion might be, under the circumstances, readily attained. To chemical readers, it is not necessary to expatiate upon circumstances which are so familiar to them; such explosions are not uncommon; but commonly they are not destructive. Even philosophical laboratories are usually furnished with forge bellows. In the laboratory of Yale College, we have, in a number of instances, witnessed explosions arising, evidently, from the suction of inflammable gas into the bellows, especially during the cessation of the blowing and the gradual descent of the lower plank of the bellows, which, in consequence of the weight usually attached to it, falls slowly as the lever ceases to work, and thus draws the inflammable gas with it, into the bellows. We have never seen the bellows actually torn by the explosion, but we have seen heavy weights thrown, suddenly, from the top, by the violent jerk, and have heard repeatedly a loud detonation.

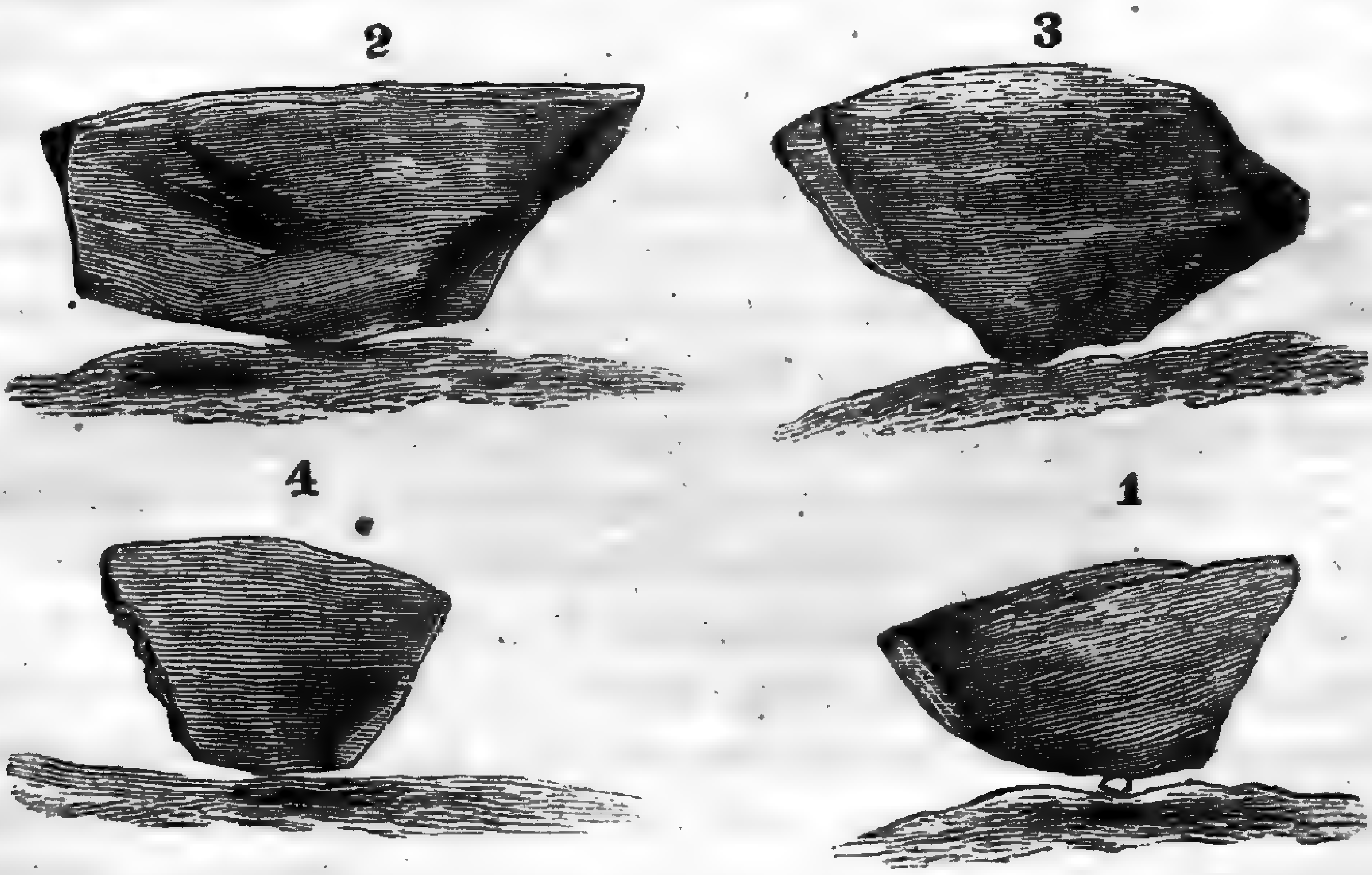
In the case related by Mr. Jones, it is obvious that the accident will be effectually prevented, by hooking up the lower part of the bellows instead of the upper, and pressing down the upper by weights so as to exclude, as completely as possible, the common air, and also to prevent the entrance of inflammable gas. When the working of the bellows commences, in the morning, it would be well to begin with short and quick movements of the lever, in order to establish a current of common air through the bellows, before there is an opportunity for inhaling inflammable gas. It is scarcely necessary to remark, that the tube or tuyere of the bellows at Newburyport escaped without injury, because it was very strong, and because the quantity of explosive gases contained in it was, necessarily, very small; just the opposite facts were true of the body of the bellows, constructed as it is of leather and wood.

14. *Abstract of a Meteorological Journal, kept in the town of New Bedford, for the year 1832.*

	Arithmetical Mean of Observations for the several Months at the hours stated.									Rain and Snow reduced.	Extremes of temperature and atmospheric pressure.				Prevailing Winds, stated in days.				Atmosphere.			
	Six's Thermometer.					Standard Barometer.					Temp.		Atm. press.									
Months.	S. rise	2 clk.	S. set.	10 clk	mean.	S. rise.	2 clk.	S. set.	10 clk.	measured in inches.	max.	min.	max.	min.	N. & N. W.	W. & S. W.	S. & S. E.	E. & N. E.	Fair.	Cloudy.	Rain.	Snow.
January,	25.9	35.2	31.2	28.1	30.10	30.070	30.042	30.084	30.105	3.54	57	—1	30.46	29.15	12	11	4	4	18	4	6	3
February,	25.5	33.4	30.3	28.1	29.32	30.153	30.129	30.153	30.150	4.77	58	3½	30.67	29.46	12	7	3	7	12	7	4	6
March,	30.6	41.0	36.4	33.6	35.4	30.045	30.001	30.005	30.029	2.68	62	14	30.52	29.43	10	14	5	2	17	6	6	2
April,	35.6	46.8	40.8	38.3	40.37	29.981	29.930	29.941	29.965	3.03	71½	22	30.37	29.39	3	10	6	11	15	7	8	
May,	46.2	60.1	51.9	48.4	51.65	30.016	29.999	30.007	30.017	5.82	75	36	30.62	29.41	3	16	6	6	16	7	8	
June,	54.8	70.0	61.5	58.1	61.1	29.983	29.977	29.996	30.011	0.37	88	45	30.33	29.66	7	14	4	5	17	6	7	
July,	60.4	75.3	66.8	63.1	66.4	29.979	29.964	29.979	29.986	1.50	85	51	30.19	29.61	3	20	4	4	21	5	5	
August,	63.4	76.5	68.9	65.7	68.62	30.114	30.109	30.105	30.116	7.38	85	52	30.34	29.64	3	20	5	3	18	4	9	
Sept.	56.15	67.7	62.0	58.0	60.96	30.091	30.071	30.082	30.092	2.67	82	44	30.41	29.75	8	14	5	3	18	7	5	
October,	49.1	59.1	54.3	51.1	53.4	30.147	30.122	30.140	30.146	2.355	68	32	30.54	29.71	5	14	6	6	14	11	5	1
Nov.	39.5	47.6	44.4	42.3	43.45	30.022	29.994	30.004	30.009	3.93	62	21	30.47	29.54	10	14	4	2	16	8	6	
Dec.	30.4	35.9	33.5	31.7	32.9	29.996	29.957	29.959	29.988	5.79	50	14	30.69	28.94	16	7	5	3	12	12	6	1
The year,	43.13	54.05	48.5	45.54	47.81	30.050	30.025	30.038	30.051	43.83	88	1	30.69	28.94	92	161	57	56	194	84	75	13

15. *Notice of a Rocking Stone.*—It is situated upon a ledge, about a mile south from Dartmouth College, and about one fourth of a mile north of where the road leading from Hanover to Lebanon, crosses Sand Hill. The ledge is an extensive range of coarse granite, of which the rocking stone is probably a fragment, detached from the most elevated part and moved to its present site; a depression, very well answering to the shape of one of the lateral faces of the rocking stone, is distinctly to be traced upon the most elevated part of the rocky ledge. The form of the stone is nearly that of an irregular four sided pyramid, with the base upward. The lateral faces are almost smooth.

In the annexed sketch, figures 1, 2, 3 and 4, represent the north, south, east and west views of the stone respectively. The north



side, (fig. 1,) is nine and a half; the south, (fig. 2,) thirteen; the east, (fig. 3,) twelve and a half; the west, (fig. 4,) nine feet in length. The height varies from five to eight or nine feet. The rock is movable only in one direction, and turns upon a small stone of a prismoidal shape, two or three feet in length, and which operates as a kind of friction roller.

One would be led to suppose, from a view of either of the figures in the sketch, that the stone might easily be moved from its position; but the fact is otherwise. Although it can be moved with one finger, and can easily be made to vibrate three or four inches with the hand; yet its equipoise being destroyed, it would rest in any direction upon the ledge beneath; from which it is separated only by a space of a few inches, and from which it could be moved only by the application of a very considerable force. As thousands live within sight of the noble Mount Washington, without attempting its ascent, and other thousands almost within hearing of the thunders of Niagara, who have hardly turned aside to see the prince of our mountains, or the prince of all cataracts, it appears the less surprising that a logan rock, almost within sight of the university of New Hampshire, should have remained hitherto unnoticed.

C. E. POTTER, Principal of the Portsmouth High School, Jan. 30, 1833.

To the Editor of the Am. Journal of Science and Arts.

16. *Notices of Wheeling, Virginia, by* JAMES W. CLEMENS; *in a letter to the Editor, dated Wheeling, May* 21, 1832.—Wheeling is a thrifty town, situated on the eastern bank of the Ohio River, in the county of Ohio and state of Virginia. Its population is, at this time, between six and seven thousand souls.

Its latitude is 40° 15′ N.; its longitude 80° 10′ W. from Greenwich. The site on which the town stands, without doubt, once formed the bed of the Ohio River, for evidence of this fact is constantly presented, but a few feet below the present surface.

The town is divided into two parts, the high and the low: the high part of the town, was used by the aborigines as a cemetery.

About three years ago, the workmen employed in excavating a cellar, in this part of the town, discovered many relics of the Indians, such as bones nearly decayed; and in the tombs with those bones were found pots in a good state of preservation, and having in them muscle shells and the bones of some small animals, as the rabbit or squirrel. There were found, also, war axes of stone, tomahawks of a species of stone no where to be found in this neighborhood, and also arrow heads of the very best quality of flint.*

* Among numerous specimens of aboriginal relics in my possession, I find arrow and spear heads of quartz, flint, hornstone and jasper: they were evidently shaped by chipping or fracture; they have a channel or hollow around the base of the arrow or spear head, which appears to have been intended for a with or string to fasten the stone to the shaft. I have bullet moulds made of soapstone, with a regular sprue, and holes for withs, to bind the two parts of the mould together; pipes, made of chlorite, pottery, or soapstone; one of these, of chlorite, is in the shape of an owl; it is as large as a small bird of that family; the tobacco was introduced through a hole in the back, and the tube was put in at the vent; mortars of agate, hornstone and jasper, with pestles of the same, thus anticipating modern improvements in apparatus for analysis; ornaments of jasper, jade, hornstone, and slate of different va-

In May, 1832, Dr. J. C. Johnston employed workmen to remove the earth from a lot in that part of Wheeling, which was used by the aborigines as a cemetery. In making this excavation, a large piece of mica was discovered. The mass was of the breadth* of the specimen herewith forwarded to you, and one inch thick. It was dug out of a bank of gravel and sand, at least eighty feet above the level of the Ohio at this place. It was found about ten feet below the present surface of the ground. This is the site of the old Wheeling fort, in which some of the present inhabitants of Wheeling were born.† It is not the first that has been discovered, but it is the largest that I have seen. Talc was also discovered a few years since, buried in the ground. Mineral coal is abundant in this neighborhood: the veins are from four to eight feet thick, and they lie parallel to the horizon. Pyrites is intermixed with the coal, and forms a considerable stratum above it; from this mineral, large quantities of copperas are annually manufactured, simply by lixiviation and evaporation, after exposure, for a sufficient time, to the action of the air. Aluminous earths are dug up in abundance, six miles east of this place, from which large quantities of the alum of commerce are made.

17. *Geological notices respecting a part of Greene County, Alabama; in a letter from* Robert W. Withers, M. D. *to the Editor, dated Erie,* (*Ala.*) *Jan.* 15, 1833.—I am a cotton planter, and am situated at the head of a beautiful prairie of six miles in length. This singular kind of country is little known to geology. The prairies, obviously, did not originate, as some have supposed, from burnings by the Indians. The soil is very peculiar, and has no resemblance to that of the land in the vicinity. Our prairies too were evidently once a part of the sea; the soil is composed of decom-

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rieties; one of the most frequent forms is that of a prolate spheroid: I have one of this form, made of beautiful hæmatite; axes, chisels, gouges, and other cutting instruments, made of hard stones; they appear to have been secured to the handles by being thrust through a split made in a branch of a tree, or by being bound by withs; tomahawks of various stones, generally not the hardest, for they were perforated for the reception of a handle; containing vessels, of soap or pot stone, or coarse pottery, &c. Considering their means and wants, and particularly that they had no iron instruments, the skill, perseverance and success of the aborigines, in fabricating these things, were truly surprising.—*Ed.*

* Five inches by three; probably from a portion of granite; the region on the Ohio, it is well known, is of a very different geological character; the aborigines may have brought this mica from some primitive region, or obtained it from some of the bowlders that are so frequent on the western secondary and transition surfaces.—*Ed.*

† Letter from Col. Noah Zane to the Editor.

posed shells and calcareous deposits, from marine animalculæ, probably resembling those about the Florida Keys. That the prairies are of oceanic origin, or had, at least, a connexion with the sea, appears from the oyster shells, sharks' teeth, and similar reliquiæ, which are here of frequent occurrence. I have, also, in my possession some of the vertebræ of an animal as large as the elephant, and some of the petrified muscles, apparently belonging to a fish. It seems to have been worm-eaten before it was mineralized. The animal perished too in a vertical position, as the vertebræ shew, having been first discovered, ranged one above another, in the steep bank of a rivulet. A few feet under the top of the soil, and sometimes on its surface, is invariably found a whitish, soft limestone rock, easily cut with a knife, and very smooth and friable. It is here called familiarly *rotten limestone,* to distinguish it from the hard blue limestone rock, found about fifty miles above this place. This rotten limestone is sometimes sawed out in blocks, with a common crosscut saw, and if kept out of the weather becomes hard, but if exposed, immediately after taking it out of the earth, to the rains and frosts, it falls into powder and becomes soil. In all our prairie region, water is scarce, and sometimes all efforts to obtain it fail, although the rock has been bored into, in some instances, upwards of five hundred feet. There seem to be no natural fissures or clefts in the rock, through which water can approach the surface. It is, in most instances, more or less mixed with shells, even to the extremest depth to which it has been penetrated. Sometimes small balls of the sulphuret of iron are found in it, and, in some instances, the shells form distinct strata. It effervesces with acids, but, when exposed to heat, does not make lime fit for the ordinary purposes. There is one variety of it, however, which is found on some of the hills below this place, in detached, porous, honey-comb fragments, which makes lime strong enough for common use.

On these hills, we have cedars vying with those of the forests of Lebanon; sometimes three feet in diameter, and towering to a great height.

This belt of prairie country extends from the eastern part of this state, quite across it, into Mississippi, being from thirty to forty miles in breadth. It is generally more or less covered with timber, although sometimes it is entirely destitute of trees, and then it is designated as *open* or *bald* prairie. The soil is generally black, and very productive in corn and grain; but where there is no timber, it is not adapted to the growth of cotton, nor of fruit trees or the leguminous plants. When wet it is like mortar, and when dry becomes very hard, where it is trampled. The creeks and rivers running through it have their beds in the rock, as the soil is friable and easily washed off.

Now the question is, how this kind of country came here? From this place to the coast of the Gulf of Mexico is two hundred miles; but in all the intervening country, there is nothing to indicate that it was once the bed of the sea. From this to St. Stephens, it is much broken, the hills, in some instances, rising to several hundred feet above the river, and there is, also, a coal formation below. From St. Stephens to the Mobile Point, (one hundred miles,) it is almost a perfect plain, covered with pines, and, except some shell banks, no fossil remains. The hills about thirty miles above St. Stephens, are composed of a sort of sandstone, and below, the soil is almost entirely siliceous and barren, except on the river banks. Here, it seems to be formed by decomposed shells, and other calcareous and marine productions. It is entirely different from the blue limestone region of the west, and from the sand hills and plains of the south; and the prairie region here, although once evidently covered by the sea, is now much higher than the sandy country immediately around it, as if the rock below had first grown by accretion, and then thrown up the prairie.

18. *Sulphurets of Bismuth; by* Lt. W. W. Mather, *in a letter to the Editor, dated West Point, March* 5, 1833.—There seems to be another sulphuret of bismuth, than the two already described. Reading your system of chemistry some time since, it mentioned that a sulphuret of bismuth, consisting of bismuth seventy two, and sulphur sixteen, may be formed by fusing three parts bismuth and one sulphur. As I had never seen the sulphuret of bismuth, I fused seventy two grains of bismuth and twenty four grains of sulphur, in a small closely covered crucible, which had been previously ignited and then weighed. The fusion was continued for about half an hour. After cooling, the crucible was again weighed, but the crucible instead of having increased in weight 88 grains, $-72+16$, as was expected, had increased only 80.15 grains $=72+8.15$, or the one proportional of bismuth $=72$, had combined with but a small fraction more than one half proportional of sulphur, or 8.15.

Thinking there might have been some error in weighing out the materials, the experiment was repeated, and, for greater accuracy, with larger proportions.

One thousand eight hundred grains of bismuth, finely powdered and mixed with six hundred grains of sulphur, which had been sublimed, were fused with the same precautions as before, and kept in fusion for about half an hour. The resulting sulphuret weighed 2003.6 grains $=1800+203.6$, or the composition is

$$\left\{\begin{array}{ll} \text{bismuth,} & 1800.0=25\times 72 \\ \text{sulphur,} & 203.6=25\times 8.144 \end{array}\right\}$$

The sulphur is about one sixth of one per cent. only in excess, to form a di-sulphuret, considering the atomic numbers 72 and 16 the true ones. The bismuth employed was the common bismuth of commerce, which contains, according to Thomson, about one third of one per cent. of iron, so that by the sulphur also combining with the iron, the combined sulphur in both together should be a little in excess.

The bi-sulphuret of bismuth described by Vauquelin contains

$$\left\{\begin{array}{lll} \text{bismuth,} & 68.25 \text{ or} & 72.00 \\ \text{sulphur,} & 31.75 & 33.48 \end{array}\right\}$$

Thomson's Elements, vol. i, p. 411.

The sulphuret described by Dr. John Davy contained

$$\left\{\begin{array}{lll} \text{bismuth,} & 9.000 \text{ or} & 72.000 \\ \text{sulphur,} & 2.007 & 16.056 \end{array}\right\}$$

The sulphuret described by Lagerhjelm scarcely differs from the last. There are then three sulphurets of bismuth, composed of

Bismuth,	72	72	72
Sulphur,	32	16	8

19. *Address of Mr. H. R. Schoolcraft*, at Detroit, on the condition of the North American Indians, May, 1832.—*Lecture on Tobacco*, by Prof. Elizur Wright, of the college at Hudson, Ohio, May, 1832.

Address before the Temperance Society of the Medical Class, in Dartmouth College, Oct. 1832, by Prof. Oliver.—*Temperance Recorder of Albany.*

If these subjects are trite, they have lost none of their importance by iteration. We are glad to see that men of talents and station are willing to come before the public, and enter their solemn protest against strong drink and its ally, tobacco. Mr. Schoolcraft has happily, although painfully sketched the destroying effects of alcohol upon the aborigines; Mr. Wright has forcibly and very plainly exhibited the evils and offensiveness of tobacco, and Prof. Oliver has, with the skill of an able professional man, sustained one of the greatest causes that has ever been brought forward in the world.

20. "The Family Cabinet Atlas," first American edition with one hundred maps and tables, very neatly executed, is a fair specimen of the multum in parvo, and may form an appropriate accompaniment to the New Universal Gazetteer.

FOREIGN.

21. *Polytechnic Society of Paris.*—This society has been organized by the former pupils of the polytechnic school, and all of them are conversant with practical arts of industry and commerce.

The object of the society is to promote the progress of industry and to supply the wants of the commercial and agricultural classes, especially of France. Its principal means are,

1. An extensive correspondence with its members at home and abroad.

2. A responsibility, in consequence of an understanding with the heads of establishments, to see all orders faithfully executed.

3. A great collection of very perfect models of machines to serve as specimens, and to be exhibited at a particular place.

4. The *Receuil Industriel, &c.* of M. De Moleon, a valuable and interesting journal, is the vehicle of all the observations and discoveries of the society, and of the results of the communication of its members in every part of the world.

In its organization are included

1. *Des Industriels,* who attend to the interests of manufacturers, machinists, &c.

2. *Des Agronomes,* who watch over rural economy.

3. *Des Commerçans,* whose vigilance is directed to commerce and its various dependant interests.

Foreign ambassadors are invited to supply the wants of their respective countries through the agency of the society, whose address *au directeur de la Société Polytechnique rue neuve-des-Capucines, No.* 13 *bis.*

Such a society under the able direction which it will doubtless receive from its president, M. De Moleon, and his associates, cannot fail of being highly useful both to Frenchmen and strangers. We add, from a letter of M. De Moleon to the Editor, dated Paris, Oct. 10, 1832, "Cette Société a pour but de satisfaire aux besoins industriels de tous les pays—de procurer aux manufacturiers, aux fabricans, aux agronomes et aux artistes les mecanismes, dont ils peuvent avoir besoin, soit sous la forme de modele, soit en grande; de surveiller leur confection, et de les expedier à destination; de fournir tous les renseignmens et documens qui pouvent contribuer à la prospérité commercial," &c.

22. *Geological Society of France.*—We have received the circular of the society, dated Dec. 17, 1832, and a sketch of its constitution, rules, and officers. The society was founded March 17, 1830, and was recognized by a royal ordinance of April 3, 1832.

Its object is the advancement of geology, in general, and particularly in France, with an especial reference to agriculture and the useful arts.

It aims to combine the efforts of all the cultivators of geology in all countries.

The number of its members is unlimited, and it enrolls already more than two hundred, scattered over Europe; for, strangers as well as Frenchmen are eligible; to obtain membership it is necessary to be named by two members, and to be proclaimed by the president; and those members who desire it, receive a diploma, with the seal of the society, and signed by the president, secretary, and treasurer.

The society, being instituted with an exclusive reference to utility, the services of all its officers and members are gratuitous, and no personal interest is in any way fostered by the institution.

Two volumes of its Bulletin, or the proces verbal of its meetings, have been published, and the first volume of its transactions, illustrated by beautiful maps, sections, and plates of fossils is in the press.

Its President is M. Alexandre Brongniart.

Its Vice Presidents, M. Cordier, M. Arago, M. Defrance and M. De Bonnard.

Its Recording Secretary is M. Desnoyers. Its Foreign Secretary is M. *Boué.*

Its counsellors are M. Elie De Beaumont, M. De Blainville, M. Brochant De Villiers, M. Cartier, M. Deshayes, M. Duperry, M. De Ferussac, M. Huot, M. Sajoukaire, M. Constant Prevost, M. Regley and M. Walfeodin.

These gentlemen are well known wherever science is cultivated.

M. Brongniart's name is enough to insure the respectability of the society, and not a few of his coadjutors are well worthy of being associated with this very eminent and excellent man.

If we were to wish the society as brilliant success as has attended the elder sister in England, we should say much. In a rivalry far more honorable than the wars which have for so many centuries distressed and dishonored the two countries, the Gallic Society will doubtless strive, by every honorable means, to eclipse its British predecessor.

While to both institutions we cordially wish all success, we should be happy to contribute to it by any effort however humble.

23. *Baron Ferussac's new work on Shells.*—We have before us a communication from M. le Baron de Ferussac, informing us that he has recommenced the publication of his great work "Histoire Naturelle Mollusques terrestres et fluviatiles."

There are now about thirty Nos. of this magnificent and highly scientific work issued from the press. In beauty of execution and faithfulness to nature, it is not surpassed by any work heretofore published in this, or perhaps in any other branch of natural science. The figures are exact representations of the most perfect and best characterized specimens which the splendid cabinet of the author as well as the other cabinets of Paris affords. The increasing labor and constant researches of the learned author guarantee to the student of natural history, the advancement of this branch of science to a state of perfection at which few others have arrived.

The Baron is also occupied with various monographs consisting of other classes and orders which he proposes to publish in succession. The whole of these works will be published under the common title "Histoire Naturelle generale et particulière de Mollusques, tant vivans que fossiles."

We are informed by the Baron that the subscription is reopened, and we sincerely hope that our public libraries as well as individuals interested in the promotion of this branch of natural science, will take advantage of it. We observe M. de Behr, foreign bookseller, New York, is authorized to receive subscribers; the price being thirty francs per No. for the folio copy colored, and fifteen francs for the 4to. plain.

The great advantage of monographs of this description must be evident even to the mere tyro—those who study nature thoroughly cannot do without them. There are, at least, two copies of this great work in Philadelphia, one of which, a fine colored copy of the largest kind, is in the rich library of the American Philosophical Society. Should the Baron live to see the whole of this great undertaking complete, he will have the satisfaction of handing down to posterity, a greater mass of knowledge on the subjects of which he treats, than any of his predecessors have been enabled to, and we wish him, most heartily, health and strength as well as assistance in a pecuniary point of view, to enable him to accomplish so desirable an object.

24. *Epistilbite from Elba.*—Among some specular iron ores from Elba, Dr. Lewis Feuchtwanger, of New York, discovered the mineral heretofore called epistilbite, but now by Mohs and others considered as heulandite.

Its color is white; lustre vitreous and pearly; fracture conchoidal; nearly transparent; structure entirely crystalline, but the crystals are crowded and indistinct. By a strong magnifier they appeared generally hemitropic, but one was a rhombic prism. The crystals were in a beautiful amygdaloid.

Before the blow pipe, like the whole zeolite family, it melted into a colorless, blebby glass.

The mineral corresponds exactly with one described a few years ago by Rose, whose localities were Iceland and Ferroe Islands; and as Elba is a new locality, not named in any work, Dr. F. requests that it may be mentioned in the Am. Journal.

Characteristic of the Epistilbite according to Rose.

This mineral is specifically distinguished from the Stilbite and Heulandite; crystals are rarely simple but generally hemitropic; the simple crystals constitute a rhombic prism of 135° 10′ terminating in a predominating acumunation of 109° 46′ superposed straight on the lateral angles, the lateral plane M, is common to the hemitropes, but the others are in the reverse position; the cleavage is very distinctly parallel to the obtuse lateral angles: the fracture is conchoidal; the lustre vitreous and pearly; the color white; transparent to translucent at the corners. Hardness, =4.5; specific gravity is =2.24; its chemical constituents are 58.59 silica, 17.52 alumina, 7.56 lime, 1.78 soda, 14.48 water.

Before the blowpipe it acts like Stilbite and Heulandite. Localities are Iceland and the Ferroe Islands in the cavities of an amygdaloid.

Notices Translated and Extracted by Prof. Griscom.

NECROLOGY.

Baron de Zach.—Science has just sustained a considerable loss in the person of François Xavier, Baron de Zach, the actual dean of astronomers, and whose reputation was truly European. Born at Pesth, in Hungary, the 15th of June, 1754, he discovered at the age of fifteen, a decided taste for astronomy, on the occasion of the comet of 1769, and of the transit of Venus of the same year.

After having travelled through various countries of Europe, on objects of science, he was appointed, in 1786, by the Duke of Saxe Gotha, to construct the beautiful observatory of Sceberg, near Gotha, which he superintended himself during several years. He published at Gotha, in 1792, tables of the sun, with a catalogue of three hundred and eighty one stars, and at a later period he brought out other astronomical tables. In 1798, he commenced, at Weimar, the publication of his Geographical Ephemerides. They were followed by his monthly German correspondence published at Gotha since 1800. This is one of the most valuable collections of memoirs, documents and astronomical notices. Having afterwards left Germany, with the Dutchess of Saxe Gotha, to reside in a more southern climate, he took up his abode for some years in the vicinity of Marseilles, where he continued to make observations, and astronomical and geodesical calculations, and published in French, in 1814, his interesting work on the attraction of mountains. He afterwards established himself at Genoa, and commenced there, in 1818, the publication in French of a new astronomical *Recueil*, entitled *Correspondence astronomique, geographique, hydrographique et statistique*, with this epigraph : *Sans franc penser en l'exercise des lettres, il n'y a ni lettres, ni science, ni esprit, ni rien.* He issued fourteen large volumes in 8vo. of this journal, prior to 1826. They contain a great number of very interesting materials, on all parts of astronomy and the sciences connected with it. A severe disease, at that time, assailed his robust constitution and compelled him to discontinue this new work. He had recourse to the skill of Dr. Civiale, who consented, at the request of Plana and Arago, to repair to Genoa, to perform on the Baron the operation of trituration. The latter came afterwards to Paris, that the process might be renewed as occasion required. The latter years of his life were passed in great suffering, but in possession of his usual activity of mind, interesting himself constantly with astronomy, maintaining his extensive correspondence, and working while his strength lasted. He died on the 2d of September last, at Paris, by an attack of Asiatic cholera, after twenty four hours illness. Endowed with rare faculties, he devoted to astronomy all the energy of his mind and character; and he was no less remarkable as a writer, and in his social capacity, by the brilliancy and keenness of his remarks, by a memory which never failed, by long experience of men and things, favored by his social positions and his numerous journeys. He encouraged, by every means in his power, a zeal for astronomy, wherever he found it; he formed several distinguished astronomers, and greatly contributed by his works and influence to that development which astronomy has undergone in Germany. Baron de Zach had, in various parts of Switzerland, as in the rest of Europe, devoted friends, who are deeply sensible of his loss. May this feeble homage of gratitude and regret, bestowed upon his memory, alleviate in some measure their reasonable sorrow.—A. GAUTIER. *Bib. Univ. Aout*, 1832.

CHEMISTRY AND MECHANICAL SCIENCE.

1. *Electro-Magnetism.**—M. Hachette announced to the French Academy of Sciences, on the 3d of September, that Pixii had constructed an electro-magnetic apparatus, which produces sparks at a distance. It was known, that if an unmagnetized horse shoe, around which is wound a connecting wire covered with silk thread, is made to approach a horse shoe magnet, with their extremities opposite to each other, a spark is perceived at the moment of their separation; but that the experiment will not succeed, unless the contact is immediate and the magnet very strong. With the new apparatus, a force of five or six kilogrammes is sufficient to produce sparks at the distance of several millemetres.

A horse shoe magnet is placed vertically, with the ends upwards. Through the center of the curved part passes a vertical axis, on which it may turn horizontally by means of a pinion and wheel on which the motion is impressed. Above, and in a fixed position, is an unmagnetized horse shoe, whose ends are adjacent to those of the magnet without touching them. It is enveloped with a wire, whose extremities rest in a capsule of mercury, one of them dipping into it and the other just bordering upon the surface. When the magnet is made to revolve, every time its poles pass under the ends of the iron, so as to be in the same vertical plane with them, a spark is manifest at the surface of the mercury, and if the motion be rapid

* We preserve this notice of a discovery already announced in this No., because it contains some additional particulars.—*Ed.*

the series of sparks produce a continued sensation of light. By means of this apparatus, sparks may be obtained as strong as with an electrical machine.—*Rev. Encyc. Sept.* 1832.

2. *On the chemical action of magneto-electric currents; by* G. D. Botto, Professor of Natural Philosophy in the University of Turin Among the qualities of the magneto-electric currents discovered by Faraday, which it is important to ascertain, is that of their chemical action. The results which I have recently obtained appear to be decisive, but I shall, at present, confine myself to a simple announcement of them, as they constitute a part of other labors relative to a series of experimental researches, which I intend hereafter to publish, the object of which is to clear up some points of the doctrine of electro-magnetism.

The apparatus which I employed in studying the chemical efficacy of the currents of Faraday, is composed essentially of an artificial horse shoe magnet, and a bar of soft iron, surrounded, in the middle, with an electro-magnetic spiral. The extremities of this bar, by means of a simple contrivance, may be detached from the poles of the magnet, and reunited with them, as rapidly as may be desired.

The apparatus is enclosed in a wooden box, and moved by a handle without. The box is also surmounted by two rods, connected, at pleasure, with the interior mechanism, so as to establish or interrupt the circuit at the moments favorable to the production of the spark. Hence, when the spark is to be produced, the extremities of the spiral are suitably connected with the rods; but when the instrument is to be used for decompositions, those extremities are so disposed that the substance to be decomposed may be introduced into the circuit.

I have experimented in this manner upon water, acetate of lead, and other saline solutions, using at first very small doses, on account of the feebleness of the instrument, (the magnet sustained scarcely six pounds or 2966 grammes,) but I soon discovered that the energy of the current was sufficient to act successfully upon larger quantities.

I attached to a small bell glass two platina wires, to serve as conductors. They were fastened, by lac wax, into two holes perforated in the sides. The glass was filled with water, rendered more conductible by a few drops of a solution of soda, and inverted in a dish filled with the same fluid. Having connected the platina wires with the electro-magnetic spiral, I put the apparatus in motion. Scarcely had the play of junction and separation commenced, before the decomposing force of the platina poles was evident, in the form of two columns of smoke, consisting of an infinite number of small gaseous bubbles, which, uniting at the top of the receiver, yielded, in a short time, a dose of oxygen and hydrogen sufficient to produce a sensible detonation.

The phenomenon is still more interesting, when the development of gas is viewed through a lens. The bubbles are more abundant, as the motions of the electromotor are the more prompt.

I shall not, at present, describe the results obtained from various saline metallic solutions; the analogy between these effects and those of hydro-electric currents appears to be complete, regard being had to the intermission and fugacity of the one, and the continued action of the other.

It is not easy to foresee to what extent the means of exciting and increasing the chemical power of the magneto-electro-motive faculty may be carried; but that a character so highly interesting to the doctrine of imponderable fluids ought to claim the attention of men of science, is very certain.—*Bib. Univ. Sept.* 1832.

3. *A water barometer.*—At the suggestion of J. F. Daniell, Esq. professor of chemistry in Kings College, London, a water barometer was ordered to be constructed under his direction by the president and council of the Royal Society, and an account of its operation was read by him to the society on the 21st of June last. The tube was skilfully made by Pellatt & Co., at the Falcon glass-house. It was forty feet long and one inch in diameter, and so nearly cylindrical throughout its whole extent as to diminish only two tenths of an inch at the upper end. It was securely lodged in a square case, by means of proper supports, and placed in the winding staircase leading to the apartments of the Royal Society. A small thermometer, with a platina scale, was introduced into the upper end of the tube. An external collar of glass was united to that end, by heating it, to give it additional support and prevent it from slipping.

This end of the tube was then drawn out into a fine tube, ready for sealing with the blowpipe, and a small stop cock was fitted to it. The cistern of the barometer was formed by a small copper steam boiler, eighteen inches long, eleven wide, and ten deep, capable of being closed by a cock, and having at the bottom a small receptacle for holding the lower end of the tube, so as to allow of the water in the cistern being withdrawn, without disturbing that contained in the tube.

The boiler was set in brick work, in a proper position, over a small fire-place. It was nearly filled with distilled water, which was made to boil thoroughly, so as to free it from air; and the cock being then closed, the water was raised in the tube, by the pressure of the steam collected in the upper part of the cistern. The tube, when filled, was hermetically closed at the top: a proper scale, constructed by Newman, was applied to it, great care being taken to determine its height, and to ensure the accuracy of the adjustments and the precision of its measurements, by an exact mode of reading; and also to provide proper corrections for temperature. The water in the cistern was protected from contact with the air, by being covered with pure castor oil to the depth of half an inch. The mercurial barometer, employed as a standard of comparison, was of a portable construction, and was provided with a platina guard.

The register of observations of this instrument, given by the author, and taken at least once a day, extend from October, 1830, to March, 1832. They afford some curious results. In windy weather, the column of water is found to be in perpetual motion, not unlike that from the breathing of an animal. Many considerable fluctuations on the pressure of the atmosphere are rendered sensible, which would totally escape detection by the mercurial barometer. The rise and fall of the water precedes, by one hour, the similar motions of the mercury. The most striking result of the comparison between the two, is the very near coincidence of the elasticity of the aqueous vapor as deduced from the experiments, with its amount as determined by calculation, in a range of temperature from 58° to 74°. But a gradually increasing difference was at length perceptible, showing that gaseous matter had, by some means, insinuated itself into the tube. When this became no longer doubtful, the boiler was opened, and it was found that a portion of the liquid oil had escaped; and that the remainder had become covered with large flakes of a mucilaginous substance, by means of which it is probable that a communication had been established between the air and the water. The water had, however, retained its purity, and no indication was afforded of the metal having been any where acted upon. The author recommends, that if these researches are prosecuted, the water should be covered with a stratum of oil of four or five inches in depth, which he has reason to think will form an effectual barrier to all atmospheric influence.—*Lond. Phil. Mag. Nov.* 1832.

4. *Vegetable matter in Carnelian.*—In consequence of some remarks contained in a memoir of Dufay, published in 1732, relative to the decoloration of carnelian, Gaultier de Claubry heated in a porcelain retort some fragments of carnelian with deutoxide of copper. There was a sensible emission of gas, which appeared to be carbonic acid, and the fragments were deprived of their color at the surface. In another experiment with pulverized carnelian, the development of gas was much greater, viz. twenty nine cubic centimetres from one hundred grammes of carnelian. This appears to leave no doubt of the existence of organic matter in carnelian quartz, and to the presence of which it owes its color.

At the recommendation of Thénard, the experimenter calcined alone one hundred grammes of carnelian, which lost in the operation 1.169 grammes, and furnished carbonic acid and some inflammable gas, besides an acrid liquor which strongly reddened tournsol: no ammonia was disengaged from the liquid when treated with lime: the residue was of a greyish white. It follows that the color of carnelian is owing to vegetable matter. A portion of the loss may be occasioned by the escape of water contained in the stone.—*Rev. Encyc. Sept.* 1832.

5. *Clay for sculptors.*—Sculptors who prepare their models in clay, have frequently occasion to leave their work for a long time unfinished, and in such cases often experience much difficulty from the drying and shrinking of the material. It is well to know that by the addition of ten to fifteen per cent. of muriate of lime, well worked or kneaded into the clay, it will be preserved for almost any length of time in a moist state, and fit for a renewal of the work without any preparation.—*Jour. des Connais. Usuelles. Nov.* 1832.

6. *Depuration of all sorts of oil and of butter*, by Curaudau.—This process is unquestionably the best which has been hitherto published.

Add to one hundred parts of oil ten parts of water, into which one part of flour has been stirred. Shake the mixture well together, and then heat it until all the water is evaporated, or rather until the oil ceases to remain in a state of intimate mixture with the substances which it held in suspension. It is then purified. In the course of twenty four hours it come out clear, and differs in no respect in quality from that which has been prepared by the best processes: it has lost all its mucilage.

In performing this process, care must be taken to heat the mixture gradually, and not to raise the temperature above 80° of Reaumur (=212° Fahr.) This heat is sufficient to effect the coction of the flour and of the muco-extractive portion of the oil,—a stronger heat would color the oil, and thus injure the sale of it.

I was led to this process, observes Curaudau, by an observation which every body may have made; viz. that a clear white sauce, when overdone, separates into two parts; the one thick, occupying the bottom of the vessel, the other clear, and swimming on the deposit; the first substance is the caseous part of the butter united to the flour, which is added to the sauce and which the coction has separated from the oil; the second is the butter deprived of all foreign ingredients. In this state it may be called depurated or clarified butter. These remark are altogether applicable to oil and fat.

To this simple observation I owe the idea of purifying oils by flour and water, which affords great advantages.

Lamp oil needs purification to render it fit for combustion. This is no other than depriving it of a muco-extractive substance, which united to the heterogeneous matters that are mingled with it, hinders it from giving, during combustion, a pure light. Since the introduction of the argand lamp, more attention has been given to the purification of oil.

Another method.—The process of M. Thenard, somewhat modified, is to add one part of sulphuric acid of commerce, diluted with ten times its weight of water, to one hundred parts of oil of Colza: agitate well the mixture as soon as the materials are well incorporated, let it rest until the oil becomes clear. An acid liquid collects at the bottom, a little colored. The acid is separated from it, and to ensure its freedom from acid, a few ounces of pulverized chalk, or white marble, are well shaken up with it, and it is again left to become clear by repose, and then decanted.

The effect of the acid, although so much diluted, is to deprive the oil of all its moisture, and of its muco-extractive portion, which diminishes the energy of the combustion, carbonizes the wick, and occasions smoke.—*Jour de Con. Usuel. tom.* 13, *p.* 21.

NATURAL HISTORY.

1. *Thermal spring in the bed of the Rhone.*—M. De Carpentier, director of the salt works at Bex, in Switzerland, describes a new thermal spring in the bed of the river, about ten thousand feet

or nearly two miles above the bridge of St. Maurice. The place whence it issues is open to view only where the water is at its lowest point, that is, during the severest cold of winter. In summer, it is covered to the depth of fourteen feet by the water. The river is here two hundred and fifty feet wide, and the spring is twenty five feet from the right bank. It was discovered by accident in a place where trout fishing is practised, on the 27th of February, 1831. The next day, the Rhone having suddenly risen, it was covered to the depth of two feet by the water, but on plunging the foot into the water, its warmth was very sensibly felt above that of the river water which was only 2° above zero. When the water subsided, a small stream was discovered issuing from under a rock, having the temperature of 106° F., and where the rock was removed several other filimentary streams were discovered issuing from the bed of the river, which is formed of sand and gravel intermingled with large rolled blocks of stone.

An excavation being made eight feet square and six feet deep, the warm water flowed in at the rate of eighty cubic feet per hour, and it was plainly perceived that the water issued vertically from below, and was by no means connected with any lateral opening from the adjoining mountains.

At the depth of twelve feet it was found that the principal stream occupied a space of five feet and a half, by four, and as it would be impossible, from the structure of the valley of the Rhone, to sink the opening to a rock, it was cased up with a strong wooden frame, around which a clay cement was rammed, and the casement was carried in a pyramidal form to the height of eight feet.

Into the top of the pyramid a tube was inserted, sixty nine millimetres in diameter, and in this pyramid and tube the thermal water rose to the height of seven feet above the then level of the river, but on attempting to carry it higher, it issued through the sand and gravel at the bottom of the encasement.

A lateral conduit, formed of bored larch logs, was then connected with the tube at the top of the pyramid, and conducted to the distance of one thousand seven hundred and eleven feet, being more than half of its distance sunk into the bed of the river, as it was found necessary in order to preserve the proper descent, to dig a trench from six to fifteen feet in depth. The thermal water was thus conveyed to place convenient for the erection of baths.

The encasement was protected from the ravages of the torrent by a very strong erection of heavy timber in the form of a cage, filled in with large stones, and the conduit tubes were also defended by suitable structures. In the course of ten weeks the works were completed, and the tepid water was introduced into the baths on the 10th of March. It lost, notwithstanding, its long course of one thousand seven hundred and eleven feet, surrounded also by the cold water of the Rhone only 5° of Fahr., so that it maintained a temperature of 30° Reaumur =99½° Fahr.

Admitting with Bohenberger that the temperature of the earth increases 1° Reaumur, (2¼° Fahr.,) for every one hundred and twenty feet of depth, and supposing, (which is very probable,) that this spring is fed by the Rhone itself, the mean temperature of the river being 5° Reaumur, (43¼° Fahr.,) the warm water must reach the surface from a depth of three thousand two hundred and forty feet.

According to all appearance it rises vertically, and as its issue is situated precisely in the direction of the superposition of the limestone upon the gneiss or schistose protogyne, it is very probable that it comes directly from that rock. It contains, in fact, very little sulphate and carbonate of lime; much less than the thermal waters that issue from the limestone.

It is very probable that it acquires the little sulphate and carbonate of Lime, which analysis proves it to contain, only by traversing the alluvium of the valley, in which is found much limestone gravel as well as larger masses.

The smell and taste of this water is sensibly sulphurous. Besides sulphuretted hydrogen and azote, its principal ingredients are sulphate of soda, sulphate of magnesia, and chloride of sodium. There were in July about fifty bathers, and judging from the effect of the waters, thus far used as a bath and as a drink, it is very efficacious in cutaneous diseases, glandular swellings, rheumatism and urinary affections.—*Bib. Univ. Aout*, 1832.

2. *Geology.*—M. de Seckendorf has found in the Hartz, in the midst of a quarry situated near the causeway which leads to Hartzburg, fragments of grauwacke containing petrifactions, imbedded (empâtes) in granite. M. Hartmann, the translator of Lyell's Geology, confirms this statement.—*Rev. Encyc. Sept.* 1832.

ASTRONOMY.

1. *First observation of spots on the sun.*—An account was read to the Royal Society of London, on the 24th of May last, of a number of unpublished astronomical papers of Thomas Harriot, found in the library of the Earl of Egremont, by which it appears that Harriot observed the spots on the sun, and the satellites of Jupiter, in the same year (1610) in which they were first observed by Galileo. Harriot's observations on the spots fill seventy four half sheets of foolscap, the first being dated 1610. The writing is clear and the drawings well defined. His first observations on the satellites of Jupiter are dated 17th of October, 1610; they are clearly written on thirteen half sheets of foolscap.

Baron de Zach had access to these papers in 1784, and inferred from the examination of them, that Harriot observed these phenomena before Galileo; but Professor Rigaud of the university of Oxford, who furnishes the present statement to the Royal Society, concludes that there is no proof whatever of such a priority, even on Baron de Zach's own showing, for he admits that Galileo discovered the satellites on the 7th of January, 1610, nearly eight months before the date of Harriot's paper. Harriot made no pretensions to priority in the discoveries in question.—*Lond. Phil. Mag. Nov.* 1832.

2. *Rotation of the planet Venus.*—According to Bianchini, this planet revolves on its axis in twenty three days, eight hours, or very nearly. Cassini makes it twenty three hours, fifteen minutes; and Schroeter twenty three hours, twenty one minutes. Sir W. Herschel considered the time of rotation to be doubtful, but thought it could not be so much as twenty four days. A paper was read before the Astronomical Society of London, March 9th, by the Rev. Mr. Hussey, in which the arguments of these observers are carefully examined, and in which the author concludes that we are justified in placing confidence in the observations of Bianchini, from the favorable circumstances in which they were made, the minuteness with which they were detailed, from their correctness having been ascertained by several bystanders, from the superior nature of the instruments employed by him, from the measurements being micrometrical, and from the character of the observer.—*Idem.*

DOMESTIC ECONOMY AND AGRICULTURE.

1. *Destruction of rats.*—M. Thenard indicates a new method of clearing houses of rats and mice. Insert the neck of a glass tubulated retort into the principal hole, lute it round carefully so as to stop the opening, then, having well closed all the other openings of these animals, put into the retort a quantity of sulphuret of iron, and add to it a portion of dilute sulphuric acid. The sulphuretted hydrogen thus disengaged will penetrate the recesses and almost infallibly stifle the animals.—*Rev. Encyc. Mars*, 1832.

This must also annoy the persons who may be in the house, whose cavities are never tight.—*Ed.*

2. *Lute for bottling wine, &c.*—One part rosin, one fourth part yellow wax, one sixteenth part tallow; add one half part yellow ochre, or red or black ochre or coal. Keep these ingredients melted over a chafing-dish, and when the bottle is well corked, dip the neck into the melted mass.—*Jour. de Con. Us.*

3. *Artificial granite.*—Take two ounces of very pure white glass, an ounce of glass of antimony, a grain of the powder of Cassius, and a grain of manganese; reduce the whole to powder, mix intimately, and melt in a crucible. The product has such a resemblance to granite that many persons mistake it for that substance.—*Idem.*

4. *Method of cleansing wool from its grease, and economizing the residue.*—M. Darcet, who has long been consulted by manufacturers, advised the following method, which was tried with complete success. Immerse the wool, well washed from dirt, in a vessel containing spirits of turpentine, and let it remain from thirty six to forty eight hours. Withdraw and immerse a fresh quantity. By means of a press, force out all the adhering spirit, spread the wool out to dry, and when it is to be used wash it in warm water containing a little alkali.

When the spirits of turpentine will no longer act upon or remove the grease, distil it for fresh use, and the matter remaining in the still, treated with soda, will make good soap.—*Idem.*

5. *To prevent vines from bleeding when trimmed or cut.*—Stick a potato, the skin of which is perfectly sound, on the end of the cut vine, and the bleeding will stop. If the skin of the potato be defective, the sap will flow through it.—*Idem.*

This mode of treating vines is familiar in this country.—*Ed.*

6. *Valuable material for walks and alleys.*—A soap maker, not knowing what to do with the black sulphurous residuum of his ley tubs, spread it in a wet state along the alleys of his garden. It soon became stiff and almost impervious to rain; the alleys were always dry; no grass or weeds appeared on it, but the plants within a few inches of it all died. He was delighted with this discovery of the means of enjoying clean and dry walks without any trouble, having only to put a covering of clean sand over the refuse. Having occasion some time after to repave his yard, he used the soft refuse instead of mortar. It soon hardened and cemented the stones so well, that the heaviest carriages occasioned no disadjustment.—*Idem.*

7. *Stucco for walls.*—In Italy, great use is made of a stucco which gives to walls the brilliancy, the cleanliness, and almost the hardness, of marble. It may be variously colored, to suit the taste of the employer. This stucco is made very easily, by mixing lime and pulverized marble, in nearly equal proportions, according to the meagerness or richness of the marble. A paste or mortar is made of this mixture, and applied to the wall in the thickness of a five franc piece, with a trowel wet with soap suds, and in such a way that the whole of the wall may be finished in the same day. None but mineral colors should be mixed with the stucco, as the lime would destroy those derived from the vegetable kingdom. To obtain the greatest brilliancy, the mortar should be applied with a cold trowel. Workmen, for the sake of ease and expedition, usually employ it warm. Chips and fragments of marble may be advantageously employed for this purpose. In cases where the appearance of a marbled wall would be objectionable on account of its coldness, any portion of it may be covered with paper.—*Idem.*

8. *Method of cutting glass vessels uniformly without cracking.*—In a great variety of circumstances, it is useful to lessen the capacity of a glass vessel; or otherwise, to turn to a good purpose a large broken bottle or demijohn. The following method it may be useful to add to others well known.

Fill the vessel with oil to the place where it is intended to be cut. Immerse a red hot iron into the oil to an inch below this line; the heat will produce combustion, with evaporation, which will cut the vessel around at the surface of the oil. Otherwise—mark with a file the glass around the place to be divided, dip a string in spirits of turpentine, tie it round this mark, and then set it on fire, and the glass will crack along the line marked.—*Idem.*

This is more neatly done by applying a red hot iron.—*Ed.*

9. *Rice paper.*—The fine and beautiful tissue brought from China and Calcutta, and employed under the name of *rice paper,* is far from being an artificial substance fabricated from rice or any other farinaceous material. By holding a specimen of it between the eye and a clear light, it will be seen to consist of a vegetable tissue, composed of cellules so exactly similar and so perfect, that no preparation of a paper could possibly be made to acquire.

It is now known to be made of the internal part of the *Œschynomene paludosa,* Roxburg,—a leguminous plant which grows abundantly on the marshy plains of Bengal, and on the borders of vast lakes between Calcutta and Hurdwart. It is a hardy plant, requiring much moisture for its perfect growth and duration. The stem rarely exceeds two inches in diameter, spreading extensively, but not rising to any great height.

The stems of this plant are brought in great quantities, in Chinese junks, from the island of Formosa and other places, to China and Calcutta. These stems are cut into the lengths intended for the leaves or sheets, and then, by means of a very sharp and well tempered knife, about ten inches long and three inches wide, the pith is divided into thin circular plates, which, being pressed, furnish the leaves sold under the name of rice paper. The operation of cutting the leaves is very similar to that of cutting corks. The leaves are generally seven or eight inches long and five wide; some are even a foot long. Those which are not fit for drawing, are colored for other purposes. Rice paper absorbs water and swells so as to present an elevation, which continues after it becomes dry, and gives to the drawing a velvety appearance and a relief, which no other kind of paper produces.

Rice paper may, with care, be written upon, as the ink does not spread. The writing is glossy, shewing some metallic surfaces.

Examined chemically, it seems to be analogous to the substance which Dr. John called medulline. Treated with nitric acid, it forms oxalic acid.

The white and pure specimens are much used for drawings; the inferior are variously colored, and now extensively used in forming artificial flowers. In India, a pasteboard is made by cementing many leaves together, and of this hats are fabricated, which, covered with silk or other stuff, are firm and extremely light.

Rice paper was introduced into Europe about thirty years ago. The flowers which were first made of it sold at an exorbitant price. A single bouquet cost the Princess Charlotte of Wales £70 sterling.

From the quality of this paper, it may be most successfully employed in painting butterflies, flowers, birds, plants and animals. For this purpose, the object is first sketched on common paper, which is then to be pasted on a card. The sketch must be of a deep black. On this the rice paper is fastened, and the painting effected with a pencil and fine colors. When executed in this way, by the most skillful hands, the pictures of butterflies, insects, &c. have been often mistaken for the animal itself pasted on the paper. Rice paper has also been employed in lithography, with the most brilliant effect.

It is desirable, for the purposes of art, that some aquatic plant should be found in our own climate, whose pith is analogous to that of the Œschynomene. Is it not possible, also, to fabricate a paper, the tissue of which may absorb water, and furnish the relief which gives to rice paper its greatest value.—*Jour. de Connois. Usuelles, Fev.* 1832.

HORTICULTURE.

Notes relative to Garden Dahlias, in a letter from Mr. Walner to M. De Candolle.—It is very probable that the Garden Dahlias are hybrids of *D. superflua* and *D. frustanea*, for plants are obtained every year by seed from plants which belong to one or the other of these species. I am in the habit of sowing, in separate pots, the grains of each plant and sometimes those of a single fruit. It appears to me that the color of the flowers of the plant which furnishes the seed, has little to do with the color of its products.

The form and disposition of the stems vary without end; they are compact, spreading, branching, smooth, glaucous, polished, hairy, and of all colors. One of my correspondents of Hesse-Cassel, Mr. Weller, sent me some leaves of Dahlia much darker than those of *Fagus atropurpurea*. The flowers so large, full, beautiful, of so great a variety of Dahlias, seem to me to be the product of many flowers united in a common calyx and cemented together. They are often seen in every stage of union, and sometimes the peduncles are found in bundles from two to five, so as to be very easily counted.

The full dwarf Dahlias rarely yield seed; but I collected last autumn a few which did.

It is very difficult to ascertain the causes of the color of flowers; for it often happens that the same stem and the same branch give different colors. The same plant entirely changes its color sometimes from one year to another; but this takes place only with the purple, brown and amaranthine colors; they have a tendency to clearer shades, that it is to say, to return to their primitive color, the *purple violet.*

What horticulturists call degradation is only an effort of nature to bring back the plant to its primitive type.—*Bib. Univ. Mars*, 1832.

MEDICINE.

Use of milk in dropsy.—A memoir on the use of milk in ascites, by Dr. Chrestien, of Montpelier, was presented to the Academy of Sciences, by M. Legrand, on the first of October. Its diuretic qualities, when used unboiled, as the only drink and aliment, have been established by the author. Since the publication of the memoir, M. Legrand has prescribed milk in two cases of hydropsy-ascites, symptomatic of an affection of the heart, one of which was a complication of hydrothorax and hydropericardium. It succeeded in emptying entirely, by the urine, both the breast and the abdomen, and in dissipating the general ædema, when all the imaginable diuretics had been administered in vain. M. Legrand has been equally successful in curing a general œdema in two individuals, which supervened, during their convalescence from a serious attack of cholera, by prescribing several cups of unboiled milk in the morning, fasting. Doctor Kapeler, physician in chief of the hospital St. Antoine, has also completely dissipated, by the same means, the dropsy of a patient resulting from chronic inflammation of the intestines, who, in this pathological condition, was unable to support any known diuretic medicament.—*Rev. Encyc. Oct.* 1832.

STATISTICS.

1. *The Savings Bank of Geneva* had, on the 31st of December, 1831, a deposit of 1,940,000 francs in the name of 5,583 depositors. The population of the town is 23,000, hence it appears that one fourth of the inhabitants were contributors to this fund. The city of Lyons, with a population of 150,000 had received in its Bank of Savings from 1823 to 1830, only 1,872,822 francs, and of this there remained on the 31st of December, 1830, but 439,857 francs

credited to 813 depositors, of whom 418 only were of the laboring class.—*Rev. Encyc. Mars*, 1832.

2. *Scientific premiums.*—The Societé Hollandaise des Sciences, at Harlem, offer their gold medal for the best memoirs on the following subjects for 1834.

1. The cause of the formation of those sandy downs which rise on different portions of the maritime coasts of Europe, and which furnish a defence to a part of Holland against the sea.

2. The nature of those soils which are called *sour* in agriculture; and the best modes of improving them.

3. Experimental results of the relative value of various vegetables used as food for cattle.

4. A critical examination of the trials or experiments relative to the progressive increase of temperature in descending from the surface of the earth. The connection of this increased temperature with the warm springs found in various places.

5. The efficacy of fumigations by means of chlorine and other gases and their compounds, as preventives or correctives in contagious or other diseases.

6. Experimental results of the application of heat in destroying contagious matters, in conformity to the views of Dr. Henry, of Manchester.

7. More exact development of the efficacy or otherwise of vaccination as a preventive of small pox, or of its modified forms.

8. On the causes of the motion of the leaves of certain plants, either diurnally or more rapidly, as in *Hedysarum gyrans*, or from direct contact as in sensitive plants.

9. On the duration of vegetable life in grains or seeds, and the best modes of preserving it.

10. As the intoxicating qualities of vinous liquors do not depend entirely on the relative quantities of alcohol they contain, but also on the presence of a volatile, essential and acrid oil, what are the liquids which contain the most of this oil,—can it be separated from them,—is it the same or different in different vegetables,—what are the qualities of this oil,—its antidotes, &c. The gold medal is of the value of one hundred and fifty Dutch florins, and when the memoir is deemed worthy, an addition is made of one hundred and fifty florins. The memoirs may be in Dutch, French, English, Latin or German, and must be addressed to Dr. Van Marum, Perpetual Secretary of the Society, at Harlem.—*Bib. Univ. Aout*, 1832.

3. *Population of England and Scotland.*—Agreeably to the returns made to parliament, the following is an exhibition of the population of England, Wales and Scotland, with the rates of increase during the last thirty years.

	1801.	1811.	Incr. per cent.	1821.	Incr. per cent.	1831.	Incr. per cent.	1831. Males.	1831. Females.
Eng. & Wales,	8,872,980	10,163,676	14 1-2	11,978,075	17 3-4	13,894,574	16	6,769,469	7,125,105
Scotland,	1,599,668	1,805,688	13	2,093,456	16	2,365,807	13	1,115,132	1,250,675
G. Brit. collec.	10,472,048	11,969,364	14 1-3	14,072,331	15 1-2	16,260,381	15 1-2	7,884,601	8,375,780
Army & navy,	470,598	640,500		319,300		277,017		277,017	
	10,942,646	12,609,864	14	14,391,631	15 1-4	16,537,398		8,161,618	8,375,780

Cities and towns.	1821.	1831.	Increase per cent.
London, within the walls, } city,	56,174	57,695	3
London, without the walls, (including the Inns of Court,) } city,	69,260	67,878	
Southwark, borough,	85,905	91,501	7
Westminster, city,	182,085	202,080	11
Par. within the bills of mortality,	616,628	761,348	23
Adj. Par. not within the bills,	215,642	293,567	36
Metropolis,	1,225,694	1,474,069	20
Edinburgh, city,	138,235	162,403	18
Manchester, Salford and suburbs,	161,635	237,832	47
Glasgow, (and suburbs,) city,	147,043	202,426	38
Birmingham, (and suburbs,)	106,721	142,251	33
Norwich, city,	50,288	61,116	22
Paisley, with the Abbey Parish,	47,003	57,466	22
Nottingham, town,	40,415	50,680	25
Liverpool with Foxteth park,	131,801	189,244	44
Bristol, (with suburbs,)	87,799	103,886	18
Aberdeen, New and Old,	44,796	58,019	30
New Castle upon Tyne, with Gateshead,	46,948	57,937	23
Hull, (with Sculcoates,)	41,874	49,461	18
Dundee,	30,575	45,355	48
Plymouth, Devonport and Stonehouse,	61,212	75,534	23
Portsmouth, Porsea and Gosport,	56,620	63,026	11

London.—The total number of inhabitants of all the parishes, whose churches are situated within eight English miles, measured directly from St. Paul's Cathedral, amounted in 1801 to 1,031,500; in 1811 to 1,220,200; in 1821 to 1,481,500; and 1831 to 1,776,556 or to *more than one million and three quarters.*

To compare London with Paris, the population of the department of the Seine was taken, as included in a district nearly circular, sixteen miles in diameter. This amounted, in 1818, to 637,000; in 1820, to 742,000; in 1829, to 1,013,000; exclusive of the resident foreigners and inhabitants of the provinces resident in Paris, who, by comparison with a non-official return from the *Bureau des Longitudes*, (14th December, 1818,) appear to have amounted to 149,000 persons.

The population of the whole metropolis, (London,) at the commencement of the last century, was 674,000; in 1831, it was upwards of 1,500,000, which gives an increase of 222 per cent. The population of the whole of Great Britain, has been augmented, in the same time, from 5,475,000 to 13,888,000, or 254 per cent., so that the whole population has increased with still greater celerity than that of the metropolis.—*Phil. Mag. Nov.* 1832.

New works in England.

A letter dated Feb. 28, 1833, just received from Gideon Mantell, Esq., of Lewes, Sussex, England, mentions that the following works are about to appear.

1. The third volume of Mr. Lyell's Principles of Geology, completing that work; it is expected in April.

2. A new edition of Mr. Bakewell's admirable Introduction to Geology—in April.

3. The Geology of the South East of England, with figures and descriptions of the extraordinary newly discovered fossil reptiles of Tilgate forest, (by Mr. Mantell,) 8vo.

4. Dr. Fitton's Geology of Hastings, just published, price 4 *s.*: a very excellent little epitome of the geology of that neighborhood.

5. A memoir on the Plesiosauri and Ichthyosauri, discovered by Thomas Hawkins, Esq., of Glastonbury; 1 vol. 4to., with beautiful plates. Mr. Hawkins has succeeded, by sparing neither money nor trouble, in obtaining the finest remains of Plesiosauri and Ichthyosauri in the world; one specimen of the latter is twenty five feet long, and perfect from snout to tail.

THE

AMERICAN JOURNAL OF SCIENCE, &c.

Art. I.—*On the principles involved in the Reduction of Iron and Silver Ores, with a supplementary notice of some of the principal Silver Mines of Mexico and South America;* by Lt. W. W. Mather, Instructor of Mineralogy and Geology at the U. S. Military Academy, West Point.

I. Iron.

1. *Roasting of Iron Ores.*

The roasting of iron ores, is almost constantly found to result in the production of a purer iron than would be obtained by smelting without previous roasting. Another advantage is, that if the roasting be properly performed, less combustible matter is required for both the smelting and roasting, than would be for the smelting alone, without the roasting.

There are three principal objects in roasting iron ores, viz.

1. To vaporize injurious substances, or change their states of combination.

2. To increase the porosity of the ore.

3. To diminish the cohesion, and render it more easily broken.

The iron ores, during the roasting process, increase in volume, and with one or two exceptions, diminish in weight. The increase of volume causes a considerable degree of porosity in the ore, and this is of great advantage during the smelting. It allows the carburetted gases to penetrate every part of the fragments of ore, and thus to deoxidize it, and to carbonize the iron, far more rapidly, than if the action was confined to the surface alone.

The ores generally contain sulphur, in greater or less proportion, and, during the roasting, they are converted either into oxides, sulphates, or sulphurets of a lower degree of combination. The latter class of sulphurets, by exposure to the weather, are converted into sulphates, and these are removed by throwing the ore into a stream of water, or by leaving it, some time, exposed to the weather. Some iron ores are in a proper state for smelting, immediately after the roasting process; some require long exposure to the weather, and others to be quenched in water, while still hot. Many ores that with the above treatment, make iron of the best quality, would, without preparation, make iron of little value. It may be laid down as a general rule, that iron ores are more easily smelted, and make a purer and better iron, by being long exposed to the action of the weather.

2. *Fluxes.*

Fluxes are substances added to the ores to facilitate their fusion, and to separate the impurities. There is another all important object in having a proper flux for the iron ores, and it is one which is generally overlooked.

It is, *to form a coating of glass over the melted globules of iron, as they fall in their passage by the tuyere,* (blast pipe,) *to the crucible of the furnace.* If they be not coated, so as to protect them from the air, that rushes through the blast pipe, they take fire as they pass by it, and are again oxidized. Hence, *it is not only necessary to have a flux, but to have one of such a degree of fusibility, as shall fulfil the conditions required.* It should not be very easily fused, else,

1. It would melt before the metal, and run through the furnace without coating the iron.

2. The melted flux would dissolve the ore which was not then deoxidized, and thus create a great loss.

3. Any iron that might be reduced and fused, would pass *naked* before the blast and be reoxidized.

4. The flux would exert a powerful solvent action upon the boshes and crucible of the furnace, so as soon to wear it out.

Again, the flux should not be very difficult of fusion, else,

1. The iron would be fused first, and pass naked before the blast, and thus be reoxidized and then dissolved by the glass or cinder in the crucible of the furnace.

2. The flux, when melted, would form a tenacious mass, in the crucible, through which the globules of melted iron could not sink.

3. It would clog and choke the furnace so as to stop its operation, in a short time, unless remedied.

It requires much care, and practical knowledge, so to arrange the fusibility of the flux, as to obtain the greatest quantity and best quality of iron.

Whatever earths may be mixed, or combined in the ores, they may always be rendered fusible by adding two others. It is necessary, however, to observe, that lime, alumina, and magnesia will not fuse together, but any two of these, with silex, or metallic oxides, will form a glass. Magnesia tends to diminish the fusibility of the substances with which it is mixed.

The usual fluxes are marl, limestone, and clay. Limestone is often used when it ought not to be, and the same may be said of marl. In Sweden, mica and mica slate, hornblende, garnet, basalt, actynolite, argillite, &c. are used as fluxes, and, in many parts of this country, these materials might be employed, with advantage.

Manganese fluxes most readily with silex, and this is what should be used in ores containing that metal, unless they already contain an excess of silex, and then, limestone should be used.

The fluxes to be used will be determined,

1. By the nature of the earths already combined, or mixed in the ore or ores;

2. By their quantity;

3. By the nature of the mineral substances in the vicinity.

It is often advantageous to mix different ores, so that the impurities may flux with each other.

The cinder (laitiér) formed by the fusion of the flux and the impurities of the ore, to be of the best quality, should not begin to melt until the iron is deoxidized, or nearly so, and sufficiently carburetted. It should have such a degree of viscidity as to remain adhering to, and enveloping the mineral in which the earthy matter is mixed, or combined, so as to prevent the oxidation of the iron, as it melts and falls into the crucible of the furnace; but the viscidity should not be so great as to prevent the globules of iron from sinking through the semi-fluid cinder which floats over the melted iron in the crucible.

The cinder, when the iron is of good quality, is often of a light gray, or of a whitish color. The French call the cinder *laitier*, from its color.

3. *Cast Iron.*

Of these, there are three principal varieties, viz. gray, mottled, and white. They are too well known to need description. Hassenfratz (Siderotechnie i, p. 57,) supposes the color of these irons to be owing to a greater or less separation of the carburet of iron during the cooling. He supposes the particles of gray iron, and also those of the dark parts of the mottled irons, to be enveloped by a coating of plumbago. On cooling the gray and mottled irons rapidly, a white iron is produced, and by slow cooling, plumbago in plates, or kish, as it is called by the workmen, collects upon its surface. Irons that by refining, would make hotshort, or coldshort malleable irons, are best employed in common castings.

Gray irons requiring much labor to refine them, if they make good iron, are well adapted for making steel, or when the iron is very tough, it is employed in the casting of cannon and machinery. White iron is rarely used for castings, except for anvils and heavy hammers, but it is much used for refining to make bar iron.

4. *Ductile Iron.*

Of these, there are four principal varieties, viz. soft iron, coldshort, hotshort, and brittle iron.

The soft iron is ductile, malleable under the hammer, capable of being bent back and forth without breaking, and without being elastic, is difficult to melt, does not acquire hardness by tempering, is of a clear gray color when filed, leaves no black spot when an acid is touched to a bright surface, rusts slowly and uniformly by exposure to air and water, burns easily when exposed in a heated state to the air, becomes strongly magnetic under the influence of a magnet, and loses its magnetism when removed from magnetic influence. Its structure is fine grained or fibrous.

Coldshort iron is distinguished by its brittleness, when cold. Its fracture developes a granular and laminated structure, and the iron is more defective, as this structure becomes more evident. It forges very easily when hot, and for this reason is much employed in forging small articles.

Hotshort irons are those that crack, break, or fly in pieces when forged hot. There are two kinds of defects in these irons.

1. Some of these irons fly in pieces when forged at *a particular temperature*, but forge well enough at a higher or lower heat.

2. Some of them *break in bending*, but otherwise forge well.

Little hotshort iron is found in commerce, because it is difficult to get it into the form of bars, and the *cracks and flaws upon the edges* would betray it. This iron is applicable to such purposes as require great strength, when it can be wrought cold into the forms required.

5. *Means of remedying the defects of coldshort and hotshort irons.*

The characteristic property of coldshort iron can be given to any soft iron, by exposing it for some time to heat. Its fracture becomes granular and laminated, but when the iron was originally good, its softness and toughness may be restored by simply heating and forging.

Many of the bog and argillaceous iron ores give coldshort iron, notwithstanding the care of the workmen. The cause why iron is in one case hotshort, and in another coldshort, is not yet fully understood, but the hotshort iron is generally found to contain sulphur, and the coldshort, phosphorus. Pyrites, in the ores, almost uniformly make the iron hotshort, and copper, lead, and arsenic are thought to produce the same effect.

When the ores of iron do not make the metal hotshort or coldshort in a very high degree, the defect may generally be remedied by carefulfully roasting them, and then exposing them for some time to the weather. In smelting the ores, a difference in the quality of the iron is often effected by giving a different inclination to the tuyere (blast pipe.)

Coldshort iron is generally brought to the state of soft iron, by vitrifying lime with the scoriæ, and using this new cinder to cover the iron in the finery furnace, or even by throwing a little lime upon the mass of iron in the finery furnace, a short time before removing it to pass between the rollers. Potassa, or ashes (of wood) will produce the same effect.

Hotshort iron is more difficult to improve in quality, but where coldshort iron is at hand, the difficulty may be remedied by melting together, in proportions to be determined by experiment, the different kinds of cast iron that would produce the two sorts. The opposite defects remedy each other. The same result is obtained by mixing the ores that would make hotshort and coldshort irons, in proper proportions, in the smelting furnace, when a cast iron is obtained which may be made directly into good soft iron.

There is another method, depending upon the same principle, by which the defect of coldshort iron may be removed. It is by using bituminous coal with the charcoal in the process of refining, but if too much of the coal be used, the iron becomes hotshort. Bituminous coal always contains some pyrites, and the sulphur contained in these, is supposed to enter into combination with the phosphorus in the coldshort, and thus both these substances become so volatile as to escape from the melted iron.

For details upon all the methods of working iron ores, the reader is referred to Hassenfratz's Siderotechnie.

II. On the extraction of silver from its ores.

Processes.

Silver is separated from its ores, either by smelting, or by amalgamation. The most important points, in determining to which of these processes they shall be subjected, are,

1. The nature of the ore.
2. The comparative facilities for obtaining lead and mercury.
3. The abundance of fuel.
4. The abundance of water.

Generally speaking, it is most advantageous to amalgamate ores in which the silver is in a metallic state, or when it is combined with substances of little value.

When the ores are very much disseminated in their gangue, so as to render stamping necessary, it is more advantageous to amalgamate. Pyrites are generally contained in abundance in such ores, and sulphur is necessary to the success of the amalgamation process.

When silver ores are rich in lead or copper, it is advisable to smelt them.

Ores, of difficult fusion, may also be amalgamated with advantage, for the nature of the accompanying materials is not important in the amalgamation process.

Ores containing from seventy to eighty ounces of silver to a ton, have been found best adapted for amalgamation, but when they contain more than eighty ounces to the ton, it is difficult to extract all the silver, by this method. It is generally most economical to smelt ores containing less than sixty ounces of silver to a ton of ore. Rich ores of silver are always smelted.*

1. *Smelting of Silver Ores.*

The silver smelting processes are very simple, and the ultimate separation of the silver from the materials, combined or mixed in the ore, depends upon the strong affinity of lead for the precious metals.

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* For minute details of the various operations of smelting and amalgamating silver ores, the reader is referred to Clemson's memoir in the American Journal of Science, vol. xix, p. 105; Taylor's Records of Mining, vol. i; Annales des Mines, tomes xxix and xxxi; Humboldt's Essai sur le Nouvelle Espagne, tomes iii and iv.

In the European and some of the South American silver smelting works, limestone, and the slags of former operations, are used as a flux. In the Mexican smelting houses, carbonate of soda is generally employed, as the flux. Carbonate of soda occurs in such abundance over extensive districts of country in Mexico, as to be considered of little value. The price, at the smelting works, is only about thirty cents per quintal. It is well adapted to the smelting of muriate of silver, and this is an abundant ore in the Mexican mines.

The poorest ores are first smelted, with one of the fluxes above described, in the common high furnace. The sulphurets contained in the ore, and perhaps some metals in a reguline state with the silver, collect in the crucible of the furnace. This mass of mixed sulphurets and metals is called "matt."

When the crucible is full of the fluid matt, the latter is drawn off into a cavity adapted to receive it. As the matt cools, so as to have a crust form over its surface, the crust is taken off in successive plates, until all the matt is in this form, the object of which is, to have as much surface exposed as possible in the subsequent roasting.

The matt, in plates, is then roasted slowly, the objects of which are, to volatilize the sulphur, arsenic, &c., and to oxidize the iron, and other metals, so that in the succeeding fusion, the metallic oxides may be dissolved by the earthy glasses.

In the second fusion, the roasted matts of the first fusion are smelted with richer ores, and with slags of a previous third fusion. The resulting matts are roasted as before, and for the same purposes.

In the third fusion, the roasted matts of the second fusion are smelted with the richest ores.

The matt, resulting from this fusion, is drawn off into a cavity on the outside of the furnace containing *melted lead.* The fluid matt, having a less specific gravity than the lead, floats upon its surface, so that it is necessary to stir them well together, that the lead may dissolve all the silver. The matt, as it cools, is taken off in plates as before, and roasted and smelted with the poorest ores of a new batch.

The silver is afterwards separated from the lead by cupellation. The argentiferous lead is kept in a state of fusion in a cupelling furnace, with a constant current of air passing across its surface. The lead is converted into an oxide, (the litharge of commerce,) and the silver finally remains, nearly in a state of purity.

The reason that the slags are used as a flux is, that they still contain a small portion of silver, which is obtained, chiefly, by successive re-smeltings. The slags of the first fusion are usually thrown away, while those of the other two operations contain silver enough to render them worth re-smelting.

2. *Amalgamation of Silver Ores.*

There are two principal methods of amalgamation employed to extract silver from its ores.

1. The Saxon method, or *amalgamation cold*, by means of iron.

2. The Mexican method, or *amalgamation cold*, by means of a mixture of salts.

There is another method in use in Mexico, but not extensively, it is the *amalgamation hot*, by means of copper.

The Saxon method, as it is called, was first discovered by a Peruvian miner, Corsa de Leca in 1586, but it was not much employed in Europe until about 1790. The two most important considerations in this method are,

1. To detach the silver from its various combinations in the ore, and bring it to the state of a chloride.

2. To reduce this chloride to the metallic state by means of metallic iron in contact with mercury, so that the silver in its nascent state may combine with the mercury.

The first operation, after the ore has been properly picked and sorted, is, to form a suitable mixture of the ores, with reference to the quantity of silver and sulphurets contained in them. The amalgamation succeeds best, when the silver is at the rate of about seventy five ounces to the ton of ore, and the sulphurets amount to about thirty five per cent. The ores after having been assayed, can be mixed so as to give the above proportions. The ore is now powdered, and undergoes various mechanical operations with screens, sieves, bolts, &c. until reduced to a very minute state of division. It is now mixed with about ten per cent. of common salt, and roasted in a reverberatory furnace. The object of the roasting is to change the states of combination of the various substances. Some of the sulphur of the pyrites burns off, and some combines with the sodium of the common salt. The metals set free by the combination of the sulphur with sodium, combine with the chlorine of the decomposed salt, and form chlorides. Some of the sulphurets are also, perhaps, converted into sulphates and oxides, but the silver, if the operation has been properly performed, is entirely converted to a chloride. During the roasting, the ore must be frequently stirred, and the heat so managed, that it shall not become in the least agglutinated or pasty. The ore now goes again through various mechanical operations, to be sure that it may be in a state of minute division.

It is now ready for the actual process of amalgamation. This is performed in barrels, revolving on an axis by means of machinery. The mixture or charge in each barrel, consists of finely divided roasted ore, mercury, and plates of metallic iron, with sufficient water to make it into semi-fluid paste.

It is a chemical principle, that when one metal precipitates another, the precipitated one is always in the metallic state, and also, that gold or silver and some other metals, in their nascent state, readily unite with mercury, and form what is called an amalgam. After the barrels have received their charges, and are put in motion, chemical changes begin to be effected. The revolution of the barrels tends to bring all the parts of the charge, successively, into contact with each other and with the iron plates. The iron having a strong affinity for the chlorine of the chloride of silver, decomposes it, and forms a chloride of iron, which, by solution in the water, becomes a muriate. The silver, thus set free, immediately unites with the mercury in contact with it, and forms an amalgam. The mercury, during the revolution of the barrels, is disseminated in small globules through the whole mass, so that as soon as a particle of silver is reduced, it is brought into contact with the mercury. When the barrels have revolved a few hours, with a proper charge of materials, and with a proper velocity, the silver is found to have combined almost entirely with the mercury. If the water be in too great or too small proportion, or if the rotation be too rapid or slow, the mercury will not disseminate itself through the mass, so as to effect the separation of silver from the materials with which it is mingled and combined. When the amalgamation is found to be complete, as it generally is at the end of a few hours, the barrels are allowed to stand a short time, that the amalgam may collect in the bottom. The amalgam and mud are then both drawn off and washed, but the washing requires care, lest a portion of the amalgam, which may be still disseminated through the mud, should be washed away and lost. The redundant mercury of the amalgam is removed by pressure applied to leathern bags; the mercury passes through the pores of the leather, and the solid amalgam, having about the consistence of butter, remains. It is next subjected to distillation in proper vessels, by which the mercury is first volatilized and then condensed again, while the silver remains. The silver, thus obtained, is not always pure, but often contains gold, lead, copper, bismuth, &c. which are separated in the refining operations.

3. *Mexican method of amalgamation.*

The Mexican method, or the *amalgamation cold, and in the open air, by means of a mixture of salts,* was discovered, in the year 1557, by Bartholomew de Medina, a Mexican miner. This method does not require, that the ores should be roasted, and the only necessary machinery is a stone moving in a circular trough,* and a vertical spindle with arms, revolving in a vat. This method may be employed, where neither water or fuel are abundant.

The amalgamation shop, is a yard paved with flat flagging stones. The moist schlich or powdered ore, coming from the stone rollers before mentioned, is deposited in forty or fifty piles, ranged circularly near each other, so that the circle may be from sixty to ninety feet in diameter. Each heap of schlich contains from fifteen to thirty five quintals in weight, so that when the whole comes to be spread, the mass may be from one and a half to two feet in thickness. Salt is now mingled with the schlich, in a proportion varying from two to twenty per cent. The mixture is left, for many days, that the salt may dissolve and be equally distributed. If the pyrites are very rapidly decomposed and other chemical changes are evident, the action is diminished by adding lime, or wood ashes, or if the decomposition be very slow, it may be accelerated by adding a mixture of the sulphates of iron and copper, formed by roasting pyritous copper and common pyrites, and exposing them to the weather.

After some days, mercury is added, in quantities proportioned to the silver in the ore, generally six or eight parts of mercury to one of silver. After a little time, from one to seven per cent. of the mixed sulphurets of iron and copper are added, and when the chemical changes begin to take place, which are recognized by the leaden color of the mercury, then, to favor the decomposition and augment the contact, the mass is stirred and moved by mules, oxen, or other animals, walking around in it in circles. This agitation of the mass is continued daily, unless the decompositions should be too rapid, and then the labors are suspended for one or more days, as circumstances

* The recent superintendent of the mine Valenciana, Mr. John Millington, tells me, that the stones do not roll in the circular trough, but are dragged around.

may require.* The labors are continued until the amalgamation is found to be completed, and this often requires from two to five months, unless the climate should be a very warm one. It may be doubted whether this method of amalgamation would succeed in this climate without artificial heat.

The mud, containing the amalgam, is now thrown into vats, in which is placed a revolving vertical shaft, with arms. A stream of water runs into and from the vat, and the arms of the shaft, by their motion, keep the earthy particles in suspension, which gradually flow off with the water, while the amalgam collects at the bottom. The excess of mercury is separated, by pressing the amalgam in leathern bags, through the pores of which the mercury passes, leaving a semi-solid amalgam.

The silver is obtained from this amalgam, by the same operations as in the Saxon method of amalgamation.

4. *Amalgamation hot, by means of copper.*

This consists in heating the powdered ores with mercury in copper vessels. It was first proposed in 1590 by Alonzo Barba. It is employed principally for amalgamating the earthy ferruginous ores of silver, called pacos and colorados, and for those ores which contain much muriate of silver.

The ebullition favors the operation, the copper tends to decompose the muriate of silver, and the loss of mercury is very small. Iron vessels would probably be as effectual as copper, and would be far more economical.

5. *Loss of Mercury.*

In the Mexican method of amalgamation, the loss of mercury is from 1.4 to 1.7 parts of mercury for one part of silver obtained; in the Saxon, not to exceed one of mercury to five of silver, so that by the Mexican method, the loss of mercury is more than seven times as great as when the Saxon method is employed. By the Mexican method, the loss of mercury forms more than one fourth of the whole expense of amalgamation.

The loss of mercury may be accounted for,

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* Sometimes, the mere cessation of labor is not sufficient to diminish the chemical action to a proper degree, and then lime or wood ashes is added. Sometimes, it is also necessary to quicken the chemical action, and then, the mixture of sulphate of copper and iron with peroxide of iron, called magistral is added.

1. In consequence of the minute state of division in the immense mass of schlich, by the washing process, many of the particles of mercury may be carried off, in a state of suspension in the mud. Even in the Saxon amalgamation works, where the process is conducted with the greatest skill and care, a sensible portion of mercury is carried off in this way.

2. The contact of the mercury with the various metallic and other materials, moistened with saline solutions, forms an infinity of galvanic arrangements, whose actions are slow indeed, but prolonged, and favor the oxidation of the mercury, and various other chemical affinities.

3. The heat of the mass, produced by the various chemical changes, and increased by a tropical sun, might be sufficient to partially oxidize the mercury, when in contact with the air.

The mines of Almaden, in Spain, and of Idria, in Carniolia, have, in general, furnished the mercury consumed in the Mexican mines. The mine of Huan-cavelica, in Peru, has occasionally furnished some mercury. The Mexican mines consumed previous to 1804, an annual average of sixteen thousand quintals of mercury.

6. *Chemical changes in the Mexican method.*

M. Humboldt is of opinion, that the sulphates of iron and copper, in the magistral, decompose the "muriate of soda," (chloride of sodium,) forming sulphate of soda and "muriate of silver," (chloride of silver,) and that the latter is, in part, decomposed by the oxide of iron set free, and the other by the mercury. Two affinities are here brought into action, viz. the affinity of iron, copper, &c. for chlorine, and the affinity of mercury for silver, both tending to the decomposition of the chloride of silver. He is also of opinion, that the reason of the usefulness of lime or ashes, when added, under certain circumstances, during the amalgamation, is, that they serve to prevent the excess of sulphuric acid, formed by the decomposition of pyrites, from acting on the mercury.

M. Humboldt and Gay Lussac, in mingling cold, the natural sulphuret of silver, sulphate of iron, muriate of soda, and lime, have not been able to obtain muriate of silver at ordinary temperatures, at the end of a fortnight, but when heated from 86° to 96° F., they obtained it at the end of a few hours. They also observed, that an amalgam was formed, when the materials were mixed cold, but that it was formed much more abundantly, when iron filings were mingled with the other materials, and they conceive that the iron serves not only to decompose the chloride of silver as in the Saxon method, but also to separate the sulphur from the sulphuret of silver. When sulphuret of silver, alone, was mixed with iron filings, it was, at the end of twenty four hours, so much reduced, that on adding mercury, a large proportion of amalgam was obtained in a few minutes.

It is probable that the peroxide of iron in the pacos, in the colpa, and that mingled in the magistral, act in a similar manner to the iron filings. It results from these experiments, that iron perfects in a sensible degree, the process of amalgamation, and in consequence, it has been recommended that the amalgamation yards should be paved with iron plates, and that the (tourte) amalgamation mass should be ploughed by iron ploughs, but the tourte is composed of schlichs forming so heavy and stiff a paste as to render ploughing it almost impracticable.

Lime seems to oppose itself to the combination of silver and mercury, for an amalgam is very difficultly formed, by triturating mercury and sulphuret of silver, and even after having formed a paste of the ore, magistral, salt, and mercury, in which the globules of mercury are no longer visible, if lime be added, the mercury soon shows itself, coalescing into globules, wherever the lime is in contact with the mixture. It is on this account, that the workmen say the *lime cools the tourte*, because it prevents its working so rapidly. The lime, then, has another use than that of removing the excess of sulphuric acid in the tourte.

The methods in use a few years since, in Mexico, were essentially the same as has been mentioned, but it seems that by the proper mixture of salt, magistral, and lime, the time requisite to perfect the operation is much lessened, as the proces now rarely requires more than twenty days.*

In Chili, the amalgamation is performed as in Mexico, except that salt, and horse or mule dung are the only materials added to the ore to assist in the amalgamation. In Chili, the heat of the sun, is, in general, sufficient, with suitable attention, to perfect the amalgamation, in eight or ten days in summer, or three weeks in winter; but on some of the high table lands of Peru, the amalgamation floor is built upon arches, under which a fire is kept up to supply the necessary temperature.

The foreman judges of the perfection of the amalgamation by washing a small portion of the amalgamation mass. If the remaining

* Vide Jour. Royal Institution, No. 1, Oct., 1830, p. 142, et seq.

amalgam be *hard*, more mercury is added, and the mass again kneaded. If, on pressing the amalgam under the thumb, globules of mercury separate, the materials have not been sufficiently incorporated, and the mass is again kneaded and left to ferment.

If the amalgam be dark colored, more salt and dung are added, and the mass being then well worked over, is allowed to ferment again.

If the amalgam, on being pressed under the thumb, form a plastic mass, adhering to the skin, the amalgamation is judged to be complete. The amalgamation mass is then washed as in the Mexican or Saxon operations, or sometimes without the aid of machinery, the mud being kneaded in a hide, water being allowed to run into it in a small stream. The earthy and vegetable substances are carried off in suspension, and to prevent a loss of mercury, the water runs off in a small gutter, connected with small successive reservoirs, in which the metallic particles subside, while the others flow off.*

In Chili, silver is obtained from its ores only by amalgamation. Even galena, containing silver, is amalgamated, and this appears to be more economical than by smelting and cupellation.†

Supplementary Notice of the principal Silver Mines of Mexico and South America.

There are, in Mexico, about five hundred towns, or principal places, celebrated for the explorations of silver that surround them. These five hundred places of exploration, comprehend, together, about three thousand mines, and there are between four and five thousand veins and masses of silver in exploration. The ore is generally in veins, rarely in beds and masses.

The vein of Guanaxuato is the greatest and most extensive one known. It is from one hundred and twenty to one hundred and fifty feet thick, and is explored in different places, over a length of about nine miles.

The silver veins of Mexico are, generally, in primitive and transition rocks, rarely in secondary. The veins of Zimapan are in a greenstone porphyry. Among the transition rocks, limestone abounds most in silver ores. Grauwacke is also very rich in them, and in this rock are found the rich mines of Zacatecas. In the secondary rocks, are found a few rich mines. The mines of Real Ca-

* Mier's Travels, ii, p. 393, et seq.

† Mier's Travels, ii, p. 406.

torce, and many others near Zimapan, are in the alpine limestone, as well as those of Tasco and Tehuilotepec, and the veins are richer in this limestone than in the argillaceous slate, which serves as a basis for it.

The three most productive mining districts have their veins situated in different rocks, viz. those of Guanaxuato in primitive argillite, ("schiste argileux primitif,") those of Zacatecas in grauwacke, and those of Catorce in alpine limestone, ("calcaire alpin.") The mines of Pasco and Hualgayoc, in Peru, are also in the alpine limestone,* but that of Potosi is in primitive slate, ("schiste primitif.")

M. Humboldt remarks, that the more we study the geological construction of the globe, the more are we led to observe, that there hardly exists any rock, which, in certain countries, has not been found eminently metalliferous.

The most common ores of silver, in Mexico, are the sulphuret, the antimonial sulphuret, the prismatic black ore, the chloride, and gray copper. It is rare not to find native silver, in small quantity, in connection with the sulphuret of silver, and one mass of native silver was found at Batopilas, weighing more than four hundred pounds. Red silver ore and chloride of silver, which are rare in Europe, are abundant ores in Mexico and South America. There are some earthy ores of silver, called *colorados*, and in Peru *pacos*, which contain imperceptible particles of silver ores, disseminated in a basis, which is mostly oxide of iron. This ore is generally found where a vein of silver ore approaches the surface of the earth. Among the other ores explored for the silver they contain, are the argentiferous sulphurets of lead, iron, and copper.

The quantity of silver in the ores, averages from three to four ounces to the quintal, or from $\frac{1}{448}$ to $\frac{1}{597}$ of the weight of the ore. The annual produce of silver, during the last years of the eighteenth century, by Mexico, was 537,512 kilogrammes, or 1,134,424 lbs., a kilogramme being 2 lbs. 3 oz. 5 dr.; but $\frac{19}{20}$ of the mines do not produce $\frac{1}{12}$ of this amount. Thus we see $\frac{1}{20}$ of the mines, being the most productive, give more than $\frac{11}{12}$ of the whole amount.

Most of the mines of Mexico are situated either upon the back or sides of the Cordilleras, and particularly on the west side, and they are the most abundant between the eighteenth and twenty fourth degrees of north latitude.

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* Annales des Mines, t. xxix, p. 113.

I. *Mines of Guanaxuato.*

There is one circumstance in the situation of the immense silver vein, called "la veta madre," which is very remarkable, viz. that it is parallel to the strata containing it.* This vein has been recognized over a length of fourteen thousand yards, or about nine miles, and has a breadth of about forty five yards. Most of the nineteen mines wrought on this vein, are very productive.

The materials composing it, are native silver, sulphuret of silver, red silver ore, native gold, sulphurets of lead, zinc, iron and copper, carbonates of iron and lead, and some gray copper. The stony materials are quartz, calcareous spar, pearl spar, feldspar, chalcedony and fluor spar. The vein of Guanaxuato passes through argillaceous slate, and also through porphyry. The argillaceous slate appears to be the most ancient rock of the district. It sometimes passes into talcose and chloritic slates, and beyond, it is seen reposing upon the granites of Zacatecas and Penon Blanco. This slate contains subordinate beds of sienite, hornblende slate, serpentine, and greenstone, and it is observed that the *sienite contains veins of greenstone, and the greenstone veins of sienite.*

Upon the argillaceous slates repose two different formations, viz. porphyry and "grès ancien,"† the former constituting the elevated peaks, while the latter fills the ravines and low grounds.

The porphyry presents gigantic masses, like ruins, and precipitous escarpments, of from one thousand to one thousand five hundred feet in height. This porphyry is, in general, of a greenish color; its paste is variable, being in the oldest, compact feldspar or petrosilex—in others, it approximates to jade, or to phonolite.

The newer porphyries contain glassy feldspar, and much resemble the porphyritic slate (porphyrschièfer) of Bohemia. Enormous concentric balls of these porphyries are sometimes seen reposing upon isolated rocks. The aggregate of the characters of these rocks, indicates that they belong to the class of trap rocks, except that rich gold mines have been found in them at Villalpando.

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* For evidences of its being a vein, and not a bed, see Humboldt's Essai sur la Nouvelle Espagne, t. iii, p. 395, and Ann. des Mines, t. xxxi, p. 323.

† Annales des Mines, t. xxxi, p. 325.

These porphyries have the same direction and dip as the argillaceous slate, the line of bearing being from north west to south east, and the dip from 45° to 50° to the south west.

The "grès ancien" is an aggregate of angular fragments of quartz, lydian stone, sienite, hornstone and porphyry, cemented by an argillo-ferruginous cement. This rock rests upon the argillaceous slate, but has an opposite inclination. There is also another grauwacke, (grès,) which differs much from the last. It is composed of fragments of quartz and slate, and particularly of *uninjured crystals of feldspar*, which might cause it to be mistaken for a porphyry. M. Humboldt calls it "grès," or "agglomérat feldspathique." The cement is argillo-ferruginous, and thin layers of shale ("schieferthon") alternate with the rock. It is an excellent building material, easily dressed, and is called in the country "lozero." A limestone, analogous to the Jura limestone, overlies all these grauwackes. There are also local, calcareous breccias, transition limestone, and various trappean rocks.

Upon the vein of Guanaxuato, which is the only one of the whole district, there are nineteen explorations. They furnish one fourth of all the silver of Mexico. The richest of these mines, and in fact the richest of all Mexico, is that of Valenciana. This mine was opened in the sixteenth century, and afterwards abandoned. In 1760, it was opened again, and wrought for several years, under very discouraging circumstances, by M. Obregon, since Count de Valenciana. He arrived, finally, at a rich part of the vein, and soon replaced all his former losses, and many fold more. During some years, the net profit of the mine was $1,200,000 per annum. The three old shafts of the mine cost the Count de Valenciana $1,200,000. In 1792, it was judged expedient to construct a new shaft for the extraction of the ore. It was commenced, at that time, with a diameter of thirty feet, with the expectation of being able to reach the vein in 1815, at the depth of one thousand six hundred and fifty feet. The shaft is well executed; the stone lining is perfect of its kind, and Humboldt considers it a model worthy of examination. The objects of this shaft were not only, as usual, to facilitate the extraction of the mineral, but also to diminish the number of porters.

Comparison of the expense and profit of the mine of Valenciana, in Mexico, and Himmelsfurst, in Saxony.

	Mine of Valenciana.	Mine of Himmelsfurst.
Quantity of silver, - -	360,000 marcs.	10,000 marcs.
Total produce, - -	$1,600,000	$66,000
Expenditures, - - -	$1,000,000	$48,000
Net profit, - - -	$600,000	$18,000
Quantity of silver, per quintal,	4 ounces.	6 to 7 ounces.
Number of workmen, -	3100	700
Do. do. in the mine,	1800	550
Value of one day's labor,	$1 to $1.20	$0.18
Expense of powder,	$80,000	$5,400
Quintals of ore sent to the amalgamation works,	720,000	14,000
Depth of the mine,	1650 feet.	1050 feet.

The proprietors of Valenciana receive, then, a profit of 37½ per cent. on the gross receipts of the mine, while at Himmelsfurst the profit is only 27 per cent.

II. *Zacatecas, Fresnillo, Sombrerete, and Catorce.*

The district of Zacatecas is situated to the north west of Guanaxuato, to which, in its geological constitution, it is, in many respects, analogous. The veins are explored in the grauwacke, and are found to be richer upon the highest and most barren summits, than upon the declivities, or in the ravines and valleys.

The principal ores are sulphuret of silver, native silver, red silver, black silver, chloride of silver, argentiferous galena, carbonate of lead, sulphuret of zinc, pyrites, pyritous copper, carbonate of copper, sulphuret of antimony, and native gold. The principal secondary rocks of Zacatecas are compact limestone, siliceous slate, "grès ancien," containing fragments of granite, and an argillaceous feldspathic conglomerate. Both these last are different from grauwacke.* Argillaceous slate and porphyry are also observed.

The district of Fresnillo bounds that of Zacatecas on the north west, and its mines are also situated in grauwacke. The veins of chloride of silver are very numerous. The ore is generally of a green or gray color.

* "Tous deux differens de la grauwacke." Ann. des Mines, t. xxxi, p. 331.

The mines of the district of Sombrerete, which approaches that of Fresnillo on the north west, are in a compact limestone, which contains siliceous slate and lydian stone. There are some veins of from three to four feet in thickness, whose entire mass is formed of antimonial sulphuret of silver. One of these veins gave, in six months, seven hundred thousand marcs* of silver. The limestone, in this vicinity, is much more elevated than the porphyry.

The district of Catorce is situated about 24° N. latitude, one hundred miles east of Sombrerete, and about three hundred miles north of Mexico. A great number of small and very variable veins have been explored. The masses of the veins are disintegrated, so that the ores are earthy, and most of them are colorados, or earthy ferruginous ores. The veins traverse a compact secondary limestone, which covers argillaceous slate, (schiste argileux de transition.) Masses of basalt and cellular amygdaloid, which contain olivine, zeolite and obsidian, are protruded above the limestone.

III. *Pachuca, Real del Monte, and Moran.*

These mining districts are very near each other. Four great veins, viz. la Biscaina, le Rosario, la Cabrera and l'Encino, traverse all these districts, to great distances, without changing their direction, and almost without being crossed or deranged by any other vein.

The veins traverse a decomposed porphyry, whose basis is sometimes a scaly hornstone, and sometimes an earthy mass. Common and glassy feldspar, and some spots of green hornblende, are observed, but no quartz. In the vicinity of these rocks, on the highest summits, are other porphyritic rocks, with a basis of pearl stone, mingled with beds and nodules of obsidian.

Upon the first or metalliferous porphyry, reposes the alpine limestone, (calcaire alpin,) which contains some veins of galena. This is covered by Jura limestone, which, in its turn, is covered by slaty sandstone, and finally, gypsum, mingled with clay, completes the series observed. From the vein Biscaina, in the district of Real del Monte, the Count de Regla, in twelve years, cleared $5,000,000.

These mining districts have enjoyed great celebrity, both on account of their great wealth and their vicinity to the capital. The

* A Spanish marc is equal to 7 oz. 3 dwt. 14 grs. troy.—Mier's Travels, II, 405.

minerals, in the veins near the surface, are in a state of decomposition, and mingled with much oxide of iron, like the pacos of Peru.

IV. *Pasco mines.*

These mines are situated south west of the city of Mexico. The most ancient rock is argillaceous slate, and this is covered by a formation of porphyry, which contains common and vitreous feldspar, and beds of blackish brown pitchstone; and again, the porphyry is covered by a bluish gray compact alpine limestone, which is often porous, and contains subordinate beds of gypsum and argillaceous slate, and also univalve shells. The limestone is overlaid by a sandstone, with a calcareous cement.

The veins traverse both the limestone and argillaceous slate, but they are richest in the limestone. Some of the veins have a breadth of thirteen feet, but the ores are not uniformly disseminated in their gangue, and in general their produce is very variable.

These mines must not be confounded with the Pasco mines of Peru, which are situated about thirty or forty leagues north of Lima. For an account of these, the reader is referred to the American Journal of Science, Vol. XVII, p. 43, and Mier's Travels in Chili, II, p. 432, et seq.

The principal mining districts of Peru, are those of Pasco, Chota, and Huantajaya. The veins of silver ore are very numerous, but nearly all the silver produced is from a few mines. The Pasco or Yauricocha mines have been already referred to, in the American Journal of Science, Vol. XVII, p. 43.

The mines of Chota are situated on the Andes, at about 7° S. latitude. The principal ones are those of Gualgayoc and Micuipampa, and their discovery dates from 1771, but the ancient Peruvians had explored silver veins in the vicinity. The veins, composed of sulphuret of silver, red silver, and native silver, traverse sometimes alpine limestone, and sometimes hornstone, which forms subordinate beds. The upper part of the veins is a red earthy ferruginous mass, containing silver, and called *pacos*. In some places, large quantities of ore are found on the surface of the earth. In a small plain, called *la Pampa de Navar*, wherever they have removed the turf, they have found sulphuret of silver and native silver, adhering to the roots of the grass, and often the silver is in irregular masses, as if the melted metal had been poured upon soft clay.

The mines of Huantajaya, are situated in the southern part of Peru, near the Port of Yquique, in a low desert plain, entirely deprived of water. The ore is a decomposed mass, mingled with native silver, chloride and sulphuret of silver, and galena. It is accompanied by quartz and carbonate of lime. These mines are celebrated for the large masses of native silver found in them. One mass weighed more than eight quintals. Rock salt occurs in abundance in the vicinity of the mines.

V. *Mines of Potosi.*

These mines are situated in about 20° S. Lat. upon the eastern declivity of the Andes, near the most elevated sources of the La Plata. They were discovered in 1545, and had furnished, up to 1804, more than $1,100,000,000. The first eleven years were most productive, the annual produce during that time, being 1,300,000 pounds weight. Many of the ores then gave from $\frac{40}{100}$ to $\frac{45}{100}$ of metallic silver. In 1574, the ores produced from 4 to $4\frac{1}{2}$ per cent; in 1607, $1\frac{1}{20}$ ounce per quintal or $\frac{93}{10000}$; at the beginning of the eighteenth century, $\frac{40}{100}$ to $\frac{64}{100}$ of an ounce per quintal of ore. Thus, it seems that these mines have lost in richness, as the excavations have been carried deeper, but as the entire product of silver is not greatly diminished, the *quantity* of ore, compensates for its *poverty*. In 1804, Potosi reported an annual product of 400,000 pounds weight of silver.

The veins of ore, at the Potosi mines, traverse an argillaceous slate, which forms the mass of the mountain, but the summit is crowned by a bed of argillaceous porphyry, containing garnets. The veins are very numerous, and some of them are elevated in the form of a crest; the rocks of the floor and roof having been more rapidly decomposed than the vein. These crests were composed almost entirely of red silver, sulphuret of silver, and native silver. One of the veins, viz. *del estano*, presented for its crest, and even for a great depth, only the *sulphuret of tin*, below which is found the chloride of silver. This is an example of two mineral formations in one vein, similar to what has been observed in the Freyburg mines in Saxony, and in the tin and copper mines in Cornwall, Eng.

Peruvian method of smelting.

The Peruvian method of reducing the silver ores, was to melt them with galena, in broad circular clay furnaces, pierced with a great number of holes, so that the free access of the exterior wind, might produce an intense ignition of the charcoal, contained in them, and to increase the effect, the furnaces were placed upon the summits of the hills, where, of course, the wind was most powerful. The result of this operation, was an argentiferous matt, which was remelted in similar furnaces in the Indian cabins, the blast being supplied by ten or twelve men with long copper tubes, having small orifices. This method was followed up by the Spaniards in the Peruvian mines, until 1571, when the Mexican method of amalgamation was adopted at Potosi.

Mining system.

The exploration of the Mexican mines, up to the time, when Humboldt examined them, was very defective, although mining had been, for more than three hundred years, a constant source of employment to many of the inhabitants. The only improvement that had been introduced, was that of blasting with gunpowder.

Some of the defects of the system of mining employed in Mexico are,

1st. They have no plan of the works, so that two galleries may be very near each other, without their knowing it; they have no sure rule, either for forming a communication, or for directing the excavation of new galleries, upon a point found to be very rich. Two hundred and fifty miners perished in 1780, at Guanaxuato, because they had, without knowing it, imprudently advanced near some old inundated excavations, from which they thought themselves at a considerable distance.

2d. In most mines, the communications between the different parts are circuitous. This is one of the great faults of their explorations, which are, in this respect, like a badly constructed edifice, in which, to pass from one room to an adjoining one, you must travel through the whole house. Some of the mines, consisting of several small works, each of which has only one opening, without any lateral communications, are still more defective.

3d. The shafts and galleries are much too large. There are galleries of research, from twenty-five to thirty feet in height! The miners were under the impression, that the great height facilitated the ventilation. They also entertained the prejudice, that the galleries should be broad, instead of cutting transverse ones at short distances between the others, or towards the walls of the vein. The galleries, when large, are so expensive, that they cannot multiply them, as much as the ventilation of the mine demands.

There are some shafts, thirty or forty feet in diameter, and they were made so large, on account of the clumsiness and multiplicity of the machines used in extracting the ore and water. A better choice of machinery, would enable them to diminish the diameter of the shafts, and consequently the expense of new excavations.

4th. The lining of the shafts, when of wood, is little attended to, but those of stone, are in general well executed.

5th. In blasting, more powder is used than is necessary, and they do not lay bare that part of the rock which is to yield to the explosion.

6th. The interior transportation is upon men's backs, but, in some mines, mules are employed. Rail-ways were not known, and on account of the bad arrangement of the internal communications, it would be difficult to introduce them. The *porters* or *tenateros* carry for a load, from two hundred and twenty-five to three hundred and fifty pounds, and in some mines, they have to ascend thousands of steps, at an angle of 45°. The labor is so severe, that it injures their health, but the appetite for gain retains them. They can earn $1,25 in six hours. In the mine of Valenciana, there are three porters to each miner, and their wages, alone, amount to $10,000 per month. Two thirds of this expense might be saved, by having well arranged internal communications, rail-ways and machines for raising the ore and water.

7th. The method of draining the mines, is very defective. The water is either drawn up in leathern sacks, which are expensive, and from their constant friction against the sides of the shaft, last but a few days, or, it is carried up on men's shoulders. In some mines, the water which comes in far above the bottom, instead of being stopped out, or conducted off, is allowed to collect in the lower parts of the mine, whence it must be removed with great labor and expense.

8th. The mechanical preparation of the ores, consists in picking, stamping, and pulverizing, under the stone rollers, which were mentioned in the Mexican method of amalgamation. The different washing tables, do not appear to be known. Mier, in his travels, mentions, that the roasting of silver ores is common, for the *purpose merely of rendering them capable of being more easily pulverized.**

The methods of mining, and working the ores, have undergone little variation, since Humboldt's visit to the mining districts. It has

* Mier's Travels, Vol. ii, p. 401.

been found almost impossible, to introduce the improved methods and machines of Europe. Some of the obstacles are,

1. The difficulty and expense of transportation of all the materials for labor and subsistence, which have often to be brought from great distances.

2. The frequent deficiency of water for machinery, of timber for supports, &c. in the mine, and of combustibles for roasting and smelting the ores, and for supplying steam engines.

3. The difficulty of employing large capital, advantageously, in mining operations, for its employment in those sparsely populated countries, creates such a demand for labor, materials, and subsistence, as to raise them far above their ordinary value, and thus to absorb all the profits.

4. The prejudice of the persons concerned and employed, against any change from the ordinary routine, is not the least obstacle to the introduction of improved methods. While the mines of South America were still under the control of Spain, efforts were made to introduce improvements, by sending out the most distinguished metallurgists of Europe, but even royal authority, was insufficient to make any important change in the metallurgic operations.

The principle upon which the mining system is conducted, is the same in all countries, where the government has no direct control, viz. to *draw the greatest present benefit, without regarding the future.*

The metals are of national importance, and a mine once exhausted, is not renewed; therefore, it is desirable, that the ores should be so wrought, that there may be no waste, that the shafts and galleries should be properly secured, and all parts of the work conducted on the most approved principles.

To effect these objects, to afford all the necessary information to individuals working mines, and to make known to the government, the mineral resources of the country, France has her corps of Mining Engineers.

Many other governments, exercise such a control over mining operations, as to render them *permanently* useful to the country.

Where the conducting of mines, is left altogether to individual enterprise, only those ores of any particular metal found in a mine, which will yield a handsome profit, are wrought, and all the others are thrown away as useless. A proper mixture of the rich with the poorer ores, although the profit will be less than with the rich ores alone, will yield a moderate and long continued one, by which the mine may continue to be wrought for centuries. If the rich ores alone be wrought, and should they diminish, the mine is abandoned and is regarded as being no longer valuable.

Again, when left to individual enterprise, the shafts and galleries are so lined and supported, as only to answer for the *present purposes*, without regarding the permanent stability of the works.

The mineral resources of the United States, are known to be very great, but of how small a portion of its territory, have we accurate information, as to its mineral products, or geological constitution. The United States are in want of a corps of engineers of mines, whose duties should be, to develope the mineral resources and geological structure of the country; to give advice and information, in relation to all the operations of working mines and ores of all kinds, and minute statistical information, as far as relates to mines and the marketable products of mines.

Art. II—*Miscellaneous Notices, in a letter to the Editor, dated from an American National Ship, off Cape de Gatt, in Spain, August* 11, 1832.

Dear Sir—We are at length upon the blue waters of the Mediterranean, its surface just ruffled by a gentle breeze—a dozen of the light and graceful vessels of this sea are gliding around us, while close on our left, rise the grand and picturesque mountains of Grenada, now dressed in most splendid coloring by the declining sun. I suppose you will imagine us now all gay of heart, rejoicing in the beautiful scenery, and our thoughts full of Italy, Athens, Ionia, Syria, and Egypt. The case is far different. We are all out of humor, and our conversation is all about health officers, lazarettos and quarantine. It will be well for us if we are allowed to set foot in any of the countries around us for many a week to come. We are, in short, in a singular dilemma. We dropped anchor in Gibraltar bay, last Friday, after a passage of forty three days, via the Azores, Madeira and Lisbon, and were in high spirits at the idea of getting once more among old friends and familiar scenes. But a sad disappointment awaited us. They had heard of the Cholera in New York, and were disposed to be rigid: the health boat came along side, and in answer to their questions, our surgeon most unfortunately dropped an expression, conveying to their alarmed minds the idea that we had that disease on board. The board of health sat on our case,—we explained, urged and made every effort, but nothing would do. They refused to admit us even to quarantine. Now, our ship has not lost a man since we left the N. River: for one of its class, it is remarkably healthy and as to Asiatic Cholera, we have nothing bearing any resemblance to it on board. So we were forced to heave anchor and be off, and now find ourselves a little like the spectre ship of Cape Horn, flying about on the waters without a resting place, every where feared and shunned; what will be the result we cannot tell. Gibraltar is usually considered quite lax in its sanitary regulations; it may be that we shall succeed in Mahon, to which we are now bound, but the court at Madrid, has just sent them word at Gibraltar, that unless they became more rigid there, they shall be cut off from all intercourse with Spain. This seems but poor comfort as regards Mahon, but we have no better resource.

Notice of Madeira.

I mentioned that we stopped at the island of Madeira. Few things can be imagined more beautiful than this gem of the ocean, (as it is called) as it disengaged itself from the darkness, one fair morning, toward the close of last month, and its lofty, picturesque mountains, its ravines with their cascades, and its numberless vineyards, became rapidly developed. The island is sixty miles long and about twenty in breadth. Its general appearance, will be best understood from a few simple remarks as respects its geology. It appears to have been originally a small and rather low island, composed principally or entirely of transition limestone. It seems at some remote period of time, to have been suddenly torn asunder by volcanic action, and an immense mass of mountains ejected, in a double ridge, with a vast chasm between, running nearly the whole length of the island. The chasm is called by the natives Corràl. Simultaneous with this, appears to have been the ejection of a great quantity of liquid matter, which flowing from the sides of the ridge, has formed a smoother surface down to the sea, in some places leaving the basalt exposed, sometimes tearing it up, and at others covering it to a great depth with tufas, various in color and consistence. A short time before our arrival, part of a bank close by the usual landing place of Funchal, and nearly a mile west from the city, having been undermined by the constant action of the water, had fallen down. I clambered over the huge pieces of rocks barely to examine it, and found the upper twenty feet of the bluff to consist of firm and compact basalt, while below were numerous strata of tufa, red, yellowish, and dark, and of various degrees of compactness. Near the water, was a stratum five or six feet in thickness, of a dark blue color, and so loose as to fall to pieces in my hand, as soon as it was wet.

Soil, Vines and Grapes.

The soil of the island is formed from these tufas, and to them, together with the uniform mildness of the climate, the peculiar character of Madeira wine is owing. The soil, as may be supposed from all this, is by no means uniform. In a ride to the Corral, along a road which led us for some miles about half way between the mountainous district and the beach, we passed, one while, among vineyards whose richness and beauty could not be any where excelled; at another, among naked, red hills, with here and there a stunted pine; then, across deep ravines, with walls of naked basalt, and here and there below, a little field of yams or cane, and then we suddenly emerged again into districts, where for miles were seen only the rich clusters of the grape. The fruit was then beginning to ripen, and hung in great profusion, from the cane trellis work, usually at a height of four or five feet from the ground. The vintage, however, is not expected to be as productive this season as usual. The crop had promised to be larger than customary, until about a week before our arrival, when a hot wind from Africa, called the Leste, to which this island is exposed, had blown upon it with great violence for a few days, and a large portion of the grapes immediately withered and dropped from the vines. The soil is naturally very dry, but the numerous rapid streams from the mountains afford the greatest facilities for irrigation: they accompanied us in the course of our ride, usually in paved channels, formed along the side of the road, and added much to the freshness and beauty of the landscape. Great pains seem to be taken, not only to impart a proper degree of moisture, but where this is possible, to produce also a proper mixture of the soil. Three kinds are chiefly in use—the *Saibro,** the *Pedra Molle* (red and yellow Tufa) and a

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* The *saibro* was carefully analyzed in 1823, by an English traveller, the late T. E. Bowdich, and was found to consist of silex 46.8 parts; alumine 9.1; oxide of iron 27.3; soda 2.7; water 3.8; the loss, principally vegetable matter 10.8. "The *Pedra Molle* seems to contain less soda as well as less iron than the *saibro*"—Specific gravity, Saibro 1.75; Pedra Molle 1.95; Massapas 1.90; Cascalta 2.1.

clayed earth called *Massepas*. A mixture of all three, in equal portions, is preferred in very dry situations; but in general the *saibro*, or equal portions of the *saibro* and *pedra molle*, are considered the best. The Caslaelpa, a decomposed, basaltic conglomerate, is valued next to these: next comes the Massapas, and next and last in value, the *barros* and *marracota*, both a coarse and impure species of clay. These clays are sometimes mixed with a volcanic cinder, called *araga*, and although the mixture is less productive, the vine in it will last longer than in any other kind of soil.

Wines.

The best wine is produced on the southern side of the island, that of the northern side called *Verdelho*, being in no respect superior to the wine from other places. It is a singular circumstance however, that in forming a vineyard, cuttings from the *Verdelho* are always preferred. The richer soil and milder temperature act so as to produce from this the most valuable fruit, while cuttings from the southern side, are always found to give wine of an inferior quality. The grape usually met with is white with a light tinge of yellow; it is oval and of a delicious flavor: the blue grape is also frequently seen, and I could not ascertain that the color made any difference in the wine. The different varieties of grape produced on the island, are ranged under the heads of the *Verdelho*, the *Bastardo*, the *Negro Molle*, the *Bual*, and the *Tinta*. The "Madeira wine" is generally a mixture of all these, in greater or less proportions, but the flavor is chiefly owing to the *bual* and *tinta*. The *tinta* is often kept separate, and being left to ferment with the husks remaining in the cask, takes from them a deep red color like that of Burgundy, which however, leaves it as it grows older. In flavor, it has a close resemblance to good *port*, except that it is not so rough: it costs on the island about one half more than the "Madeira." Considerable quantities are exported to England, but in our country it is almost unknown, except, I believe, at Washington. It is the only red wine produced on the island. The *Malmsey*, at least the best of it, is from a vine said to have been imported from Candia about four centuries ago. Its fermentation is checked sooner than that of other wines, in order to increase its sweetness.

Much of the wine which in the United States, passes by the name of Madeira, has probably never been near the island whose name it bears, and indeed unless the consumer imports it himself, or has it imported by some trusty person, he will run great risk of being deceived. Even in importing for private consumption, particular pains are necessary, as the merchant in Madeira, I believe, in answering orders, always distinguishes between that intended for individual use, and the market. The best houses or "brands," as they are technically called, are that of Marsh, (the U. S. Consul,) Gordon, & Co. (English,) Lacock, (English,) Wallis, Barr, (English,) and Olivera, (Portuguese.) We purchased a pipe of eight years old wine there, for private use, for $180, which I belive may be considered a fair price. The consul had some of the same age, kept in the garret, and valued at $220 the pipe: owing to evaporation, he considered it less profitable to himself at this, than the other at $180.

An acre, under the most favorable circumstances, will produce as much as four pipes of good wine; but one pipe to the acre, is the usual average. From one to three acres are considered as much as one family can well attend to. In the richest parts of the island, the cottages are scattered so thickly as, to a vessel sailing along the coast, to appear like an endless succession of villages. Their houses are thatched, and are generally nothing more than miserable hovels of basalt, cemented with mud, and without a chimney; but I have never, any where, been treated with greater respect than among this simple, and I believe, industrious peasantry. A drunken man I did not see during all my stay in the island. One half of the wine goes to the landholder, as rent: the remainder is usually purchased by the wine merchants, a considerable time before the vintage, one third of the money being paid at the time of purchase, and the remainder on delivery. The price given by the latter, for the best "Madeira," is $70 a pipe. The wine is racked once a month, during the first year, and once every fourth month, during the second, the loss at each racking, being about a gallon: from one to two gallons of brandy are put into each pipe during the fermentation.

My stay was too short to enable me to gather much information on the mode of cultivating the vine, and I take the liberty of quoting from the book of Mr. Bowdich, a work bearing in itself evidence of close observation, and which is spoken of as a production of great correctness and excellence. It is said that the vines will last sixty years, if planted wide enough apart. The ground being turned up, the trenches are dug from four to seven feet deep, according to the nature of the soil. And a quantity of loose or strong earth is placed at the bottom to prevent the roots from reaching the stiff, clayey soil beneath, which would oppose their growth. They water the ground three times, if the summer has been dry, leaving the sluices open until the ground is pretty well soaked; the less the ground is watered, the stronger the wine, but the quantity is diminished in proportion. Some cultivators lay cow-dung at the roots of the vines when they plant them, and when the wine becomes poor, mix a fresh quantity with the soil at the surface. Others believe that animal manure injures the flavor of the grape, and instead, sow the *Lupinus perennis* among the vines; this they do in the January of every second year, cutting it down and burying it, by turning over the surface of the soil after the small rains, which prevail for about ten days, at the end of April. On the cutting of the Verdelho, (or northern vine,) they engraft any other variety they may wish: the grapes yield no wine until the fourth year. The stalks of the *Arundo Sagitta* are used in making frames for supporting the vines in the southern parts of the island, and the *Salix rubra*, for tying them to this trellis work. In the northern parts of the island, the vines are trained around the chesnut trees, this firmer support being necessary, it is said, on account of the higher winds prevailing there. The vines in Madeira, give fruit as high as 2700 feet but no wine can be made from it: the greatest height at which they are now cultivated for this purpose, is in the valley of the Corràl das Frieres, which is 2080 feet above the the sea. There is much dispute as to the best month for pruning the vines. Some prefer February, others the middle of March: it depends principally however, on their foresight as to the weather, when the flowing takes place, which is six weeks or two months after the pruning. As to the treatment of the wines, I have observed that the produce of a particular season, must frequently be treated one year, very differently from that of another. When the grapes are green, the fermentation must be checked; when they are wet from unseasonable rains, it must be assisted; generally speaking, the riper the fruit, the more difficult the fermentation. A very agreeable *liqueur* is made in the island, from the second pressure of the grape, (the first being made with the feet,) into which, an equal quantity of brandy is immediately thrown, to stop the fermentation and produce sweetness. Gypsum is pretty generally used to clarify and mellow the wines while working, unless they happen to be of a green vintage."

From all this, I think it must be apparent, that the attempt to produce Madeira wine in our country, from cuttings from the vines of that island, must be entirely hopeless. Even on the island of Madeira itself, it can be produced only on the southern side. Its flavor is owing chiefly to two causes, the peculiar nature of the soil, and the remarkably uniform temperature of the climate*: here too, the vineyards unless supplied with cuttings from another part of the island, would be in danger of speedily deteriorating. Indeed, in our cold climate, and with our soil, every effort to produce more than grapes for our table must produce disappointment, unless we can do something with our own hardier grape. And such, I believe has already been the experience both in Pennsylvania, and in the States further west.

Naples, October 5, 1832.

Vesuvius, &c.

I have visited all the places of interest here, among them the Grotto del Cane and Mt. Vesuvius, and cannot tell you how much I have been gratified. Vesuvius is quite different from what I expected to find it. I ascended it in company with our friend Johnson, and while we were on the lip of the crater, we had several explosions of ashes and red hot stones—a sight which visiters now have not often the pleasure of seeing. The stones were thrown to a height of two hundred feet, and came rattling around us in a manner that, at the moment, was any thing but agreeable. There was an eruption in August, and the crater and sides of the mountain still presented the appearance that they do on such an occasion, with the exception that the lava was cold and black. There are now strong indications of another approaching eruption; the mountain frequently trembles, it sends up quantities of white smoke, and the springs around it are dried up. At night we have lately had some brilliant sights; but it is scarcely probable that we shall be here long enough to see the conclusion.

Monday morning, Oct. 15.—I mentioned on my last sheet, that I had just been up the mountain, a second time, with the Commodore

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* Dr. Gourley, a resident at Madeira, after eighteen years' observations, gives the following as the mean temperature:

January,	64°.18	July,	73.45
February,	64.03	August,	75.02
March,	65.08	September,	75.76
April,	65.05	October,	72.50
May,	66.53	November,	69.08
June,	69.74	December,	65.00

Average or mean of the year, 69°.90.

and his family. Several changes had taken place since my last visit, indicative of increasing violence in the volcano. The guide came on board yesterday with information that on the evening after our visit, six streams of lava had burst out from the spot in the crater where we had taken our breakfast. It has not yet overflowed, and will discharge itself down the other side of the mountain. I have some thoughts of going up this evening to see it. We sail to-morrow—the Concord, with our letters, is to leave this to-day.

Grotto del Cane.

I believe I did not tell you, in my last, that I made a visit to the famous *Grotto del Cane*, a visit to me so full of interest, that I cannot help giving you some account of it, notwithstanding the numerous descriptions we already have of that singular place. I was enticed onward, one bright morning, by the numberless curious objects that present themselves about Naples, till I found myself at the entrance of the Grotto of Posilipo, then at its further extremity, then in the beautiful valley beyond; and being now not far from the Grotto del Cane, set out in earnest for a treat that I had, from the first, been promising myself. A guide was quickly selected from a set of ragged urchins, who offered themselves along the road. Thus escorted, I soon reached the house of the Custode, or show-man, and a rapid knock and short dialogue having settled the preliminaries, I pushed on towards the Grotto, leaving him to hunt up his dog and follow at his leisure. The road, which had hitherto obliquely crossed the valley noticed above, now approached its edge, and led us among rough, abrupt hills, until suddenly turning to the right, and entering a deep, natural chasm, it brought us in a few minutes to the edge of the Lago d'Agnaro. This lake is about four miles in circuit, and evidently occupies the crater of an extinct volcano. My little Cicerone led me along the border of the lake, for about a hundred yards, when pointing to a small door against the side of the crater, a short distance above us, he told me that there was the object of my search. The name *Grotto* had misled me, and my disappointment was great, when, on the door being unlocked and thrown open, an excavation, of not more than twelve feet in length, and seven or eight in height, made its appearance. To the right, it was the rudest thing possible. The bottom, sides, and top, were of the bare earth, very uneven, and, as the cave was shaped much like an egg, it was only at the centre or near it, that a person could stand upright. The floor, and sides to a well-defined horizontal line eight or nine inches above it, appeared moist, and on stepping in, I immediately became sensible of a small degree of warmth up to the same height, although the atmosphere down to the ground was perfectly transparent. The custode first directed me to get on my hands and knees, and to bring my face within the influence of the gas. I took the posture desired, and as I had lowered my head to within a short distance of the ground, and found myself breathing a pure air, was beginning to think the wonders of the grotto far overrated, when I suddenly found myself bolt upright, and on my feet, having been brought there by a sensation as if a thousand needles had been at once thrust into my nostrils. The feeling was like that often experienced after drinking strong soda water, only to an almost overpowering degree.

The next experiment was a cruel one, but I hope pardonable, in as much as the cruelty was far from being of a wanton kind. The man looked for a dog which he had brought with him, and tied to some bushes near the door, and taking the struggling animal in his arms laid him down in the deepest part of the cave. The dog laid quiet for a moment, and then, with a sudden start, nearly escaped from the custode's hands, but was brought back, and once more held down within the full power of the gas. His struggles were violent, and his eyes, turned upward toward his master, showed a high degree of suffering; but presently, his muscles began to relax, and his struggles ceased, his open and beseeching eye only showing life. His master now took him up, and laid him in the pure air, outside the cave. Here he remained motionless for nearly two minutes, when he was seized with violent spasms, gasped for breath, at length got on his feet, staggered about, and then recovering himself fully, darted away into the bushes. A whistle brought him back, and he came up, wagging his tail, to receive the customary crust of bread. The man now lighted a couple of torches, and placing one in my hand, allowed me to amuse myself with such experiments as are frequently practised in our Larboratories with this gas, and others of a similar character. The flame began to separate from the torch as soon as it was lowered to the line noticed above, showing a smooth uniform surface to the gas. When moved along the sill of the door, it burnt with undiminished brightness, except where a small channel was made by an inequality in the wood; when it sunk into this, the light was immediately extinguished. In the same manner, I could discern the gas flowing down the hollows leading from this to the lake. When I had satisfied myself with these experiments, the custode took both the torches, and rubbing them against the sides of the cave, filled the bottom of it with smoke; the hitherto invisible spirit of the cave took form and substance; and I was warned by a gentle hint, for half a dollar, that the exhibition was at an end.

Art. III.—*Miscellaneous Communications, from* Dr. Hare.

There is scarcely any one of the phenomena produced by a powerful voltaic series, which creates greater surprise in the beholders, than the intense ignition which ensues, when a platina wire of about No. 24, connected with the negative pole, is brought into contact with the surface of a concentrated solution of muriate of lime. The end of the wire quickly fuses and falls to the bottom of the glass in successive drops, which are so perfectly globular as to indicate that a high degree of fluidity must have preceded their congelation. The communication of the liquid with the positive pole, which is of course indispensable to this experiment, is effected by the employment of a platina wire much stouter than that which is above described in connexion with the negative pole. This brings me to the most inexplicable feature in the case, which is, that if the arrangement be reversed, so that with the smaller wire in communication with the positive pole, and in contact with the surface of the liquid, the series be brought into action, the ignition is comparatively feeble, and will not effect the fusion of the wire.

I have a magnet made essentially after the plan of Prof. Henry, excepting the use of paper and shell lac, in lieu of silk as an insulator, which method I devised and mentioned to you more than two years ago.

This magnet weighs seventeen pounds. It is surrounded by fourteen coils of copper wire, No. 15, each sixty feet in length. Its maximum of cohesive power is equal to seven hundred and eighty pounds.

I was curious to see if there would be any re-action between this magnet and the jet of igneous matter between the poles of a deflagrator, of seven hundred pairs of plates of four inches by three. The only remarkable result was, that the conducting power of the iron of the magnet was much reduced when subject to the inductive influence of the coils.

This was demonstrated by attaching one pole of the series of seven hundred pairs to one leg of the magnet, while the other pole was made first to touch the end of the other leg, and then retracted so as to produce the vivid discharge of igneous matter, well known to ensue under such circumstances. The discharge being thus established, it was arrested, as soon as a calorimotor was made to act upon the coils. The experiment was reiterated again, and again, with the same result.

About two years ago, I stated that taking the iron of an electromagnet into the circuit of a calorimotor fifty times larger than that used for the coils, the attractive power, though enfeebled, was not destroyed. I have lately ascertained that a knitting needle may be magnetized and have its poles reversed while subjected to a direct current from the same large instrument, the inductive magnetic power being meanwhile due to a calorimotor of not more than a fiftieth of the size.

I avail myself of this opportunity of mentioning that fused caoutchouc inflames in concentrated nitric acid.

This result was unexpected by me, never having met with any account of this habitude, and which I presume had not been before noticed.

Art. IV.—*Apparatus and Processes; by* Robert Hare, M. D., Professor of Chemistry in the University of Pennsylvania.

Communicated by the author.

1. *Apparatus for evolving Silicon from Fluo-silicic Acid Gas.*

Into a stout mahogany block as a basis, two iron rods A, A, are so planted as to extend perpendicularly, and of course parallel to each other, about two feet in height. Upon these rods two iron bars are supported horizontally, one, B, near their upper extremities, the other at the height of about six inches from the wooden basis. In the centre of the lower bar, there is a screw, D, having a handle below the bar, and supporting above it a circular wooden block. Into a hole in the upper iron bar, equidistant from the rods, is inserted a hollow brass cylinder C, which at the lower end screws into an aperture in a circular plate of brass, E, which is thus supported horizontally a few inches below the bar. By these means room is allowed for the insertion into the cylinder of four valve cocks, each furnished with a gallows screw. The cylinder is surmounted by a stuffing box, through which a copper sliding rod, G, passes air tight. The brass plate is turned and ground to fit a bell glass of about five inches in diameter, and eight inches in height, which is pressed up when necessary between the plate and the block by the screw D, supporting the block. Within the space comprised by the bell glass, and on one side of the centre of the plate, two stout brass wires are inserted, one of them insulated by a collet of leathers, so as to admit of the ignition, by a galvanic discharge, of a small arch of platina wire, which terminates them. The sliding rod above-mentioned as occupying the stuffing box, terminates below the plate in an elbow which supports a cap at right angles to the rod, at the same distance from the rod as the platina wire, and on the opposite side of it, there is a brass cover, H, for the cap, supported from the plate. The arrangement is such that by a suitable movement in the sliding rod, made by grasping it by the handle G, in which it terminates externally, the cup may be made either to receive into its cavity the platina wire, or to adjust itself to its cover H.

The bell being removed, about sixty grains of potassium in pieces not containing more than fifteen grains each, are to be introduced into the cup, which is then to be adjusted to the cover, and the bell secured. In the next place, by means of the flexible lead tubes, P, P, P, P, and the gallows screws attached to the valve cocks, establish a communication severally with an air pump, a self-regulating reservoir of hydrogen, a barometer gage, and a jar over the mercurial cistern containing fluo-silicic acid gas. First by means of the air pump exhaust the bell, and in order to wash out all remains of atmospheric air, admit hydrogen from the reservoir. Again exhaust, and again admit hydrogen. Lastly exhaust the bell of hydrogen and admit the fluo-silicic acid gas. By means of the gage, the exhaustion is indicated and measured, and by the same means it will be seen when the pressure of the gas within the bell, approaches that of the atmosphere. When this takes place, the cocks being all closed, by means of a calorimotor, the platina wire is to be ignited, and the potassium brought into contact with it.

A peculiar deep red combustion ensues, evolving copiously chocolate colored fumes, which condensing into flocks of the same hue, subside throughout the receiver, (excepting the color,) like snow in miniature. On removing the bell after the potassium is consumed, the cup which held it, will be found to contain, silicon mixed with the fluoride of potassium, and with this indeed the whole of the powder deposited is contaminated. Silicuret of potassium is likewise formed in the cup, since on the affussion of water, a fetid evolution of silicuretted hydrogen ensues. By repeated infusions, first in cold, and afterwards in boiling water, aggreeably to the directions of Berzelius, the silicon is left in the state of a brownish ash colored powder.

Thus obtained, silicon does not appear to be acted on either by sulphuric, nitric, fluoric, or muriatic acids; nor when exposed to nitrate of potash liquified by heat. It seems to be soluble for the most part in a mixture of nitric and fluoric acid, which by analogy we may call nitro-fluoric acid; but after exposure for eighteen hours to this solvent, a small proportion of a black matter remained undissolved. This is, in all probability, carbon derived from the potassium, which, according to Berzelius, when obtained by Brunner's process, is liable to be combined with carbon. The solution of nitro-fluoric acid, decanted from the residual black powder into a solution of pearlash, gave a copious, white, gelatinous precipitate like silex, which, when thrown into a large quantity of water, subsided undissolved. When on subjecting the silicon to red hot nitrate of potash, anhydrous carbonate of the same alkali was added, so as to cöoperate with the nitre, an explosive effervescence took place. All the silicon disappeared, and a compound resembling the silicate of potash was produced. This anomalous reaction may be considered as characteristic of silicon.

The impression that the black matter insoluble in the nitro-fluoric acid, was carbon, is confirmed by the fact, that after the silicon had been digested for some hours in strong nitric acid, and finally boiled in it to dryness, it dissolved in nitro-fluoric acid without any such residuum.

2. *Improved process for the evolution of Boron.*

By means of an apparatus represented by the annexed engraving, I have succeeded in evolving boron by the reaction of potassium with vitrified boracic acid, in vacuo, without encountering the evil of any explosive action, to which the process, as heretofore conducted, in pleno, has been found liable.

A circular brass plate, is prepared, like the plate of an air pump, so as to produce with any suitable receivers properly ground, an air-tight juncture. It is supported on the upper end of a hollow brass cylinder, B, with the bore of which it has a corresponding aperture. The brass cylinder is about three inches in diameter, and six inches in height, being inserted at its lower end into a block of wood as a basis. This cylinder receives below, a screw, which supports a copper tube, C, of about two inches in diameter, so as to have its axis concentric with that of the cylinder, and to extend about four inches above the plate. The copper tube, thus supported, is closed at the upper termination by a cup of copper, of a shape nearly hemispherical, and soldered at the upper edge, to the edge of the tube; so that the whole of the cavity of the cup, is within that of the tube. Hence the bottom of the cup is accessible to any body, not larger than the bore of the tube, without any communication arising between the cavity of the tube, and that of any receiver placed upon the plate, over the cup and tube, as in the figure.

Into the side of the cylinder supporting the plate, a valve cock is screwed, by means of which, and a flexible leaden tube, a communication with an air-pump is opened, or discontinued, at pleasure.

The cup being first covered with a portion of the vitrified boracic acid, as anhydrous as possible, and finely pulverized, the potassium is introduced, and afterwards covered with a further portion of the same acid, two parts of the potassium being used for one of the acid. A large glass receiver is now to be placed on the plate, secured by rods A, A, concentric with the tube and cup; from the heat of which the glass is to be protected by a bright cylinder of sheet brass, S, placed around it so as to be concentrical with the receiver and tube.

The apparatus being so prepared, and the receiver exhausted of air by means of the air pump, an incandescent iron is introduced through the bore of the tube, so as to touch the bottom of the copper cup. In a short time a reaction commences, which aiding the influence of the hot iron, renders the cup and its contents red hot. A deep red flame appears throughout the mass, after which the reaction lessens, and the heat declines.

When the cup has become cold, the air is admitted into the receiver, and the contents are washed with water. If any of the acid has escaped decomposition, it may be removed by boiling the mass with a solution of potash or soda. After this treatment and due desiccation a powder will remain, having the characteristic color and properties of boron.

The additional valve cock, represented in the figure, gives the option of introducing dry hydrogen for the purpose of washing out atmospheric air, as described in the process for silicon.

3. *Description of the Valve Cock, a perfectly air-tight substitute for the common Cock, alluded to in the preceding articles.*

This figure is intended to illustrate the construction of a substitute for a common cock, which I have been accustomed to call a valve cock. It was devised by me about twenty years ago, among a number of other analogous contrivances, and seems upon the whole less liable to fail than any other which I have tried. The engraving represents a longitudinal section of the valve-cock. At *a* is a piston with a collar enclosed in the stuffing box *b*, so as to be rendered air-tight by means of oiled leather. Hence the piston may be turned or made to revolve on its axis, while incapable of other motion. Upon the end of the piston a thread for a screw is cut which fits into a female screw in the brass prism *c*, so as to cause this prism to approach to, or retreat from a bearing, covered by leather, in the centre of which there is a perforation *o o* communicating with one of the orifices of the instrument. This orifice is surrounded by the male screw *d*, so that by means of this screw, the valve-cock may be fastened into an appropriate aperture, properly fitted to receive it, subjecting an interposed leather to such pressure, as to create with it an air-tight juncture. The prism *c*, has two of its four edges cut off (see fig. 2,) so as to allow a free passage by it, reaching to the lateral perforation terminating in another orifice, over which there is a gallows screw, *g*. By means of this gallows screw, when requisite, a brass knob, such as that represented by a fig. 3, soldered to a leaden pipe, may be fastened to the valve cock. The juncture is rendered air-tight by the pressure of the screw in the gallows, upon a leather which is kept in its place, by means of the nipple *n*.

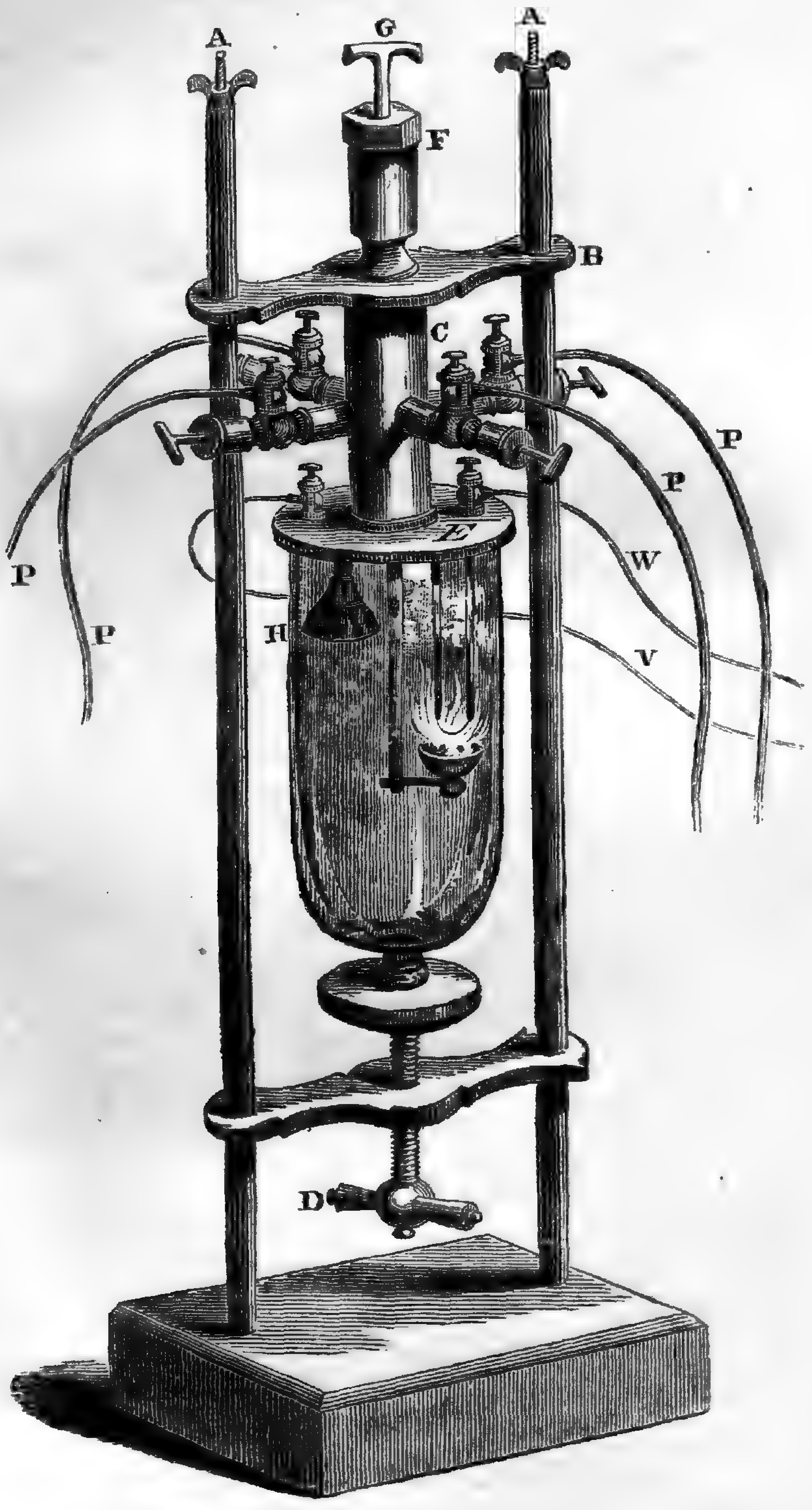
The method last mentioned, of producing an air-tight juncture, was contrived by me about seven years ago, and proves to be of very great utility. There is no other mode with which I am acquainted, of making a perfectly air-tight communication, between the cavities previously separate, at all comparable to this in facility.

4. *Apparatus for separating Carbonic Oxide from Carbonic Acid, by means of Lime Water.*

Lime water being introduced in sufficient quantity, into the inverted bell glass, another smaller bell glass, C, is supported within it as represented in this figure. Both of the bells have perforated necks. The inverted bell is furnished with a brass cap having a stuffing box attached to it, through which the tube D of copper slides air-tight. About the lower end of this tube, the neck of the gum elastic bag is tied. The neck of the other bell is furnished with a cap and cock, surmounted by a gallows screw, by means of which a lead pipe P P, with brass knob at the end suitably perforated, may be fastened to it, or removed at any moment. Suppose this pipe, by aid of another brass knob at the other extremity, to be attached to the perforated neck of a very tall bell glass filled with water upon the shelf of a pneumatic cistern: on opening a communication between the bells, the water will subside in the tall bell glass, over the cistern, and the air of the bell glass C being drawn into it, the lime water will rise into and occupy the whole of the space within the latter. As soon as this is effected, the cocks must be closed and the tall bell glass replaced by a small one filled with water, and furnished with a gallows screw and cock. This bell being attached to the knob of the lead pipe to which the tall bell had been fastened before, the apparatus is ready for use. I have employed it in the new process for obtaining carbonic oxide from oxalic acid, by distillation with sulphuric acid in a glass retort. The gaseous product consists of equal volumes of oxide and carbonic acid, which, being received in a bell glass communicating as above described by a pipe with the bell glass C, may be transferred into the latter, through the pipe, by opening the cocks. As the gaseous mixture enters the bell C, the lime water subsides. As soon as a sufficient quantity of the gas has entered, the gaseous mixture may, by means of the gum elastic bag and the hand, be subjected to repeated jets of lime water, and thus depurated of all the carbonic acid. By raising the water in the outer bell A, the purified carbonic oxide may be propelled, through the cock and lead pipe, into any vessel to which it may be desirable to have it transferred.

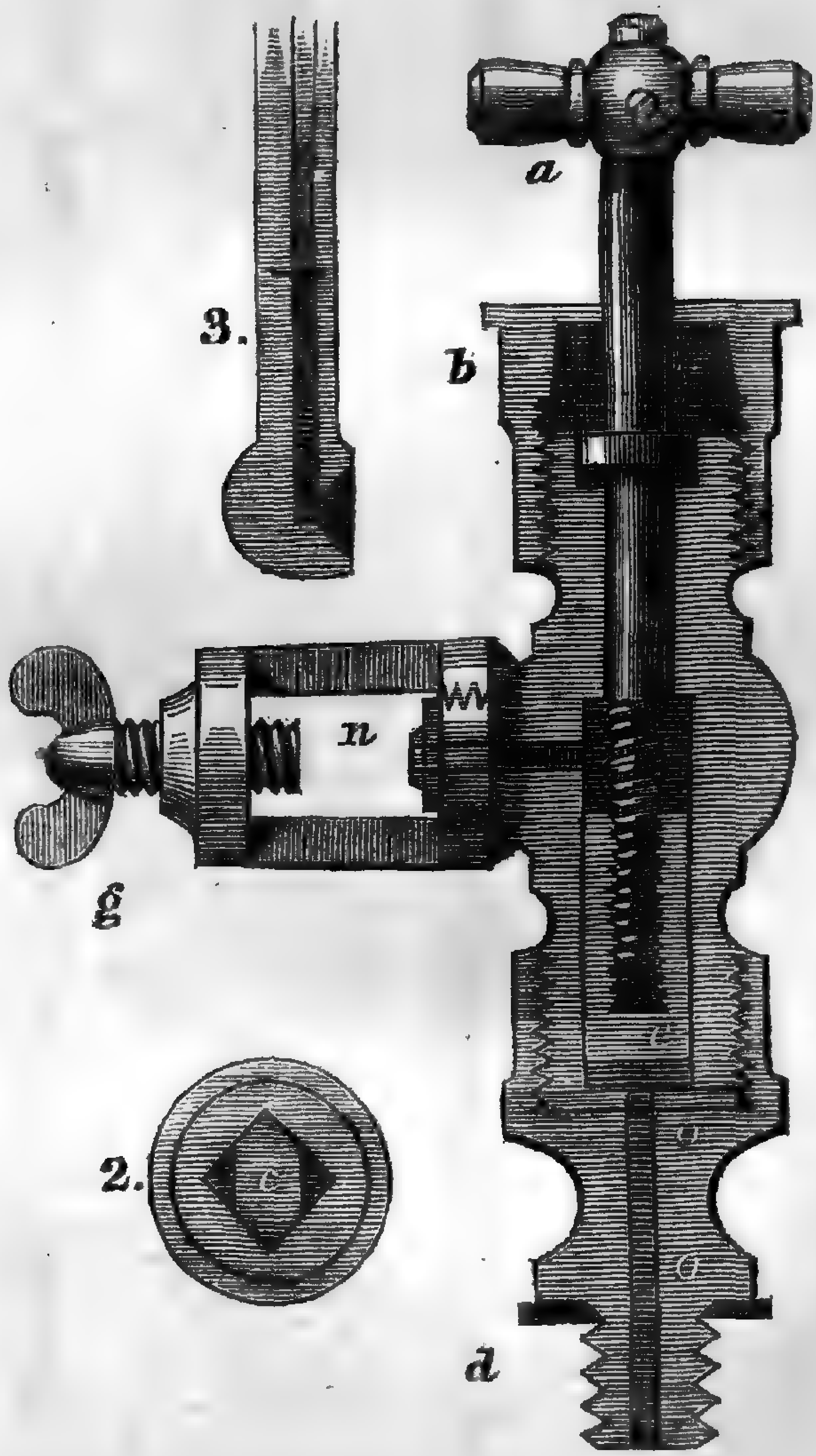
APPARATUS FOR SEPARATING CARBONIC ACID FROM CARBONIC OXIDE, BY MEANS OF LIME WATER.

APPARATUS FOR THE EVOLUTION OF SILICON FROM FLUO-SILICIC ACID GAS, BY MEANS OF POTASSIUM AND A WIRE IGNITED BY A CALORIMOTOR.



THE VALVE COCK.

A PERFECTLY AIR TIGHT SUBSTITUE FOR THE COMMON COCK.



APPARATUS FOR SEPARATING CARBONIC ACID FROM CARBONIC OXIDE, BY MEANS OF LIME WATER.

Art. V.—*Remarks on the error of supposing that a communication with the Earth, is necessary to the efficacy of Electrical Machines; by* R. Hare, M. D., Professor of Chemistry in the University of Pennsylvania. Communicated by the author.

Sometime since, in looking over a volume of Cavallo's Electricity, I was surprised to observe that in order to give the greater efficacy to an electric machine, he advises that the cushion, or negative pole, should be made to communicate advantageously with the earth. As the means of accomplishing this object he suggests a conducting communication "with moist ground, with a piece of water, or with the iron work of the water pump."

It appears from the following passage in Turner's Chemistry, a work generally of great merit, that the erroneous impression which gave rise to these suggestions, has been adopted by a more modern author. We find, page 77, American edition, the following allegation.

"The electricity which is so freely and unceasingly evolved during the action of a good electrical machine, is derived from the great reservoir of electricity, the earth. This is obvious from the fact that if the whole apparatus is insulated, the evolution of electricity immediately ceases; but the supply is as instantly restored, when the requisite communication is made with the ground. In the state of complete insulation, the glass and prime conductor are positive as usual, and the rubber is negatively excited; but as the electricity then developed is derived solely from the machine itself, its quantity is exceedingly small. When the machine is used, therefore, the rubber is made to communicate with the earth. As soon as friction is begun, the glass becomes positive and the rubber negative; but as the latter communicates with the ground, it instantly recovers the electricity which it had lost, and thus continues to supply the glass with an uninterrupted current. If the rubber is insulated, and the prime conductor communicates with the ground, the electricity of the former, and of all conductors connected with it, is carried away into the earth, and they are negatively electrified."

I conceive that the earth has never, of *necessity*, any association with the phenomena of the electric machine; of which the power is evidently dependent on the efficacy of the electric, in transferring the fluid from the negative to the positive conductor. When the conductors are both insulated, by the revolution of the electric they are brought into states of excitement as opposite, as the power of the machine is at the time competent to produce. If, under these circumstances, with one end of a metallic rod, (terminating in a metallic ball, or other suitable enlargement, and held by means of an insulating handle,) we touch the negative conductor, while the ball is approximated to the positive conductor, sparks at least as long, and as frequent, will be obtained, as when the negative conductor, or cushion, has the best possible communication with the earth. I conceive that any metallic surface or surfaces, duly connected with either conductor, must become virtually a part of that conductor, and partake of its excitement. In this predicament, whilst receiving a charge, are the coatings of a Leyden jar, or an association of such jars in a battery. The effect of the machine is merely to transfer the fluid from one surface to another. After the conductors, and any jar, or battery, associated with them are charged, there is no more electricity in the surfaces than before; since whatever one has gained, the other has lost.

If the impression of the learned professor, were correct, how could a battery or a jar be charged, where both it, and the machine are insulated from the earth? Yet experience shows that it is under these circumstances that a charge is most easily imparted. When the conductors are in a state of excitement, and both insulated, the one will of course be as much below that of the surrounding neutral medium, and of the great reservoir, as the other is above that standard. When we connect either conductor with the earth, it returns of course to the neutral state of the earth; but the difference between the excitement of the conductors is sustained by the power of the machine to the same extent as before; hence the length and frequency of the sparks will not be found to be sensibly altered. It follows that when either of the conductors is made neutral by connexion with the earth, the other will have its excitement as much above or below neutrality, as the sum of the differences between each of the two conductors and the terrestrial neutrality when both are insulated. Thus supposing that when insulated, the one conductor is relatively to terrestrial electricity minus ten, and that the positive conductor is plus ten; when the negative conductor alone is uninsulated, the positive will be plus twenty, when the latter is alone uninsulated the former will be minus twenty.

It seems to be a common, though as I believe an erroneous idea, that a spark changes its character with the conductor from which it appears to be taken; so that when produced by presenting a body to the positive conductor, it is considered as positive, and as negative when produced with the negative conductor in like manner.

I have already observed that any conducting surface in connexion with either conductor, must act as a part of that conductor. Approximating to the negative conductor, a body (a ball, for instance,) while in communication with the positive conductor, is really enlarging on elongating the surface of the latter, so that when the spark passes, it must still be from the positive to the negative pole: and vice versa, elongating the surfaces associated with the negative conductor, till sufficiently near the positive conductor to receive a spark, does not alter the character of the phenomenon. In each case, according to the theory of one fluid, a current passes from the positive to the negative pole, and according to the doctrine of two fluids, two currents pass each other.

The cause of the difference observed in the sparks in the two cases is, that they are usually received from a small knob upon a big ball, or the hand; or some other body comparatively large.

Whenever the fluid is contracted into a small jet on the positive side, its projectile power is increased; while under the opposite circumstances, its projectile force is lessened. This is the sole cause of the long forked erratic form, of what is called the positive spark; and the short stubbed appearance of what is called the negative spark. The whole difference may be effected in whatever situation the sparks may be taken, by causing a large and a small ball to exchange sides. When the surface on the positive side is so small as to condense the electric matter before it jumps, the projectile force is greater, and as in the case of the jet pipe in hydraulics, there is a medium size, at which the greatest projectile power is obtained. When the emitting surface is too large, the projectile force is lessened, and the spark consequently made shorter.

The following passage in Cavallo's Electricity is that alluded to above. See vol. 1st, page 184: London, 1786.

"Sometimes the machine will not work well because the rubber is not sufficiently supplied with electric fluid; which happens when the table upon which the machine stands, and with which the chain of the rubber is connected, is very dry, and consequently in a bad conducting state. Even the floor and the walls of the room are in very dry weather bad conductors, and they cannot supply the rubber sufficiently. In this case the best expedient is to connect the chain of the rubber, by means of a long wire, with some moist ground, a piece of water, or with the iron work of the water pump, by which means the rubber will be supplied with as much electric fluid as is required."

The learned author was, I think, altogether wrong in imagining that the dryness of adjacent bodies could have any ill effect. In common with the great mass of electricians of this time, as well as his contemporaries, he has overlooked a real cause of deterioration. I allude to the imperfect conducting power of cushions, made as they are usually, of silk, or leather stuffed with hair, or other nonconducting substances. The desiccation of the cushion and other parts of the rubber, may counteract the benefit otherwise produced by any increase of aridity in the surrounding medium.

By stuffing the cushions with the elastic iron shreds scraped off from weaver's reeds in manufacturing them, and making a communication between the shreds and the steel spring supporting the cushion and attached to the negative conductor, I have seen the sparks yielded by a machine more than trebled in length, and frequency.

As a coating for the cushion upon the whole I find the aurum musivum, more efficacious than the amalgam usually employed, which is apt to adhere to the glass, and promote the passage of sparks from collecting points of the positive conductor to the cushion. I question if the amalgam does not owe its efficacy to its conducting power, which tends to compensate the absence of this property in the cushion.

In speaking of experiments performed by means of electrical machines, the poles and conductors may in general be treated as synonymous; yet strictly the poles are those parts of the conductors, or conducting surfaces in connexion with them, between which the discharge takes place; so that when insulated metallic rods, however long, are each at one end in contact with the conductors of the machine, the poles may be at the other ends of the rods. This view of the subject is generally recognized in the case of Voltaic series, which not being terminated by conductors, in the technical sense used in speaking of the machine, gives rise, in this respect, to less cause of misapprehension.

I conceive it an error to suppose that the association of a large conductor with a machine, contributes to the intensity of the sparks.

It appears to me to render the sparks shorter, and less frequent, though otherwise larger.

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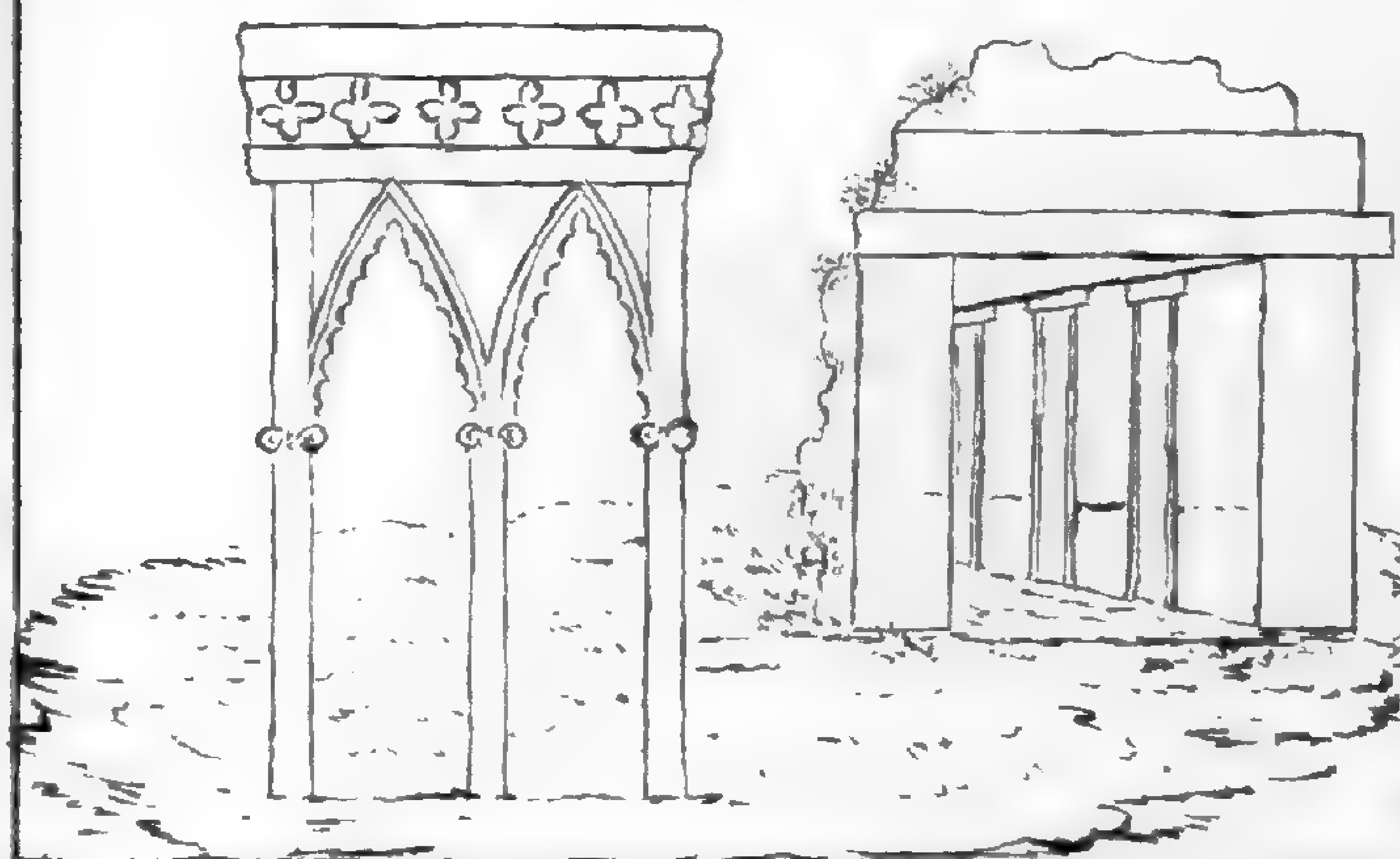

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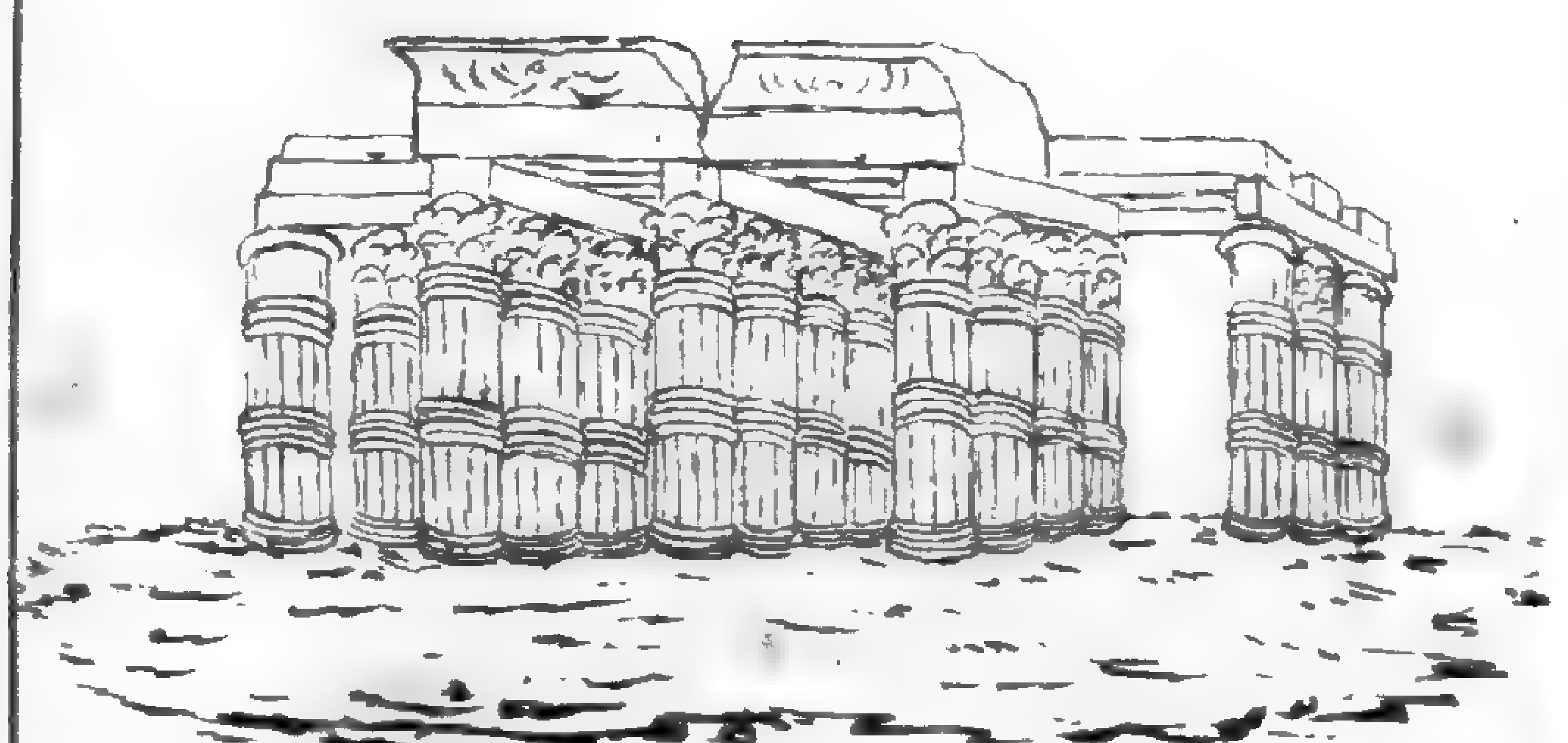

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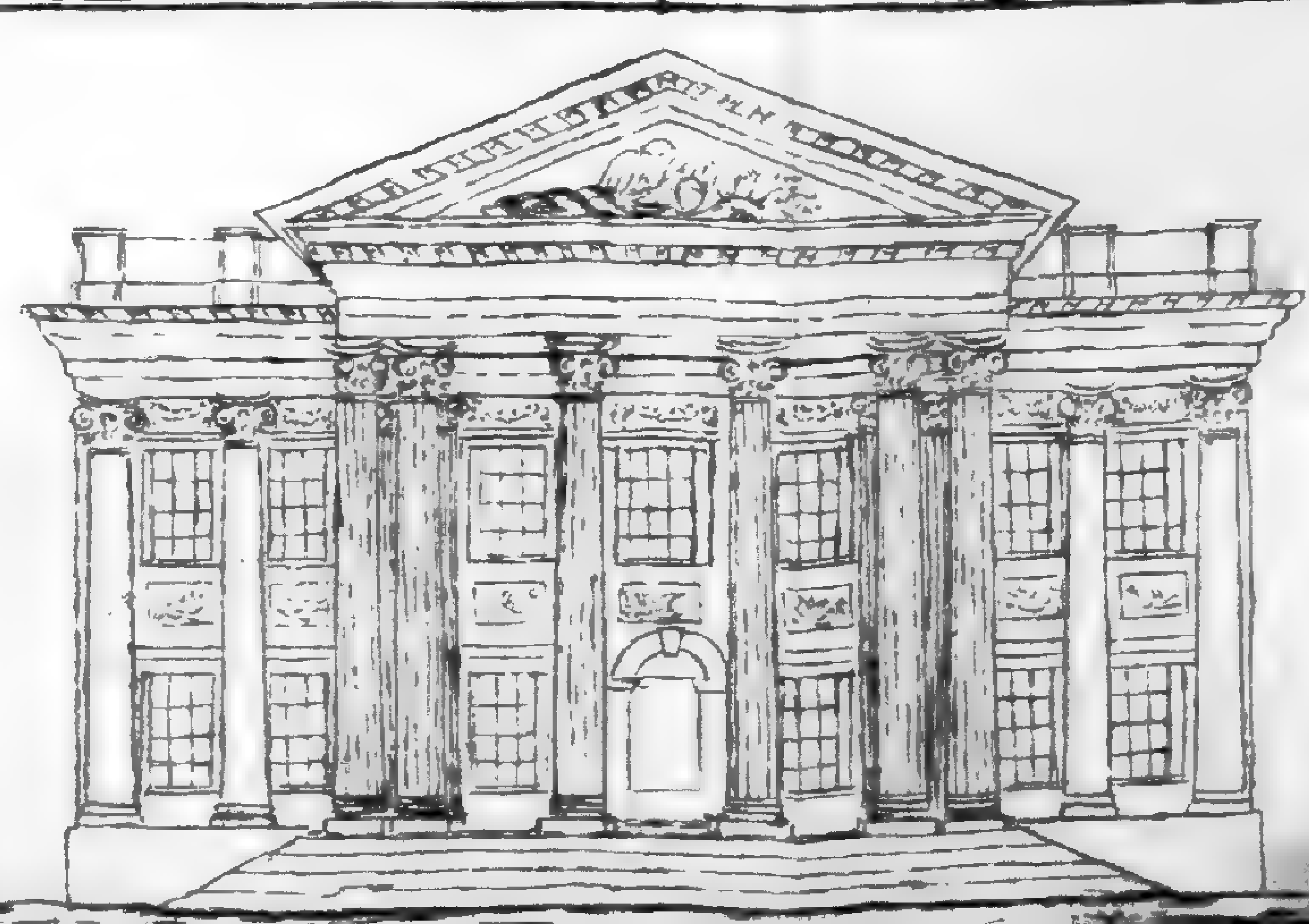

Art. VI.—*Architecture.**

Introductory Remarks.—The following observations appeared to me happily adapted to convey to young people some elementary ideas of architecture, about which, especially as regards the orders, their views are often confused and imperfect. The author has kindly yielded to my request in permitting these notices to appear in this Journal, in which the fine arts might advantageously occupy a more considerable space, than they have hitherto done.—*Editor.*

Hartford, February, 1833.

To Mr. B——, of —— Seminary.

Dear Sir.—If in compliance with your wishes, I can furnish a few useful hints on Architecture, I shall be gratified; but my knowledge is limited and accidental. I presume that your object is, to give the Young Ladies, (your pupils) such general information on the subject, as shall at the same time be so distinct, as to convey a knowledge of the different orders, so far at least, that when hearing a fine building somewhat technically described, or seeing it externally for the first time, they may have it in their power to determine upon its style, have a correct impression of it upon their minds, and be able to understand, why its proportions and decorations, make a pleasing, or disagreeable impression.

The *Grecian*, orders are but *three*, the *Doric*, *Ionic* and the *Corinthian*. It is common, however, to speak of *the five orders*, of architecture, because in Rome, five orders were in use. The Tuscan, whose column is *seven* diameters in height, the Doric, *eight*, the Ionic, *nine*, the Corinthian, *ten*, and the Composite, *eleven*; all of which columns, have in *Roman* architecture, bases to them. I will not go on to enumerate the divisions, proportions and decorations of the other parts, included in the architrave, Frieze and Cornice making up the Entablature, as you will find them all in the book you took from me,

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* To Professor Silliman.—*My Dear Sir.*—According to your request, I send you a copy of some remarks on Architecture, which a gentleman wished me to prepare for him, by way of assistance, in a few lectures, intended to be given by him to his pupils, members of a very respectable female Seminary, of which he is principal. He has however so much readiness in acquiring and communicating knowledge, that he probably found my contributions, less important than he anticipated. If on reading them deliberately, you do not change your mind as to the object you had in view, they are at your service, and I may add also, at your *risk*, since you are disposed to give to the public, what was intended for private use.

Your Friend and Servant,

Hartford, April 23, 1833. Daniel Wadsworth.

which I think gives as handsome specimens of *measured drawings*, to work from, in *Roman Architecture*, as any one I know of. The same will also be found in many other books, which you will probably consult. The *Roman* Doric, is altered from the *Grecian*, by being much lighter, and having a base *added* to the column. The Tuscan, is *wholly* Roman, and the Composite, varies but little from the Corinthian, principally in having the shaft of the column, one diameter longer. This is really a needless order, as for all light and ornamental building, the Corinthian is the handsomest and there is no objection to enriching its plain Frize, to any degree, although it is generally left, without ornament. When these three Roman additions, or innovations were made, I do not know. The Tuscan is now almost wholly dropped, for although heavier than the *Roman* Doric, it makes none of the impression of grandeur, nor has it that look of repose and even of simplicity, that characterizes the *Grecian*, although the entablature of the Tuscan, is entirely plain, and its columns never fluted. Notwithstanding the richness of the Grecian Doric entablature, and its channeled columns, as they are without bases, and the whole is so much more massy, it has a more grave and severe aspect, than the plain and simple Tuscan. The temple of Minerva at Athens, and that on the promontory of Sunium, of which many correct prints may be found, are fine specimens of ancient *Grecian Doric.* The *pedestals* whose proportions are so accurately given in the book mentioned above, and indeed in all other books intended for the use of the practical builder, have been almost abandoned by modern Architects. There are few occasions, when they are agreeable to the eye, and as applied to columns, are, I have no doubt, entirely Roman. To support statues or vases, was I believe their only use, amongst the Greeks. In building they may sometimes become necessary, to overcome, or obviate, some difficulty, but a judicious architect, will be sparing of them. Your first impression, that the City Hall in Hartford, was Tuscan, arose probably, from the absence of the appropriate Doric ornaments of the entablature. If in addition to its fluted columns, (those of the Tuscan are never fluted,) it *had* those ornaments, it would in *every thing* be completely Grecian Doric, as it is in its proportions.

The columns of the true Grecian Doric, are rarely if ever, more than five diameters in height, and sometimes less, not diminished in a gently *curved* line, from one third up, as in the other orders, but from the foot to the capital, in a *straight* line, as in those of the Hartford *City Hall.* The *State House* at New Haven, the columns of whose two noble porticos are more than *eight feet diameter* at their base, and the new United States Bank in Philadelphia, are examples in *this country*; and in Europe, the famed temples of Pæstum, of very remote antiquity, built by the Grecians in the south part of Italy, are also examples. Of the United States Bank, I can furnish you by way of illustration for your scholars, with a handsome water colored drawing, and of the temples of Pæstum, an accurate colored copy, taken from an Italian drawing, which a gentleman to whom it belonged and who had been on the spot, told me was perfect, and it corresponds exactly, with some fine cork models* I have since had an opportunity of seeing in the Trumbull gallery of paintings in New Haven. In most instances, if not in all, I believe that in the *Grecian Ionic* the volutes or scrolls which form the principal ornament of the capital, have, as you will observe, but four faces, to each column, two presented to the eye in a line with the *external* architrave of the portico, and two in a line with the interior architrave. The same kind of capitals are found amongst the ruins of Palmyra. In the Roman Ionic, the volutes are, almost without exception, like those in the upper division of the Corinthian Capital, with *eight* faces to *each column*, presenting themselves obliquely to the eye, and having consequently two faces, to each valute, instead of one, as in the early Grecian Capital; probably this variety in the Capital is entirely a *Roman* deviation, but if it is not, you will I believe find the truth in the books you will consult, but I am not confident. Those I named to you, some of which I possess, and are at your service, will probably explain this. They contain some valuable information in aid of your present purpose. I have several very correct copies of Roman ruins, many of which are still standing in the neighborhood of Rome, although not grouped together there, exactly as they are in the prints. These will furnish good illustrations to your pupils, of the architecture of ancient Rome. Perhaps I have some views of the modern city, if I can find them in the house I will send them. I have in a book intended for beginners in practical architecture, a very perfect though small print, of the Pennsylvania Bank, which is an exceedingly beautiful specimen of Grecian Ionic, executed in marble, and also of the *Old* United States Bank, (lately Girards) of the Corinthian. The latter is much handsomer in the original structure, than in the print, although in front it is more like a richly decorated

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* Presented to Yale College by a Scotch gentleman, John McAdam, Esq., then at Rome, and brought out by Mr. Wm. McCrackan, of New Haven.

nobleman's house, than a public building. I send you also a small volume of Grecian Ruins as illustrations of Mr. Hobhouse's Journey.

I believe that all the elements of the Grecian, Roman, Moorish, Saxon, and Gothic architecture, are to be found in the Egyptian, Syrian, and Indian. In Denon's Travels, and in a colored drawing, copied from Norden's Travels of a temple at Combo in upper Egypt, both of which I can furnish you with, you will I presume find all the great proportions, of the heavy Grecian, and even the foundations or rather blocks, of many of its ornaments.* I have also noticed, in views of the Ruins of Palmyra, beautiful specimens of the lighter and more elegant columns, which we now call Greek and Roman. In buildings in India, either remaining still perfect, or existing in Ruins, are not only heavy Temples, much like those of Egypt, but *pointed* or *Gothic* arches, some plain, and others richly ornamented, supported on slender Pillars, and on arcades of these are raised square columns, like what are called "antais," of the lighter Grecian proportions, surmounted by a plain entablature, including its flat projecting cornice, and a plain, *closed* Ballustrade, of the same proportion, as those in modern use, but with no pediment. Pediments probably first arose in Greece, from the necessity of having such a covering as would discharge the rain. There are also in India, Gothic pinnacles, and Turkish Domes, in abundance. And in the Ruins of Dehli, especially, as well as in the more modern buildings, are many minute Gothic ornaments; of all these I can show you instances in a book of Indian Views.

What is now called the Gothic, should, as an English writer has declared, be stiled "*English Architecture*," for he claims that the *pointed* stile, if not invented in England, was carried to its greatest degree of elegance, in *that country*, and arose long after the time of the Goths. The same writer says, that if the word "English" is not allowed, it should be called Norman, as it was carried to perfection, under the Norman Dynasty, although introduced under the Saxon, and that the circular arch, with its short columns, if richly decorated, may be called "Saxon Gothic," and the pointed arch, and slender *Pillar*, "Norman Gothic." He asserts, that *Gothic Architecture*, is never spoken of by the earlier Historians, and prob-

* See Plate.—No. 1. Ruins of ancient Dehli.—No. 2. Part of Melrose Abby.—No. 3. Temple at Combo, Upper Egypt.—No. 4. Pæstum.—No. 5. United States Bank.—No. 6. Pennsylvania Bank.—No. 7. *Old* United States Bank.

ably the term was made use of to bring the pointed style into disrepute, at the time when it was intended to destroy simultaneously the popish religion, and its beautiful architecture, and to introduce Grecian buildings. I do not know whether the above opinions are expressed exactly in the words of the writer, but they exhibit substantially his meaning. That which is commonly called Gothic Architecture, is characterized by pointed arches, slender pillars, often like clustered shafts of pikes, or bundles of reeds, and almost every part, both flat and projecting, is enriched to the highest degree, with the most delicate tracery of flowers, and tendrils, and with an endless variety of other minute ornaments, almost always beautiful, although, sometimes intermixed with others extremely grotesque, and absurd.

There is nothing in the mere forms, or embellishments of the pointed style of architecture, in the least adapted to convey to the mind the impression of "*Gothic Gloom.*" The proportions and decorations are light, graceful, and elegant, and I have thought even when very young, and in Henry the 7th's Chapel which is one hundred feet in length, although awed by its gloom, that but for the rich twilight of its painted windows, and the dark color of its materials, rendered still more dark by time, all its forms, and all its proportions, were entirely appropriate to a splendid banqueting room, and it then appeared to me that the different impressions, even in Westminster Abbey, into which this chapel opens, were caused wholly by the artificial darkness, occasioned by shrouded windows, the gloomy color of the stone and deeper colored oak, its venerable age, the vast extent of the buildings, and the countless monuments which seem to crowd around you, as if the magnificent pile were raised only to shelter this great congregation of the dead, and as if the echo of each footstep were a voice of reproof, to the living intruder. There are several Gothic churches now in this country, two handsome ones in New Haven, and one built still later in Hartford, which I think a finer specimen of the pointed style, than either, and indeed I believe it is the handsomest, and most complete example of elegant Gothic, both in proportion, and decoration, as far as that style is attempted, which is to be found in the United States.

The *interior* of the first Gothic church built in New Haven, was at the time it was finished, a good illustration of what I would wish to express, as all those who saw it then, will I am sure, allow. Although grave, and dark, *without,—within,* it was as white as snow, and light as day, the workmanship being all delicate, and slender, of lofty pointed Gothic, the windows tall, unshrouded, divided into many tasteful compartments, and admitting a flood of light. I can believe that even the interior of Yorkminster, a larger and more beautiful cathedral, than Westminster Abbey, if white, with all the light that its vast windows could admit, would hardly produce the slightest impression of solemnity. But I have no doubt it does now produce that impression, in the extreme, in consequence of its sombre coloring, great antiquity, and mysterious light, connected with religious associations, and the impressive recollection of the ages that have past, and of how many generations which have thronged as worshipers beneath its roof, have gone down to the grave, whilst its walls have stood, for hundreds of years, unchanged, in tranquil grandeur, and may, to all appearance, if contending with no enemy but time, still remain, till hundreds of generations more, have come into being and returned to dust.

Whatever may be the claims of the English, or other European nations, to what is called Gothic Architecture, I think it must be conceded, that there were pointed arches, and slender pillars, in the East, even if the European pointed arch, arose from the accident, as has been said, of an individual happening to see the round Saxon arches, intersecting each other, in such a position, as to give to the eye the impression of the pointed arch. An opinion has been entertained that this style was introduced into Europe by the Crusaders, or by the Moors. What the Crusaders had to do with it I do not know, but it is certain that the Moorish Alhambra at Granada, has the semicircular arch, and in some parts of that Palace, pointed arches also are seen, and in its profusion of delicate tracery over a great part of the walls, it may well compare, with the rich Norman Gothic, of the Cathedrals of Spain, Italy, and the north of Europe. That the pointed style, was introduced into England, long after the Saxon, I suppose there is no doubt, and it is beautifully noticed, by Scott, as I dare say you well recollect.

"In Saxon strength the Abbey stood
Like vet'ran worn, but unsubdued,
It rose alternate row—and row—
On pond'rous columns short and low,

"Built e're the art was known
By pointed Isle, and shafted stalk
The arcade of an alley'd walk
To emulate in stone."

I can furnish you with a colored drawing of Melrose Abbey, copied from an old Book, *printed* long before Scott was born, which contained as fine a description in prose, of the ruins, as they then stood, as the Poet gives of its earlier beauty, when supposed to be perfect. The description is even more minute, than Scott's, of the admirable delicacy of the flowers, foliage and tendrils, "wrought in stone." These are distinctly mentioned, and also many circumstances, and peculiarities which I have forgotten, but all tending to impress upon the reader, that the finest possible taste in this particular style, was then at its height.

The drawing will be a familiar illustration to your young ladies, and will I think, gratify them, particularly, as the very "East window," in Scott's description, through which the moon shone into the "Oriel," is seen in this drawing. You will recollect probably the following lines—

"The moon on the East Oriel shone
Thro' slender shafts of shapely stone
By foliaged tracery combined,
You would have thought some fairy hand
Thro' poplars tall the Osier wand—
In many freakish knot had twined
Then framed a spell when the work was done
And changed the willow wreaths to stone."

I will also furnish you with a common print, although a correct one, of the west front of "Westminster Abbey," and a common print, of the façade of the chamber of Deputies in Paris, probably the handsomest modern Corinthian Portico in Europe. That of the Pantheon at Rome, is considered the handsomest ancient one of that order. The *last*, you will see amongst the prints of Roman buildings, in the Portfolio you will take from here, and also a colored drawing of the Pyramids. It would perhaps be well to remark to the young ladies, that the Pyramids are probably the oldest as well as the largest structures, as to quantity of materials, now to be seen, *raised* on the *surface* of the earth, possibly some of the tombs, and temples, cut out of the solid rock: both in Africa and Asia, may be of greater antiquity, but I do not know that it has been absolutely proved. From the variety of books which you will have it in your power to consult, in addition to the few volumes I can furnish, you will readily obtain much more information than I can give; but if these short notices, are found to aid you, it will give me much pleasure.

Your friend and servant,

Daniel Wadsworth.

Art. VII.—*A few remarks on the relation which subsists between a Machine and its Model;* by Edward Sang, Teacher of Mathematics, Edingburgh. Communicated by the Author.

From the Edinburgh New Philosophical Journal.

At first sight, a well constructed model presents a perfect representation of the disposition and proportion of the parts of a machine, and of their mode of action.

Misled by the alluring appearance, one is apt, without entering minutely into the inquiry, also to suppose that the performance of a model is, in all cases, commensurate with that of the machine which it is formed to represent. Ignorant of the inaccuracy of such an idea, too many of our ablest mechanicians and best workmen, waste their time and their abilities on contrivances which, though they perform well on the small scale, must, from their very nature, fail when enlarged. Were such people acquainted with the mode of computing the effects, or had they a knowledge of natural philosophy, sufficient to enable them to understand the basis on which such calculations are founded, we should see fewer crude and impracticable schemes prematurely thrust upon the attention of the public. This knowledge, however, they are too apt to regard as unimportant, or as difficult of attainment. They are startled by the absurd distinction which has been drawn between theory and practice, as if theory were other than a digest of the results of experience; or, if they overcome this prejudice, and resolve to dive into the arcana of philosophy, they are bewildered among names and signs, having begun the subject at the wrong end. That the attainment of such knowledge is attended with difficulty is certain, but it is with such difficulty only as can be overcome by properly directed application. It would be, indeed, preparing disappointment, to buoy them up with the idea, that knowledge, even of the most trivial importance, can be acquired without labor. Yet it may not be altogether unuseful, for the sake both of those who are already, and of those who are not, acquainted with these principles, to point out the more prominent causes, on account of which the performance of no model can, on any occasion, be considered as representative of that of the machine. Such a notice will have the effect of directing the attention, at least to this important subject. In the present state of the arts, the expense of constructing a full sized instrument is, in almost every instance, beyond what its projector would feel inclined, or even be able, to incur. The formation of a model is thus universally resorted to, as a prelude to the attempt on the large scale. An inquiry, then, into the relation which a model bears to the perfect instrument, can hardly fail to carry along with it the advantage of forming a tolerable guide, in estimating the real benefit which a contrivance is likely to confer upon society.

In the following paper, I propose to examine the effect of a change of scale on the strength and on the friction of machines, and at the same time, to point out that adherence to the strictest principles which is apparent in all the works of nature, and of which I mean to avail myself in fortifying my argument.

Previous, however, to entering on the subject proper, it must be remarked that, when we enlarge the scale according to which any instrument is constructed, its surface and its bulk are enlarged in much higher ratios. If, for example, the linear dimensions of an instrument be all doubled, its surface will be increased four, and its solidity eight fold. Were the linear dimensions increased ten times, the superficies would be enlarged one hundred, and the solidity one thousand times. On these facts, the most important which geometry presents, my after remarks are mostly to be founded.

All machines consist of moveable parts, sliding or turning on others which are bound together by bands, or supported by props. To the frame work I shall first direct my attention.

In the case of a simple prop, destined to sustain the mere weight of some part of the machine, the strength is estimated at so many hundred weights per square inch of cross section. Suppose that, in the model, the strength of the prop is sufficient for double the load put on it, and let us examine the effect of an enlargement, ten fold, of the scale according to which the instrument is constructed. By such an enlargement, the strength of the prop would be augmented one hundred times; it would be able to bear two hundred loads such as that of the model, but then the weight to be put on it would be one thousand times that of the small machine, so that the prop in the large machine would be able to bear only the fifth part of the load to be put upon it. The machine, then would fall to pieces by its own weight.

Here we have one example of the erroneous manner in which a model represents the performance of a large instrument. The supports of small objects ought clearly to be smaller in proportion than the supports of large ones. Architects, to be sure, are accustomed to enlarge and reduce in proportion; but nature, whose structures possess infinitely more symmetry, beauty and variety, than those of which art can boast, is content to change her proportions at each change of size. Let us conceive an animal having the proportions of an elephant and only the size of a mouse; not only would the limbs of such an animal be too strong for it, they would also be so unwieldy that it would have no chance among the more nimble and better proportioned creatures of that size. Reverse the process, and enlarge the mouse to the size of an elephant, and its limbs, totally unable to sustain the weight of its immense body, would scarely have strength to disturb its position even when recumbent.

The very same remarks apply to that case in which the weight, instead of compressing, distends the support. The chains of Trinity pier are computed to be able to bear nine times the load put on them. But if a similar structure were formed, of ten times the linear dimensions, the strength of the new chain would be one hundred times the strength of that at Trinity, while the load put upon it would be one thousand times greater; so that the new structure would possess only nine tenths of the strength necessary to support itself. Of how little importance, then, in bridge building, whether a model constructed on a scale of perhaps one to a hundred support its own weight! yet, on such grounds, a proposition for throwing a bridge of two arches across the Forth at Queensferry was founded. Putting out of view the roadway and passengers altogether, the weight of the chain alone, would have torn it to pieces. The larger species of spiders spin threads much thicker, in comparison with the thickness of their own bodies, than those spun by the smaller ones. And, as if sensible that the whole energies of their systems would be expended in the frequent reproduction of such massy webs, they choose the most secluded spots; while the smaller species, dreading no inconvenience from a frequent renewal of theirs, stretch them from branch to branch, and often from tree to tree. I have often been astonished at the prodigious length of these filaments, and have mused on the immense improvement which must take place in science, and in the strength of material too, ere we could, individually, undertake works of such comparative magnitude.

When a beam gives support laterally, its strength is proportional to its breadth, and to the square of its depth conjointly. If, then, such a beam were enlarged ten times in each of its linear dimensions, its ability to sustain a weight placed at its extremity would, on account of the increased distance from the point of insertion, be only one hundred times augmented, but the load to be put upon it would be one thousand times greater; and thus, although the parts of the model be quite strong enough, we cannot thence conclude that those of the enlarged machine will be so.

It may thus be stated as a general principle, that, in similar machines, the strengths of the parts vary as the square, while the weights laid on them vary as the cube of the corresponding linear dimension.

This fact cannot be two firmly fixed in the minds of machine makers; it ought to be taken into consideration even on the smallest change of scale, as it will always conduce either to the sufficiency or to the economy of a structure. To enlarge or diminish the parts of a machine all in the same proportion, is to commit a deliberate blunder. Let us compare the wing of an insect with that of a bird: enlarge a midge till its whole weight be equal to that of the sea-eagle, and, great as that enlargement must be, its wing will scarcely have attained the thickness of writing paper;—the falcon would feel rather awkward with wings of such tenuity. The wings of a bird, even when idle, form a conspicuous part of the whole animal; but there are insects which unfold, from beneath two scarcely perceived covers, wings many times more extensive than the whole surface of their bodies.

The larger animals are never supported laterally; their limbs are always in a position nearly vertical: as we descend in the scale of size the lateral support becomes more frequent, till we find whole tribes of insects resting on limbs laid almost horizontally. The slightest consideration will convince any one that lateral or horizontal limbs would be quite inadequate to support the weight of the larger animals. Conceive a spider to increase till his body weighed as much as that of a man, and then fancy one of us exhibiting feats of dexterity with such locomotive instruments as the spider would then possess!

The objects which I have hitherto compared have been remote, that the comparisons might be the more striking; but the same principle may be exhibited by the contrast of species the most nearly allied, or of individuals even of the same species. The larger species of spiders, for instance, rarely have their legs so much extended as the smaller ones; or, to take an example from the larger animals, the form of the Shetland pony is very different from that of the London dray-horse.

How interesting it is to compare the different animals, and to trace the gradual change of form which accompanies each increase of size! In the smaller animals, the strength is, as it were, redundant, and there is room for the display of the most elaborate ornament. How complex or how beautiful are the myriads of insects which float in the air, or which cluster on the foliage! Gradually the larger of these become more simple in their structure, their ornaments less profuse. The structure of the birds is simpler and more uniform, that of the quadrupeds still more so. As we approach the larger quadrupeds, ornament, and then elegance, disappear. This is the law in the works of Nature, and this ought to be the law among the works of Art.

Among one class of animals, indeed, it may be said that this law is reversed. We have by no means a general classification of the fishes; but, among those with which we are acquainted, we do not perceive such a prodigious change of form. Here, however, the animal has not to support its own weight; and whatever increase may take place in the size of the animal, a like increase takes place in the buoyancy of the fluid in which it swims. Many of the smaller aquatic animals exhibit the utmost simplicity of structure; but we know too little of the nature of their functions to draw any useful conclusions from this fact.

Having said thus much on the relative strengths of a machine and of its model when at rests, I proceed to compare their strengths and actions when in motion.

This subject naturally divides itself into two heads; the one relating to the ability of the structure to resist the blows given by the moving parts, either in their ordinary action, or when, by accident, they escape from their usual course; the second treating on the changes which take place on the friction of the parts when these are enlarged or diminished.

The ability of support to resist the impetus of a moving body, is estimated by combining the pressure which it is able to bear with the distance through which it can yield ere disruption takes place. In the case of a support which acts longitudinally, the strength is proportional to the square of the linear dimension, while the distance through which it can yield is as the linear dimension itself. Altogether, then, the ability to resist a blow is proportional to the cube of the length; that is, to the weight of the body which is destined to act upon it. If, then, the linear velocity of the machine is to be the same with that of the model, these parts, so far as this action is concerned, will be in keeping with each other.

In the case, however, of a lateral support, the distance through which it can yield without breaking is not augmented by an enlargement of the scale; so that, in these parts, the large engine is comparatively weak, even although the velocity of the motion be the same on the large as on the small scale.

But those motions which are most likely to produce accidents in this way, are generated by descents bearing a fixed proportion to the dimension of the engine: the velocity, therefore, is generally greater in the large engine than in the small one, so that large machines are more liable to accidents arising from the derangement of any of their motions than small ones are: they possess, however, more absolute strength, and are better able to resist any extraneous force. We must carefully distinguish between the absolute strength of any structure, or the power which it has of resisting impressions from without, and the ability of that structure to withstand the effects of derangement among its own parts.

Every one knows that a thermometer bulb is broken by a very slight blow, and that yet it may fall from a considerable height without injury. Yet a large ball, of a proportionate thickness, though able to resist a much severer blow, is dashed to pieces by a fall. The insect is crushed by a touch; yet many species of insects possess the power of leaping to distances inconceivable, when compared with the minuteness of the animal.

Whether we consider its ability to resist mere pressure, or its ability to resist an impulse, the performance of an engine is not at all commensurate with that of its model. It remains for me to shew that as great a disparity is perceived when we consider the friction of the parts. As, perhaps I have been rather general in my previous statements, I shall, when speaking of the friction, confine my attention to that very important instrument the steam-engine. A little consideration will enable any one to apply similar remarks to other machines.

The steam-engnie moves on account of the pressure of the steam against the surface of the piston; which pressure may be estimated at about ten pounds per circular inch. The friction which this pressure has to overcome may be divided into three parts: the first including all friction caused by the packing of the piston and stuffing-boxes, and which is proportional to the linear dimension simply;

the second including that part of the friction on the gudgeons which arises from the pressure of the steam upon the piston, and all other friction proportional to the square of the linear dimension; and the third including all that friction which arises from the weight of the parts, and which is thus proportional to the cube of the dimension.

Suppose now, for the sake of an example, that, in an engine whose cylinder is 20 inches across, and whose inciting pressure will thus be 4000 lb., the friction of each kind is 100 lb., the entire friction being thus 300 lb. or about 1-13th part of the moving force. And to make a handsome enlargement at once, let us propose one of which this may be a mere model, on the scale of 20 to 1; the new cylinder will be 4000 inches in diameter, and the pressure on the piston 1,600,000 lb. The friction of the first species would amount to 2000, that of the second to 40,000, and that of the third to 800,000 lb., so that the sum total of the friction, no less than 842,000 lb., would be fully more than half of the inciting pressure.

It is then clear that such an enormous engine would be highly disadvantageous as a mechanical agent, and that, if the enlargement were pushed a little farther, the whole of the moving force would be expended in overcoming the friction. There is, then, a greatest size beyond which it is impossible to proceed in the construction of the steam-engine. But there is also a least.

Let us, in fact, take an engine similar to our first, but with a cylinder of only 1 inch in diameter. In such an engine the pressure of the steam upon the piston would only be 10 lb.; the three kinds of friction would amount respectively to 5 lb. 1qr. and 1-80th part of a lb., the first kind alone being equal to half the inciting force. Were the diminution still farther continued, the friction of the packing of the piston might equal the pressure of the steam.

From this it is apparent that, for each shape of the steam-engine, there are two extreme limits as to size, at which the utility of the engine ceases altogether, and between which there is placed a best size, or one which is accompanied by the most complete development of the powers of the instrument. A skilful arrangement of the parts may, indeed, extend the limits both ways, and may thus change considerably the most advantageous size, yet, even with that assistance, very small or very large engines are less productive of force, in proportion to the quantity of coal they cousume, than moderately-sized ones are; and, in many instances, it would have been better to have employed two or three middle-sized engines than a single one possesed of two or three times the nominal power.

Every instrument, whether it be used for the generation or for the transference of power, has a best size and a best form. The contemplation of the whole animal and vegetable kingdoms teaches this truth. Each species of animal attains to a determinate size, beyond which it seldom proceeds, and short of which it seldoms stops, unless man has interfered with the regular course of nature, and deranged, as his contrivnaces too often do, that determinate, succession of events which is conspicuous in the history of each tribe of what we are pleased to call the lower animals. Each animal and each vegetable, in its progress from infancy to maturity, assumes, at each stage of that progress, such a form as best assorts with the consolidation of its parts, and with the mode of its living. The wisdom and the benificence of this arrangement, and the skilfulness with which it is made, become the more apparent when we carry our contemplation beyond the globe which we inhabit to those other worlds which circulate round the same sun. Were man, in his present state, and with his present powers, planted on the surface of Jupiter, he would be crushed beneath his own weight: and if, on the surface of that planet, there do exist beings of the same structure and of the same material as man, one of us would be a Man-mountain among them. If, on the other hand, we were transported to the surface of the Moon, or of one of the Asteroïds, our strength would fit us for progressing rather in the manner of the grasshopper than of the man: bipeds, living and moving as we do, would there realize the counter-vision of Gulliver.

The sizes, then, of the objects which, on the surface of this earth, surround us, are not fixed by chance, but determined by the immutable laws of nature; and, in every case, Nature has pushed her exertions to the utmost. There is a limit, both ways, to the size of quadrupeds; there is a limit, both ways, to the size of birds; and, although myriads of insects may be as yet unknown, I hesitate not to affirm that, among these also, we have the double limit. These are not mere speculative truths; they teach us this useful and needful lesson, that there are bounds beyond which no ingenuity can carry us, and toward which we can only hope to approach. How often have men attempted to plume themselves with wings? How many years were spent in search of the golden secret? How many fortunes have been wasted in the contrivance of perpetual motions! And, to come nearer the present moment, how many have ruined themselves with the locomotive engine! This last is the bubble of the present day, and on it I shall make a few observations.

At the surface of Jupiter a steam-engine of twenty horses' power would be unable to move: at the surface of our Earth, one of perhaps 1000 horses' power might perform pretty well; but at the surface of the Moon they might be made of perhaps 20,000 horses' power,—supposing the pressures of the atmosphere in the three cases to be alike. On Jupiter a steam-carriage would be an absolute chimera; on the earth it is barely possible; but on the moon nothing would be more feasible. An intensity of gravitation slightly greater than that which the earth exerts, would altogether preclude the hope of obtaining a locomotive engine. As it is, on flat rail-roads they perform well; as the road becomes inclined, they become less practicable; and, on common roads, nothing but the most consummate skill in the selection and in the use of the material, as well as in the contrivance of the parts, can ever be successful in their construction. Security demands strength, strength requires weight, weight increases friction, friction calls for additional power, and power can be procured only by an increase of weight. To reconcile these conflicting claims is not the task for a beginner in mechanical contrivance, but for one well versed alike in the theory and in the practice of the arts. Models are of no use, for, although the model be able to climb a considerable ascent, that fact is no guarentee that a full-sized instrument will be able to follow its prototype. Let those who speculate on this matter remember that the elephant inhabits the plains, and leaves the mountains to be tenanted by the smaller tribes; and let them also recollect, for the fact bears more upon the subject than at first may appear, that the larger animals are most easily exterminated; that we have the fox and the rat, though the wolf be long since gone.

In the remarks which I have made, it has been my wish to place the subject in such a light as might enable all to perceive the importance of its bearings; and I have refrained from being practical, lest in making myself better understood by some, I had rendered my meaning obscure to others. My intention throughout has been to inculcate the important truth, that no machine ever can be enlarged or diminished in proportion.

Art. VIII.—*Considerations on the Bitterness of Vegetables, etc.; by* J. B. A. Guillemin, Doctor in Medicine, 4to. Paris, 1832.

Translated for this Journal, by J. H. Griscom, M. D.

Mr. Guillemin is known among Botanists by many interesting works, and especially by the part which he has had in the publication of the Classical Dictionary of Natural History, and of the Flora of Senegambia. The dissertation which we here notice, shows that he has carefully studied the connections between botany and medicine, and tends to confirm the usefulness of that kind of study, which, as it is intermediate to the two sciences, more rarely makes a part of the direct studies of those who devote themselves to both. The work of Mr. Guillemin is founded entirely upon the general law of analogy of the properties of plants which belong to the same family, and becomes, consequently, a new confirmation of the principles exposed in the Essay upon the medical properties of plants, compared to their natural classification. (1 Vol. 8vo. Paris, 1816.) The author divides the families endowed with bitterness, into several groups, viz: 1, the families purely bitter; 2nd, the acrid and bitter; 3rd, the astringent bitter; 4th, aromatic bitters; 5th, the cathartic bitters. He reviews the plants which enter into these different divisions, and analyses their modes of action, in as clear and precise a manner as our knowledge of them will permit. He enters particularly, into some interesting details upon the Gentians, which contain bitterness in a high degree of intensity and purity, and his chapter upon this subject, is the more interesting, as it is extracted from a large work on this family, which the author has for a long time intended, and we hope still intends, to make a botanical monograph. We might direct our attention, with great interest, to many of the articles of this dissertation; but we think, seeing the circumstances in which Europe is placed, it will be more suitable to give almost textually that which relates to the properties of aloes, and especially to its employment in the treatment of the Asiatic cholera. In inserting this article here, we shall give an idea of the wise and reflecting manner in which the author considers the subject, we shall show how general considerations may be reduced to particular applications, and perhaps we may suggest to some physicians of infected districts, or which may be so, the idea of researches beneficial to humanity.

The author remarks (page 51,) that the monocotyledones are less abundantly provided with bitter juices than the dicotyledones, but that the juice extracted from the leaves of different species of aloes makes a remarkable exception to this general observation. After relating the facts known upon the chemical nature of the juice of aloes, he analyses its properties as follows.

"Aloes is one of the most eminent substances employed in medicine. It exercises its action upon the organs of digestion. In very minute doses, (two or three grains,) it slightly excites the stomach, and facilitates digestion; it is in this way that the health grains of Dr. Frank, and the antecibum pills, etc., act. In a stronger dose (eight grains,) its action, according to most authors, extends to the intestines, and is exerted especially upon the lower tract of the digestive canal. It there increases the afflux of blood, the mucous secretion, and occasions the expulsion of matter, amassed in the large intestine. Finally, aloes when given in a stronger dose, and its use continued, gives rise to colics; the rectum becomes the seat of a genuine flux, the hæmorrhoidal vessels are distended, hæmorrhoidal tumors become painful, and frequently gives place to an abundant oozing of blood. We have profited by the stimulating action, especially, which aloes exercises upon the rectum, and the determination which it produces to this part, in order to cure certain megrims, caused by obstinate constipations. In producing a useful direction towards the rectum, it has often diminished a sanguinary congestion, induced towards the head."

"Such was the general opinion of physicians upon the *modus operandi* of aloes; but we have to oppose them with more positive and totally contradictory experiments."

In a Memoir upon the employment of the aqueous extracts of aloes, and its manner of acting, published by Baron de Wedekind, (Isis 1825; 11th No. p. 1227,) this physician promulgates the opinion, after multiplied experiments, that the purgative effects of aloes are not dependent upon, as is the case with other cathartics, an augmentation of the intestinal secretion, and an immediate stimulation of the contractile fibres of the intestines, but that this substance is first absorbed, carried into the circulation, then secreted in great part by the liver, whose activity it increases, and is finally ejected from the body in consequence of a purgative effect which is only secondary. In fact, the purgative action of aloes is only manifested several hours after its injection, in whatever dose it may have been taken.

Individuals of bilious habits are more strongly purged by aloes. The introduction of aloes into the circulation by its external application to ulcers, is sufficient to produce a purgation, and even to give rise to hæmorrhoidal accidents or to hæmorhages. Thus, the ointment of Arthanita, which contains aloes, purges, when it is employed externally."

From experiments made upon persons in health, and from observations collected from the sick, it appears that a purgative, as, for example, a potion composed of the *laxative infusion of Vienna* three ounces, and of *sulphate of soda*, one ounce, given at once, with two or four grains of aloes, acts as it would if it were given alone; but the aloes given two hours before this potion, does not begin to operate until the effect of the dose has ceased for some hours, and this second purgation does not resemble the first in relation to the appearance and odor of the matter evacuated. When on the contrary, the aloes is given six or eight hours before this potion, the effects of the two means coincide, and the evacuations become ordinarily very abundant.

"Icterus, which Baron de Wedekind has frequently observed in the military hospitals, has been treated with constant success by means of aloes. As long as the alvine evacuations continued white or greyish, the medicine, even in very large doses, (as an ounce a day,) did not purge. Its cathartic effect, on the contrary, was evinced as soon as the fæcal matter began to show the presence of bile in the intestinal canal, and this is one of the conditions necessary to its purgative operation. On the other hand, we run the risk of inducing a violent bilious diarrhæa, if we give this substance in strong doses when the fæcal matters are tinged with bile."

"Finally, an ulterior fact, which proves that the ultimate action exercised by aloes upon the large intestines is not primary, is, that *lavements* of tepid water with from two drachms to half an ounce of the extract of aloes, irritate no more than lavements of warm water, and purge, when they are not returned too soon, after an interval of seven or eight hours, consequently after the medicament has been absorbed, and has traversed the circulation. Afterwards, secreted in the liver with the bile, it augments the properties of this fluid, and it is then that it manifests its particular action upon the large intestines."

"The result of the preceding observations is, that the primary action of aloes is exerted upon the liver, that this organ is excited in the same manner as the salivary glands by mercury, and the kidneys by cantharides."

"The practical conclusions which we may therefore draw, are, that aloes is principally indicated when the biliary secretion is insufficient, when there is a complete constipation, an atonic state of the colon and rectum, in icterus, which we may attribute to atony of the liver, and against ascarides which are found principally in the rectum. It is necessary to exercise great precaution in the employment of this remedy in persons of irritable habits, and those disposed to an abundant biliary secretion, and in febrile conditions. It is decidedly contra-indicated in cases of jaundice with a spasmodic condition or inflammation of the liver, in cases of biliary calculi, in obstructions of the liver with dropsy, and in cases of abdominal plethora with a disposition to hæmorrhoids."

"It is useless to give aloes with the neutral salts and other purgatives which act promptly, at least if we wish to excite the intestinal and biliary secretions at the same time; but in that case it must be given several hours before the other medicines. In order to increase simultaneously the pancreatic and hepatic secretions, we may administer a compound of aloes and calomel."

"The reading of the memoir, a very concise summary of which I have just *exposed*, had strongly interested me; its important conclusions were fresh in my memory, when the Asiatic cholera morbus was announced among us, about the end of March, 1832. It appeared to me that aloes might be rationally employed in the treatment of this terrible disease. Indeed, the suppression of the biliary secretion* coinciding with the abundance of whitish or greyish dejections, is one of the most alarming symptoms. When, by the power of nature alone, or by the effect of some therapeutic agent of whose properties we are ignorant, this suppression ceases, and the dejections begin to be colored, we have then an almost infallible sign of amendment, and we may hope that the disease will not prove mortal. Indeed, if it is admissible, if it is even urgent, to make use of symptomatic medicine, it is certainly in cases like the present.

* We know that the principal physiological difference observed between ordinary cholera and Asiatic cholera is, that in the former there is an excess of the secretion of bile, and in the latter a total suppression of this secretion. We may, and perhaps we ought, to give the latter the name of *Acholera*, which, in avoiding the always embarrassing employment of compound terms, will have the advantage of neatly expressing the character of the disease.

To determine the intensity of a symptom whose results may be happy, is then the end of the practitioner. But, whatever may be the part which the affection of the liver acts in cholera, whether relatively to hæmatosis or to the biliary secretion, it appears to me very proper to employ aloes, either by the mouth in the form of bolus, powder or tincture, or by the anus in the form of lavements. The frightful rapidity with which the disease advances, would be the only obstacle to its employment; for according to what we have said above, its action is slow and is not manifested until several hours after its administration. But, may it not still be very useful to exhibit aloes to the patient at the first onset of the disease, that is to say, as soon as vomitings, dejections, coldness of the extremities, or cramps, announce a choleric attack? I communicated these reflections, in the early part of April to the learned and unfortunate Dauce, one of the first victims of the scourge, as well as to M. Rostan, who objected that the inflammatory state of the intestines would not admit of the administration of so irritating a medicine as aloes. It is clear that these celebrated physicians grounded their supposition upon the general opinion that this medicament exerts a primary action upon the intestinal canal, and that they had not given sufficient attention to the researches of Baron Wedekind in this respect. I believe then that there is good reason, in regard to this subject, to institute experiments which may have an important bearing upon the interests of science and humanity."

"This view, which I expressed at the beginning of July, just as the cholera was disappearing, has since been set forth by one of our most able therapeutists. Dr. Biett, physician to the hospital Saint Louis, immediately after the communication of my paragraph upon aloes did not hesitate to administer this substance to some cholerics, and has obtained satisfactory results. The following is the note which he has had the goodness to address to me upon this subject."

"I have been very tardy, sir, in returning the manuscript which you have been so obliging as to lend me. Your researches upon aloes presented a great deal of interest; you have summed up, with great conciseness and clearness, all the facts which prove the properties of this substance, and you have been led to think that this medicine might be advantageously employed in Asiatic cholera. The objections of Dr. Rostan have great force; but in the actual state of our knowledge, it is impossible to say that all irritating substances are injurious in the treatment of this terrible malady, since we observe it modified very often under the influence of very stimulating medicines. Be this as it may, I have had recourse to aloes in three cases of very serious blue cholera, and the success has surpassed my expectations. The first case was that of a man of fifty years of age; he was attacked in the night; the matter vomited and the dejections were white and abundant; the skin cold and livid; the tongue cool, and the prostration extreme. The aloes was prescribed in doses of two grains every hour; its action was slow, but at the fifth hour, the stools were colored, not with the golden yellow of aloes, but with the greenish yellow of bile; the matter vomited presented the same character. The urine soon reappeared, as well as the heat of skin. The livid tint was replaced by a lively red color. This state continued to improve. The aloes was continued for two days in the dose of twelve grains; the amendment continued to advance. Cold mucilaginous drinks were continued, and shortly after some slight nourishment was allowed, by which means he was in a condition to leave the ward five days after entering it."

"Still more prompt and satisfactory results were obtained with the two other patients. The one, named Gaudin, aged thirty years, entered on the 18th of July, with the most serious and well marked symptoms. The aloes, continued for two days in the quantity of nine grains, reinduced the biliary and urinary secretions, and the heat, and finally caused the rapid and progressive disappearance of all the symptoms."

"The other, named Clement, a young man of twenty, was equally blue, having vomitings and white dejections, with but few cramps. The aloes, given at the rate of twelve grains a day, produced the same effects."

"This medicament has been administered only to these three patients. Its action was noticed at the end of three or four hours, and when once commenced, it was continued without interruption. We prefer the gummy extract, the action of which appears, in general, less irritating. These three patients did not evince *any trace of irritation*, in their convalescence. The only well founded objection which can be made, at present, to this medicinal substance, is the slowness of its action. It has probably already been had recourse to in India, for its presence is easily recognized in the bitter drug, a composition which is often employed in India against cholera."

The bitter drug, of which Mr. Biett speaks, is composed of the following substances: *Aloes Socotorine*, one pound; *Myrrh, Mastich, Benzoin*, each eight ounces; *Rad. Colombæ,—Gentiana;—*

Angelica, each four ounces; *Alcohol aquosi* (common brandy,) thirty six pounds; *Tincture of Juniper*, twelve pounds. Keep forty days, and filter. This preparation is given in the dose of half an ounce to an ounce, united with a camphorated portion. This drug is only the supplement to a preceding one, which consists of eighty drops of Laudanum, a wine glass full of brandy, and two spoons full of Castor oil; another dose of brandy to which are added forty drops of Laudanum is sometimes given. (Medical Reposit. Feb. 1826, and Bull. de Ferussac Sc. med. VIII, 149.)

The missionaries of Serampore assure us that this medicament cures in India almost all the sick when it is administered in time. I do not doubt, that the action of this drug, which on all other occasions would be qualified as *inflammatory*, should be attributed entirely to the aloes, which enters into its composition in scruple doses; the other substances, including even the myrrh, being but insignificant drugs. In the advice which I have given for the employment of aloes against cholera, I had, by induction, another practical fact, which I ought not to pass over in silence. Mr. Barberet, apothecary at Baume (Côte-d'Or) has assured me that the Polish refugees in their passage through that city gave to their hosts the recipe of an anticholeric liquid. It was simply that of the elixir of long life or of compound aloes, which they said had always been employed with success, and which they believed even to be an excellent prophylactic. I cannot neglect these notices, for popular remedies are not always the least efficacious; they are often it is true, the fruits of blind empiricism; but those which really exert some action, have in their favor a multiplied experience which physicians should not disdain to verify, while endeavoring to obtain a positive idea of their mode of action in diseases.—*Bib. Univ., Aout*, 1832.

Art. IX.—*On the Eupatorium Huaco;* by* W. R. Johnson.

Philadelphia, May 10th, 1833.

TO PROFESSOR SILLIMAN.

Dear Sir,—The appearance in a late number of the American Journal of Science, of an account of certain singular cases of hydrophobia, will probably render acceptable to your readers some infor-

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* See a short notice of this plant, by Dr. L. Feuchtwanger, Vol. xxii, p. 182.

mation concerning a remedy, professing to subdue that formidable malady, even *after the full development of its symptoms.* I am satisfied from *personal experience,* as well as from an immediate knowledge of six or eight cases among my acquaintance, and from information received relative to more than fifty other patients, treated under the direction of a single physician, that the bite of a mad dog is as much under the control of medicine, *if administered in due season,* as the bite of any venomous reptile; or, indeed, as any acute disease whatever. The remedy to which I refer, does not, however, rest its claim to notice exclusively, or even chiefly, on its efficacy in curing hydrophobia. It is a well known specific, in the countries in which it is indigenous, for the bite of venomous reptiles, particularly of the rattlesnake; and has recently, we are assured, been applied with singular success, in the treatment of yellow fever.

The remedy in question, is the plant well known in several parts of Mexico, and in some portions of Central and South America, under the name of *Huaco* or *Guaco.* Having received from a friend, a quantity of this plant in a dried state, embracing roots, stems and leaves, I have enclosed a specimen for your inspection. That it possesses powerful medicinal qualities, may readily be believed from its strong aromatic properties, and from its intense bitter, almost acrid taste.

Without offering to vouch for the authenticity of all that has been said concerning it, I will will give the substance of a communication, published in a Mexican newspaper, (El Censor,) at Vera Cruz, on the 31st of August, 1832. As it states facts which would easily be refuted if untrue, (since they must be familiar to many persons in Mexico,) and as it asserts cures, in which other members of the medical faculty besides the author of the communication, must feel some interest, we may perhaps, be justified in believing that the author, at least, fully confided in the truth of his own statements. It will also be seen, that he refers to several names well known among the distinguished men of Mexico.

The paper, of which a translation is here subjoined, is entitled, "*Observations on the Huaco, by J. L. Chabert, M. D., Consulting Physician of the Military Medical Staff, at Vera Cruz, &c. &c.*"

"The Huaco or Guaco, a valuable plant which grows abundantly in the forests of the warm districts of several states in the Mexican Union, is a certain antidote against the bite of venomous serpents. The learned Mutis affirms, that repeated experiments which he has made have proved the truth of the above assertion, and that celebrated physician of New Grenada, consequently regards this plant as the most beneficent gift bestowed by nature, on the regions which abound with venomous reptiles. Cabanillas affirms, that the Huaco is an excellent stomachic and vermifuge. In the states of Chiapas and Tabasco it is applied as a remedy for intermittents, diarrhæa, and severe bilious fevers. Several physicians in the city of Mexico, (and among them, my associate and friend Dr. Pedro del Villar,) have employed it in cases of nervous affection accompanied with a derangement of the nervous system or a diminution of its energy. In the hospital of San Carlos at Vera Cruz, it has been used in intermittents, which had withstood the power of all other known febrifuges. It has been frequently applied solely with a view to remove diseases or severe *pains* of the breast, to excite warmth of the skin, and create perspiration. The effects have always been favorable, and have never deceived the expectations of the practitioner. Finally, according to the statement of Don Pedro Bolio, Commissary General of Tabasco, in a letter dated the 31st of July, 1832, the Huaco is regarded in that state, as a sure antidote against the bite of the mad dog, and even as a specific against *confirmed hydrophobia.* This latter quality, it has recently been *proved* to possess, by the testimony of a physician at Oajaca, who, by administering this plant, has cured a patient suffering under hydrophobia *with all the symptoms completely developed.* Were the Huaco endued with no other virtue than that of a specific against this dreadful disease, still should that be indisputably established by new facts, its introduction into the *materia medica* must doubtless be regarded as an inestimable blessing to mankind."

"The Indians and Creoles of the districts of country in which it grows, attribute to the Huaco properties almost miraculous; but without overstepping the bounds of reason and observation, may we not reasonably infer that a plant, which by a *simple application* to the bite of a rattlesnake, or other venomous reptile, removes at once the tremendous consequences of such an occurrence, must be endowed with qualities extremely active, the analysis and developments of which would afford numerous benefits to the human race?

This reflexion, and the resemblance between the most striking phenomena observed after *inoculation* with the rattlesnake poison, and those violent symptoms which often transpire during the yellow fever, had created in my mind a strong desire to ascertain by direct expeperiment its efficacy in combating the later disease."

Having as long, ago as the year of 1828, been authorized by General Pedraza, then minister of war, to make all the investigations and experiments which I should deem expedient, in regard to this question, and having received detailed communications on the Huaco, from General Anaya on his return from Chiapas, where he had resided as chief commandant of that province, I determined to direct my inquiries to the actual effects of this singular plant.

A quantity of it had been ordered from Tabasco, by General Pedraza, but arrived so late, that the fever of that season had ceased before it came to hand, and the year 1828, passed away without an opportunity for experiment.

Various circumstances conspired to prevent the desired trials, until near the close of 1831.

But, notwithstanding the recent political condition of the country, the General Government, as well as General Santa Anna, and Colonel Juille, have taken measures to furnish me with the necessary supply of the plant; and in the months of April and May, of the present year, (1832) I have been able to make the application.

Four cases of yellow fever in the *town*, and seventeen in the military hospital of Vera Cruz, came during that period, under my care. In all four of the former, and in sixteen of the latter, the Huaco was administered and all were cured.

A single patient, whose symptoms were so uncertain, as to prevent a seasonable treatment for yellow fever, had become incapable of relief and fell a victim to the disease. During the present month of August, five additional cases of the fever have occured in my practice, in all of which, the Huaco was prescribed, and in every case effected a cure. Though still not very numerous, the above mentioned cases will doubtless be considered sufficient to strengthen the opinion which I had conceived, that if not an absolute remedy, this medicine may at least be found a valuable auxiliary in the treatment of yellow fever. The *effects* of its application have been decided and remarkable. The patients have in every case experienced an immediate cessation of the anxiety and agitation previously existing, which indicates that the medicine acts an important part in modifying the action of the *nervous system*. There has uniformly been a sensible development of heat in the stomach, succeeded by a glow over the whole surface of the body, and speedily followed by copious perspiration." The mode of administering this medicine is extremely simple. A drachm of the leaves and twigs, or two drachms of the woody part of the plant, are to be boiled in a quart of pure water, until it is reduced to a pint and a half, or a pint and three fourths. This decoction is to be sweetened with sugar and a small tea-cup full administered, while warm, at every half hour until the heat and moisture of the skin are restored,—which commonly happens at the third dose. The repetition of the dose may then be delayed for two or three hours."

The paper from which the above extract is derived, promises in the following number, a series of observations, made by a gentleman of Oajaca in particular reference to the successful application of the Huaco, to the cure of hydrophobia.

Besides the remarks already cited, Dr. Chabert has expressed his confident belief that the same remedy would be found beneficial in the treatment of malignant cholera, but as that part of his paper is founded only on analogical reasoning, I have not deemed it necessary to translate it. It is not improbable that he may ere long have an opportunity of testing by observation and experiment, the justness of his deductions. He pointedly disclaims all pretence of offering this plant as a *panacea*, but earnestly invites the notice of the attentive cultivators of medical science, to its known and acknowledged properties, as likely in their hands, to become extremely beneficial to the public. With a similar view is it now offered to the readers of the American Journal. The friend* who has obligingly furnished me with the specimens herewith forwarded, has the expectation of receiving a quantity sufficient to supply those who may desire to procure it for trial or use, and has ordered some specimens in a green state, for the purpose of ascertaining whether it may not be successfully cultivated in some parts of our extensive territory.

The opinion said to be entertained respecting the Huaco, in New Granada, is I find corroborated by information from other parts of Colombia. It appears to be there employed for obtaining, not merely relief from the consequences of a single bite of a venomous reptile when actually received, but also an immunity from all danger that may at any time occur from the same source. This immunity, is, it should seem, procured by a species of inoculation with the snake venom, and the Huaco, is employed to counteract its immediate effects. The information alluded to is contained in extracts from

* Stephen Sicard, Esq., merchant of Philadelphia, and late resident at Vera Cruz.

two letters from a resident near Caraccas, to a friend in Germantown, who has obligingly furnished me with copies. The first is dated at Tapatapa, near the lake of Valencia, Nov. 15, 1827, and after describing the lake on, and near which, a party of ladies and gentlemen were spending the day, it proceeds:

"During the day, a man named Martines, who has the care of the cattle on the estate, came to the lake to see Mr. Alderson," (a gentleman well known in Philadelphia,) "and, to our amazement, carried in his hand a large live rattlesnake, with eight rattles. He had caught it on the road not far from the house we were in. He threw it down on the corridor, and as one of the men who were with him produced its fangs, which Martines, had pulled out when he caught it, we were not so *very much afraid,* though we all kept at a most respectful distance. Martines is one of those persons who can *charm* snakes; in other words he is inoculated with some of the venom of the snakes, which effectually secures him from all danger and he handles the most venomous kinds without the least apprehension.

"Marvellous as this may appear to you, it is really true. He never hesitates to catch hold of a snake, meet it when or where he may. He seizes it just below the head, holds it dangling between his finger and thumb, and after depriving it of its fangs, carries it about in the crown of his hat. He often takes it out, and placing it upon the ground, and retiring to some little distance places his hand on the earth, and raps to attract its attention,—calls it to come to him, and, believe it! the horrid reptile crawls to him, gets on his hand and is instantly recaught in the manner I have described. Remember this is not a "*hearsay story.*" I have seen it done before yesterday, and know that Martines is not the only one who can do such things, there are many people about Maracay who are *inoculated* as he is, and none of them fear to catch snakes."

Having been requested, on behalf of a physician in this vicinity to obtain further particulars in regard to this interesting subject, the following statements were made in a letter dated Chacao, May 19, 1828.

—— "I will now tell you all we have learned on the subject of *Snake-vaccination,* while at Tapatapa, which I request you to communicate to Dr. —— and assure him from me, that I tell '*the truth and nothing but the truth.*' Our information is gained from a medical man as well as from the unlearned. The doctor was questioned by Mr. A. as he was anxious that there should be no mistake in what we repeated to you.

"There are only two men who possess the secret," (of inoculating;) "one lives at Turmero, (between Maracay and San Mateo) and the other at Victoria.—The one at Turmero imparted it to the other. The inoculation is performed by making an incision in the flesh, with the tooth of the snake, into which place is rubbed something which is a profound secret. They also administer a kind of medicine, made of an herb called 'Guaco' (or Huaco) which grows in the valleys, but how it is prepared and what is the quantity taken are also mysterious, which they cannot be induced to reveal. In the interior, it is customary to carry some of the Guaco about the person, and it is affirmed that no snake will attack one who has it. Mr. Alderson *knows* this to be the custom, as he has repeatedly seen it worn."

"The doctor said, that inoculation does not always secure people from *some* of the bad effects of a snake's venom; but it is never mortal, to those thus guarded, as in no instance has any one who had been inoculated, died of a wound inflicted by a snake however venomous; and as to their handling them with perfect security, we have all seen it too often to doubt the fact. Even after we all saw the rattlesnake at Valencia deprived of its fangs by Martines, the men who were with him drew back in terror from the terrific creature, while he took it up, caressed it, suffered it to coil itself around his arms and body, and carried it away in his hand."

From the remark of Dr. Chabert respecting the neutralizing of snake venom, by a simple application of Huaco to the exterior wound, it should seem likely that the South American remedy about which so much mysterious secrecy is preserved, is no more than a portion of the same plant which is administered internally in the form of decoction. However this may be, there can be no doubt of the facts above stated, as the source, whence the communications proceeded, is entitled to implicit reliance.

Observation by the Editor.—Since the preceding piece was put into type, a friend has called our attention to a paper by Dr. Honcock, published in the English Quarterly Journal of Science, for July, 1830. The contradictory statements of the two papers, ought to elicit additional observations, in a case so interesting to mankind. In the paper cited from the English Journal, the curative and anti-poisonous properties of the Huaco are denied.

ART. X.—*Memoir on the elastic force of the vapor of Mercury, at different temperatures;* by M. AVOGADRO.*

Translated for this Journal, by Prof. A. D. BACHE.†

The experiments of Dulong and Petit, give for the boiling point of mercury, under the atmospheric pressure, 680° F.‡ estimated by the mercurial thermometer, and 662° F.§ by the air thermometer, corrected for the expansion of glass. At this temperature, then, the maximum tension of mercurial vapor corresponds to a pressure of about thirty inches of mercury. I am not aware that any experiments have been made to ascertain the tension of this vapor at temperatures either below or above its boiling point. Such a research cannot fail to be interesting, whether we consider its results as mere additions to the list of properties of this valuable metal, or in their connexion with the facts, already developed, in relation to the vapors of other liquids. In this latter point of view, it may serve to test the truth of existing opinions, in relation to the laws of vaporization.

The object of the memoir, of which this paper is an extract, is to give the result of certain experiments, made with the views just stated, and their application to test the formulæ by which the tensions of the vapors of other liquids, in terms of the temperature, have been represented.

My experiments were made at temperatures below the boiling point of mercury: near enough, however, to that point, and extending through a sufficient range of temperature, to determine the law of tension with some precision. In order to have applied the method by which Dalton determined the tension of the vapor of water between 32° and 212° F., namely, the depression of the column of mercury in a barometer tube by the tension of the vapor, I must have heated the upper part of the tube, uniformly, and to a temperature between 390° and 570° F.,‖ by surrounding it with a liquid

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* Extract communicated by the author to the Editors of the Annales de Chimie et de Physique. The entire Memoir is contained in the thirty-sixth volume of the Memoirs of the Academy of Turin.

† In the original memoir, the degrees of the Centigrade scale are referred to, both in the observations and in the formulæ. I have supposed that the translation would be rendered more acceptable, by converting the degrees of the Centigrade thermometer into those of Fahrenheit's scale, and by adapting the formulæ to the same scale. The original temperatures and formulæ will be given at the bottom of the page on which they may occur.—[*Translator.*]

‡ 360°C. § 350°C. ‖ 200° to 300°C.

through which to communicate heat, a method which would have been scarcely practicable. In the mode of experiment just referred to, the only effect of the vacuum is, that the vapor rises as soon as formed. If air be present, the vapor will ultimately rise in the same quantity as if not subjected to pressure, and its elasticity, added to that of the air within, will depress the column of mercury; the amount of the depression being measured, and correction being made for the expansion of the air by heat, the tension of the vapor, at the temperature of observation, becomes known.

The apparatus which I used in determining the tension of mercurial vapor, consisted of a glass siphon tube, the longer leg of which was open, and the shorter terminated by a bulb. The shorter leg of the siphon, and about two thirds of the bulb, were filled with mercury, which rose to nearly the same level in the two legs; so that the air confined in the bulb was nearly of atmospheric density. When most expanded by heat, and with the additional elasticity of the mercurial vapor, the air hardly filled the whole of the bulb, and, therefore, never reached the leg. The surface of mercury, on which the air rested, was, therefore, that of a section of the bulb, and was always considerable; this arrangement insured the saturation of the space, above the mercury, with mercurial vapor, at the different temperatures. To the longer leg of the siphon a metallic scale was attached, the divisions being in twenty fifths (.04) of an inch.* By this scale the increase of tension of the air in the bulb, by heat, and by the tension of the mercurial vapor, was readily measured. To ascertain the bulk occupied by the air in the bulb, the apparatus was plunged into boiling water, at the temperature of which the tension of mercurial vapor is known not to be appreciable. From the rise of the mercury, as shown by the scale, and the law of expansion of air by heat, after correcting for the expansion of the mercury and for the pressure due to the difference of level of the mercury in the two legs, the number of divisions on the scale corresponding to the whole bulk of the air in the apparatus at a temperature of 32° F. was found.† This result was in accordance with the approximate estimate, obtained by measurement of the bulb and tube.

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* Millimetres.

† A further correction was necessary for the expansion of the glass, to render the result rigidly exact. The apparent expansion of air contained in glass is substituted for its real expansion throughout the inquiry.—*Trans.*

The air was, previous to this experiment, and to the introduction of the mercury, carefully dried, as well as the interior of the bulb and tube, by placing the apparatus under a receiver with quick lime; the mercury was then heated and introduced without allowing any communication between the tube and the exterior air. Without these precautions the vapor of water, mixing with the air and mercurial vapor, would have vitiated all the results.

To obtain the tension of mercurial vapor at temperatures above 212° F., the apparatus was placed in a vessel containing olive oil; the liquid covered the bulb, near which was placed a thermometer, graduated beyond 572° F.* The bath was now heated gradually, to this temperature, and the height of the mercury in the longer leg of the siphon, corresponding to different temperatures, noted at intervals. When the temperature of 572° F.† was attained, the apparatus was allowed to cool slowly, noting the heights of the mercury, corresponding to the temperatures recorded in the ascending series of observations. The errors produced by any difference in the temperature of the mercurial vapor and the bath were thus eliminated, by taking a mean of the observations corresponding to the same temperature, in the ascending and descending series.

In order to determine from these observations the height of the column of mercury corresponding to the increase of tension derived from the vapor of mercury in the bulb, it was necessary to correct for the expansion of the air under the pressure to which the rise of the mercury subjected it, and for the expansion of the mercury itself, in the longer leg of the siphon. The pressure, in addition to that of the atmosphere, to which the contents of the bulb were exposed, was the difference of level observed by the scale attached to the longer leg added to the depression in the bulb, which latter could be estimated with sufficient accuracy. This column was of course to be reduced to the length which it would have measured at 32° F.

In the memoir of which this is an extract, I give all the details of these corrections and calculations, as applied to the apparatus used, under the circumstances of the experiments; I propose giving in this place merely the resulting formula, by which the observations were reduced.

Call L the observed bulk of the air and vapor contained in the bulb, at any temperature, expressed in divisions of the scale attached

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* 300° C. † 300° C.

to the longer leg; this bulk is equal to the sum of the original bulk of the air, expressed in parts of the scale, and of the observed difference of level of the mercury, corrected for expansion. Further, let l be the bulk, in parts of the same scale, which the air, alone, would occupy, at the temperature and pressure of the experiment, according to the laws of Gay-Lussac and Mariotte. The difference, $L-l$, between these two columns, will be the bulk of vapor, expressed in parts of the same scale, at the temperature and pressure of the experiment. Let P represent the combined tensions of the air and mercurial vapor, at the temperature of observation, and T the tension of the mercurial vapor alone, then

$$L : L-l :: P : T, \text{ whence}$$

$$T = P\cdot\frac{L-l}{L} = P\left(1-\frac{l}{L}\right)$$

The quantities in the second member of this equation are all given by the observations, or by calculation. This formula supposes that the law of Mariotte applies to the vapor of mercury, as well as to air. This may not be true for temperatures and pressures near to the point at which the vapor is converted into a liquid; but we have no means of correcting the small errors which may be thus produced.

From the data furnished by my experiments, and by the method just stated, I determined the following numbers for the tensions of the vapor of mercury, for every eighteen degrees from 446° F. to 554° F.* The tensions are given in inches† of mercury at 32° F.

Temperatures,	446°,	464°,	482°,	500°,	518°,	536°,	554°F.
Corresponding tensions,	2.285,	3.152,	4.170,	5.263,	6.508,	8.177,	9.946.‡

The observation at 572° F.,§ the highest temperature to which the bath was carried, gave 12.187‖ inches for the tension; but this result having been obtained only from one observation, made while the temperature was rising, is not altogether comparable with the others which result from two observations, one in each series.

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* 230° and 290° C. † Millimetres.

‡ Temperatures, 230°, 240°, 250°, 260°, 270°, 280°, 290° C. Pressures, 58.01, 80.02, 105.88, 133.62, 165.22, 207.59, 252.51 millimetres. The numbers for the pressures have been reduced in the translation, at the rate of 39.39 inches to the metre.—*Trans.*

§ 300° C. ‖ 309.40 millimetres.

I observed, also, the tensions at temperatures below 446° F., but conceive that at those temperatures the tension is so small and the errors of observation so much increased, in reference to the tensions, that the results are not to be relied upon.

Having thus obtained, from experiment, the tensions of mercurial vapor, corresponding to a considerable range of temperature, I endeavored to represent the result by some empirical formula, by the aid of which I might obtain the approximate values of the tensions at other temperatures, between that at which the tension begins to be sensible, and that at which it is equivalent to the pressure of the atmosphere.

I tried first a formula which has been found to apply to the vapor of water, namely, $e=(1\pm at)^m$,* in which e represents the tension of the vapor, taking atmospheric pressure, or 29.94 inches of mercury as unity; t the corresponding temperature, in degrees of the thermometric scale, reckoned from the boiling point of the liquid, 100 degrees being taken as unity; a, a coëfficient, to be determined, as well as the exponent m, from experiment. This formula evidently satisfies the condition, that at the boiling point of the liquid the tension is equal to the pressure of the atmosphere, since for $t=0$, we have $e=1$, whatever may be the values of a and m.

Determining a and m, in the formula just given, by the tensions corresponding to the two extremes of temperature 446° and 554° F., taking for unity 100 degrees, I find $m=2.875$, $a=0.2527$,† so that the formula becomes $e=(1+0.2527t)^{2.875}$. A comparison of the tensions given by this formula, with those furnished by observation, shows that the formula may be considered as representing, very nearly, the law of the tensions in terms of the temperature.

There is an experiment which seems to show that this formula does not truly express the law of the tension of mercurial vapor; at all events, that it does not apply at tensions much lower than those within the range of the experiments.

We know that mercury emits, even at ordinary temperatures, a vapor which is recognized by its deleterious action on the animal economy, its chemical action on certain metals, &c.; and from the experiments of Faraday it appears that the limit to this evaporation

* This formula, as applied to the vapor of water, was printed erroneously in Vol. XIX, p. 182 of this Journal. It should have been, $e=(1+0.7153t)^5$.—*Trans.*

† For the Cent. thermometer $a=0.4548$, and the formula is $e=(1+0.4548t)^{2.875}$

is at or near the freezing point of water. It follows, that although the tension at such temperatures would be too small to be detected by the column of mercury supported by it, a formula representing, precisely, the law of tensions, would indicate the zero of tension somewhere about the limit of which we have just spoken. The formula $e=(1+0.2527t)^{2.875}$ does not satisfy this condition, for when $e=0$, $t=-\frac{1}{0.2527}$, $=-3.96$ or 284° F.* It is thus evident that the tensions decrease more rapidly, with the decrease of temperature, within the range of temperature embraced by my experiments, than would be shown by any expression which should also correspond to the observations of Faraday. It is easy to see that the errors of the formula would be increased, if the tensions were referred to the temperatures obtained by an air thermometer, corrected for the expansion of the glass, since my experiments refer to the common mercurial thermometer, which, at high temperatures, is in advance of the air thermometer.

It is by no means strange that this formula should fail to express the law of tensions, through the whole extent of 648° F., between the boiling point of mercury and the melting point of ice. It contains but two arbitrary constants, to be determined by observation, and, therefore, its use as an empirical formula is limited to a certain range of temperature. The agreement of a similar formula with observations on the tension of the vapor of water, would seem to be accidental.

I have for the reasons developed in the preceding remarks, endeavored to represent my results by another formula, into which as many arbitrary constants may be introduced, as are necessary to express the results of all observations. The formula, to which I refer was first used by Laplace, in the Mécanique Céleste, to represent the observations of Dalton on the tension of watery vapor: he found it necessary to use but two terms of the formula. Three terms were afterwards used by Biot, in his Traité de Physique, to express, more accurately, the law of tensions of the vapor of water, between 32° and 212° F. This formula, calling A, the tension at the boiling point, under atmospheric pressure; *e*, the tension corresponding to the temperature *t*, reckoned from the boiling point of the liquid, and

* $t=-\frac{1}{0.4548}=-2.2$, or 220° below the boiling point of mercury, that is, 140° C.

a, b, c, &c. coëfficients to be determined by experiment, is of the form, log. $e = \log. A + at + bt^2 + ct^3 + \&c.$

Taking the terms containing the first three powers of t to determine the value of log. e, I have deduced a formula for the tension of mercurial vapor, which gives results in accordance with the experiments of Faraday.

I assume as before, an atmosphere of 29.94 inches of mercury, as unity of tension, and 100° Fah. reckoned from the boiling point of mercury, as unity of temperature, t representing the number of these units; but in order to avoid the changes of sign for the different powers of t, I consider t positive *below* the boiling point of mercury. The formula just given, neglecting the terms containing powers of t above the third, and observing that log. 1=0, becomes, log. $e = at + bt^2 + ct^3$. The seven observations already given, between 446° F. and 554° F.* would furnish seven equations of this form, which combined by the method of least squares would give the most probable values of the coëfficients determined from all the experiments. I have not considered such a proceeding to be necessary, but have taken the two extreme observations, and an intermediate one, viz. that at 500° F.† to give three equations by which to determine the coëfficients. By the aid of logarithmic tables, I find $a = -0.35909$, $b = +0.023443$, $c = -0.03164$.‡ The formula, therefore, is, log. $e = -0.35909t + 0.023443\,t^2 - 0.03164t^3$.

The tensions calculated by this formula agree within one or two twenty fifths of an inch (.04 to .08 in.) of those observed; the differences being within the limits of errors of observation. The value of e given by this formula does not become zero at any temperature; neither does the formula show any minimum of tension, for the equation corresponding to that supposition would be $-0.35909 + 0.023443.2t - 0.03164.3t^2 = 0$, which has none but imaginary roots. The tensions according to this formula, should decrease with the diminution of temperature, and, become insensible, though never mathematically nothing. If, for example, we determine from the formula the tension of mercurial vapor at the melting point of ice, we find $e = 0.0000000011208$ atmospheres, or 0.0000000335 inches, a quantity altogether inappreciable. Faraday's observation that mercury is not vaporized at temperatures below 32° Fah. cannot be consider-

* 230° and 290° C. † 260° C.

‡ In the Centigrade thermometer, $a = -0.64637$, $b = +0.075956$, $c = -0.18452$.

ed as contradicting this result; for although the delicate methods employed by that chemist, enabled him to detect vapor at temperatures as low as 32°, it may readily be conceded, that below this the exceeding tenuity of the vapor might have caused it to escape his researches. But even if the limit determined by Faraday, be considered absolute, it may be attributed to a physical cause, entirely independent of the tension of the vapor, and by which the formation of vapor is suddenly checked.

The formula gives for the tension of mercurial vapor at 212° F. $e=0.00003889$ atm. $=0.001164$ inches, or less than twelve ten thousandths of an inch; an elasticity which may be considered as insensible in experiments on the elasticity of its vapor.

The formula, therefore, although empirical, not only represents the results of experiments between 446° F. and the boiling point of mercury, 680° F., but also the observations on its vapor at temperatures as low as the freezing point of water. It may be used, therefore, to calculate a table of tensions from the boiling point of water, up to that of mercury, the temperature being estimated by the mercurial thermometer. A table thus calculated will be found at the end of this extract, and may be considered as a condensed expression of the results of my experiments. It is probable that the estimation of these tensions may lead to the application of a correction in certain experiments, in which no correction has been used, owing to uncertainty as to its amount. This table can hardly be considered accurate beyond hundredths of an inch, although I have carried out the figures given by the formula.

In the table the temperatures are given in intervals of degrees, while in the formula, a range of a 100 degrees was taken as unity. The formula expressed for degrees of Fah. would be,* log. $e = -0.0035909t + 0.0000023443t^2 - 0.00000003164t^3$.

The degrees are reckoned from the boiling point of mercury, (680° F.;) that is, the value of t will be found by subtracting the given temperature from 680° F. One column of the table gives the tensions in atmospheres, and a second in inches of mercury. The numbers of the second column would be found from the formula, by adding to log. e, which it gives, the logarithm of 29.94. I may remark that from the elasticity of mercurial vapor, at different

* In the Centigrade scale, log. $e = -0.0064637\,t + 0.0000075956\,t^2 - 0.00000018452\,t^3$.

temperatures, its density compared with that of air at 32° and at a pressure of 29.94 inches may be found, if we know the ratio which the two densities bear to each other, at any determined temperature and pressure. For example, if we admit this ratio to be seven, as it was given by the experiments of Dumas, the density of the vapor of mercury at 212° F., the elasticity being according to the table .0012 in., will be almost 0.0002: that is, if the air were saturated with the vapor of mercury at 212° this vapor would have a density 0.0002 of that of air at 32° and under a pressure of 29.94 inches; and since 100 cubic inches of air weigh about 31 grains, there would be in a space of 100 cubic inches about .0062 of a grain of mercury. Similar calculations for ordinary atmospheric temperatures, may give an idea of the relative danger of an exposure to mercury, in cases when the space may become saturated with its vapor, at the assumed temperature.

The different forms of the expression for the elasticity of the vapor of mercury, refer to the temperatures as given by the mercurial thermometer; they may readily be changed into others which shall have reference to the air thermometer, corrected for the expansion of glass. To make these changes, the approximate relation between the temperatures shown by the two instruments, must first be expressed. This may be done by referring to the experiments of Dulong and Petit on the subject of the comparative indication of the two instruments. I find that if t denote the degrees of the mercurial thermometer, and τ those of the air thermometer, the relation, in degrees of Fahrenheit's scale, will be $t=0.9845079\tau+0.000063492\tau^2+0.4307312$,* or if the degrees be reckoned from the boiling point of mercury downwards $t=1.0685714\tau-0.00063492\tau^2$;† if each interval of one hundred degrees be considered as unity, this formula will become $t=1.0685714\tau-0.063492\tau^2$.‡ If, now, this value of t be substituted in the formula $\log. e=-0.35909t+0.023443t^2-0.03164t^3$ it becomes, neglecting the powers of τ higher than the third,§ $\log. e=-0.38372\tau+0.02905\tau^2-0.03893\tau^3$. From this formula a table might be constructed in which the temperatures would refer to the air thermometer.

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* For the Centigrade scale $t=0.9885714\tau+0.000114286\tau^2$.

† $t=1.0685714\tau-0.0001142856\tau^2$, for the Centigrade thermometer.

‡ $t=1.0685714\tau-0.01142856\tau^2$.

§ $\text{Log } e=-0.69069\tau+0.094117\tau^3-0.22700\tau^3$.

The law of the tension of the vapor of mercury may now be applied to test certain principles and theoretical formulæ which have been proposed to represent the elasticity of vapors in general, and which have been applied to the vapors of water and of some other liquids. If the principles of these formulæ should prove applicable to mercury, a liquid so different from water, they would receive a striking confirmation, and if not, their conformity with the law of elasticity in certain other liquids may be looked upon as entirely accidental.

First, it is evident that the elasticity of the vapor of mercury does not conform to the theory advanced by Dalton, that the tensions of the vapor of all liquids, at temperatures equally distant from their respective boiling points are equal. If this were true of the vapor of mercury, as compared with that of water, the tension at 500° F. or 180° below the boiling point ought to be about .2 of an inch, whereas according to my experiments it is about 5.3 inches. The inaccuracy of this theory had already been remarked in relation to liquids more volatile than water, and Dalton, himself, seems to have abandoned it. M. August, of Berlin, in Poggendorff's Annals of Philosophy and Chemistry, No. 5, 1828, and Professor Roche, of Toulon, in a memoir presented to the Academy of Sciences of Paris, during the same year, have both proposed formulæ to represent the law of the tensions of the vapor of water, based, at least in part, upon theoretical principles, and which, as I have shown in my memoir, although different in form are really identical. These formulæ are essentially of the following form, $\log. e = \frac{At}{B+t}$, in which e is the elasticity of the vapor, t the number of degrees from its boiling point, and A and B two constants to be determined by observation. Messrs. August and Roche propose to determine the constant B by considering that the tension must be nought at $-448°$ Fahr.,* which they regard as the absolute zero of temperature. Calling n the number of degrees from the boiling point of the liquid to this absolute zero, we have $e=0$ when $t=-n$, whence $\log. e = -A \cdot \frac{n}{B-n} = -\infty$, or $B-n=0$, and $B=n$. Substituting the value just found for B, the formula becomes $\log. e = A \cdot \frac{t}{n+t}$, and there remains only the constant A to be found by observation.

* $-266\frac{2}{3}$C.

The form of the expression just given, leaving out of consideration the determination made of B, is arbitrary; it has been found applicable to the tension of watery vapor, and M. Roche endeavors to derive it from an examination of the forces which may be supposed to act, in the vaporization of liquids. Without discussing the reasoning, I purpose to test this formula by my experiments on the vapor of mercury. The boiling point of this liquid being at 680° Fahr. $n=680+448=1128$.* My observation of the tension at 500° or 180° below the boiling point of mercury, or $t=-180°$, gives $A=3.976$ and the formula becomes† $\log. e=\frac{3.976t}{1128+t}$. If this formula were applicable to the observations, it should when thus deduced from the medium temperature, give very nearly the result obtained by observation for the two extremes, or 446° Fahr. and 554° Fahr.; for the first it gives $e=0.091$ atmospheres, and for the second, $e=0.316$ atmospheres. The coëfficient of this formula, therefore, when determined by an observation at a medium temperature, gives results which are too high at low temperatures, and too low towards the upper limit of the series; in other words the rate of increase of elasticity, for an increase of temperature, is less than that shown by my observations. The formula would vary still more from the truth if the air thermometer were referred to as a standard. The failure of this formula is unfavorable to the theoretical views of M. Roche, and it seems probable that the expression has no special advantage over other empirical formulæ which have a single constant to be deduced from experiment.

I have further shown in my memoir that the form of the function which I formerly supposed, from theoretical views, to express the laws of the tension of the vapor of water,‡ namely, $\log. e=a(\sqrt{t+b^2}-b,)$ in which e and t represent the same quantities as in the formula last given, and a and b are two constants, to be determined by experiment, does not apply to the tension of the vapor of mercury.

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* $n=360+266.67=626.67$, for the Centigrade scale.

† $\text{Log. } e=\frac{3.976t}{626.67+t}$.

‡ Pavia Philosophical Journal, 1819.

Table of the Elastic Force of the Vapor of Mercury for every eighteen degrees, from 212° F. to 680° F., the boiling point of Mercury.

Temperature by the Centigrade scale.	Temperature by Fahrenheit's scale.	Pressure in parts of an atmosphere of 29.94 inches of mercury at 32° F.	Pressure in inches.
100	212	0.00004	0.00119
110	230	0.00009	0.00269
120	248	0.00022	0.00658
130	266	0.00047	0.01407
140	284	0.00096	0.02874
150	302	0.00188	0.05628
160	320	0.00343	0.10269
170	338	0.00603	0.18054
180	356	0.01015	0.30389
190	374	0.01638	0.49042
200	392	0.02539	0.76017
210	410	0.03790	1.13473
220	428	0.05466	1.63652
230	446	0.07633	2.28532
240	464	0.10349	3.09849
250	482	0.13655	4.08830
260	500	0.17582	5.26405
270	518	0.22145	6.63022
280	536	0.27355	8.19009
290	554	0.33225	9.94756
300	572	0.39780	11.91013
310	590	0.47073	14.09365
320	608	0.55181	16.52119
330	626	0.64261	19.23974
340	644	0.74523	22.31217
350	662	0.86286	25.83402
360	680	1.00000	29.94000

Art. XI.—*On the application of the Fluxional Ratio to particular cases; and the coincidence of the several orders of Fluxions, with the binomial theorem; by* Elizur Wright, Esq.

The object of this essay is to develope more fully the nature of the fluxional ratio; and to apply it to particular cases. To do this it will be necessary to bring into view certain particulars, familiar probably to every one, who has paid any attention to the subject. When the method, used in algebra, of determining unknown quantities is extended, by considering the unknown quantity as capable of increase or decrease, that is, of taking all possible values, from 0 to x^n, it is called fluxions. If this principle be applied to quantities, in which the rate of increase is uniform in all its parts, no advantage is gained. But if it be applied to those, in which the rate is variable according to some given law, it affects quantities, which require an artful management, and involves problems, that are sometimes of very difficult solution. It may therefore be understood, that fluxions have respect to those quantities, which increase or decrease by degrees that are less than any assignable one; that is, in which the alteration of magnitude is produced by one continued increment or decrement, and in which the rate of increase is variable. The laws, by which the rate of increase is regulated, result from the various dimensions of the variable, and are intimately connected with the development of the binomial series. In the year 1772 La Grange in the Berlin Memoirs proposed to show, that the theory of the development of functions into series, contains the true principles of the Differential Calculus (Fluxions) independently of the consideration of infinitely small quantities; and he demonstrated by this theory the theorem of Taylor, which he regarded as the fundamental principle of the Calculus, and which had been demonstrated only by the help of the Calculus itself, or else by the consideration of infinitely little quantities. La Grange, in my opinion, has hit upon the true method of explaining the theory of fluxions. He doubtless gave a just view of the elements of a fluxion, when he said, that, in the development of a binomial, the fluxion is expressed by the second term of the series.* But notwithstanding all that La Grange has done, the

* Ryan's Dif. and Int. Calculus, Art. 19.

principles of fluxions have not yet been so completely disclosed, as to give entire satisfaction. That distinguished Mathematician, Carnot, supposed that something is lost, when a fluxion is introduced into an equation; and that the error in this defective equation is compensated by an error of equal magnitude, but opposite value, produced when the fluent is taken.* In an essay, contained in Vol. XIV of the Journal of Science, page 297, after mentioning some difficulties attending the metaphysics of fluxions, the Author goes on to say; "For an illustration of our remarks, suppse e be an increment of a uniformly varying quantity x: then $x+e$ will be the quantity varied by the increment. This variation will be uniform in all values of x, but the variation of the variables dependent on $x+e$, or what is denominated the functions of this new value of x, as $(x+e)^n$, will not be uniform; but may be easily investigated by the development of $(x+e)^n$. For greater simplicity suppose the function to be $(x+e)^2=x^2+2xe+e^2$, the increment, or variation of this from its first value, when it had no increment, is $2xe+ee$, which is to the uniform increment of x, as $2xe+ee : e$, or as $2x+e : 1$. Here the ratio of the increment of the function to its base, or root, is ascertained very readily by its algebraic development; and if this were truly its differential or fluxion, there would be no ground of questioning the legitimacy of the logic of this science; but the objection to it rests entirely on casting away the increment e from the expression $2x+e$ of the ratio of the whole increment of the function; since e must ever constitute a part of it, while it has any finite value. It may be said that the ratio $2x : 1$, or what is called the differential coëfficient, is independent of e, and has a real value, when e vanishes; which is true, but it is then at its limit, and the ratio is that of the *limit*, and not of the *increment*, consequently no new discovery is made by this mode of conception. If the second term of the development be assumed as the true differential, this will be a *petitio principii*. In short we perceive no logical principles in La Grange's analytical demonstrations, which are not common to the geometrical."

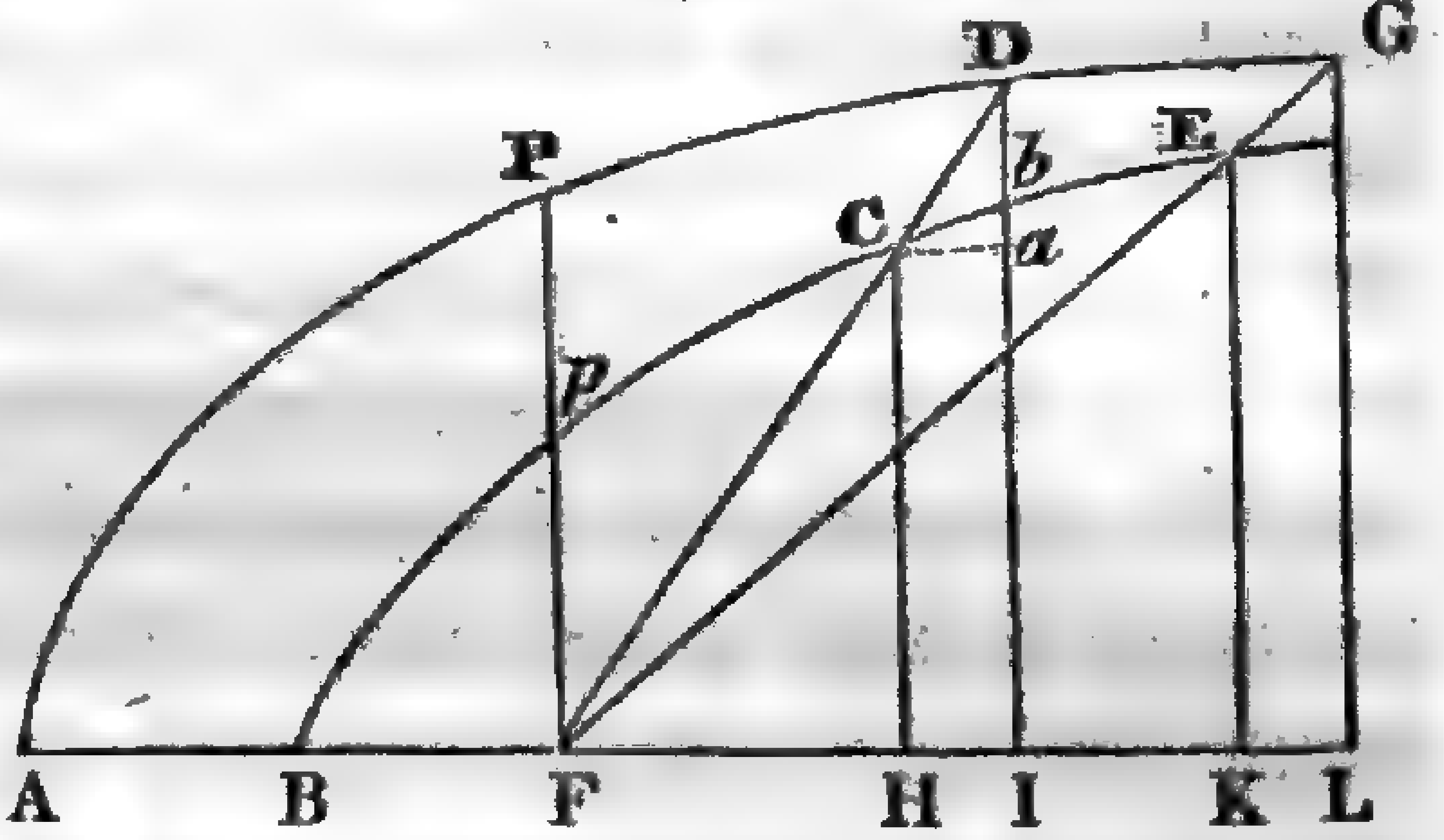
It is true that, when rightly understood, the principles in the analytical method of La Grange coincide with those in the geometrical method. The error lies, not in the contrariety of the methods, but in taking it for granted, that the ratio between two fluxions is that of *the increments;* for instance, that of *the increment* of a function which

* Tilloch's Phil. Mag. Vol. 8, Art. iv.

is *momently varying* to the *increment* of its base or root, which is considered as *uniform*. To render the results of any two flowing quantities analogous, their rates of increase must be similar. A quantity, therefore, generated by a uniform motion, cannot be compared with a quantity generated by an accelerated motion; for it would involve the same absurdity as to say, that a certain given *line* is three times greater than a certain given *cube*. Mathematicians were aware of this, but instead of taking the limits according to Sir Isaac Newton's view of the subject, they have taken the increments, for they say by way of objection: "but it is then at its limit, and the ratio is that of the limit, and not of the increment." Under the influence of this view, they have sought for an analogous term by making the increment small. Hence they have been deceived by contemplating a quantity, in which the error is less than the imagination can reach, and have dignified it with the name infinitesimal. Instead of laying hold of the finite quantity, they have sought for the increment, and have attempted to overtake it at the end of an infinite series!—a thing impossible. So far from its being correct that an error is committed by casting away the increment *e*, it is true, that if we introduce the quantity *e* at all, an error exists exactly proportional to the magnitude of *e*. The *petitio principii*, then, lies on the other side, for the ratio is not that of a whole to its part, but that of a whole to the sum of its sources of increase, which consists of the limits made analogous by combining them with the fluxional base. These sources of increase are dependent on the dimensions of the variable function, and in case of the first fluxions are expressed by the second term in the development of the binomial series. That this term is the *true fluxion*, and not a *petitio principii* is made evident, as will be shown hereafter, by the coincidence of the second term with the first fluxion, of the third term with the second fluxion, of the fourth term with the third fluxion, and so on, in expanding any power of a binomial quantity. Fluxions, therefore, are the elements, that arise in the development of a binomial quantity. We may, then, describe a fluxion to be an artificial finite quantity, arising from the sources of increase belonging to any power of a variable quantity; which sources are exhibited, when that quantity is expanded in the form of a binomial series. Quantities thus constituted may be analogous, and may admit of the existence of a ratio between them. The fundamental principle of fluxions is, that while the fluent is generated with an accelerated or retarded motion, and consequently the rate of increase is momently varying, ***the fluxion in all its parts is produced by a uniform motion.*** This may be regarded as a true definition of fluxions. In algebra the *fluxion* is expressed by a single term in the binomial $x+x'$ raised to the given power; while the *increment* is expressed by all the terms that remain, after the first is withdrawn. In as much as an abstruse principle is best elucidated by an example, let us suppose that $x+x'$ is the variable root, and this root raised to the fourth power, or $x^4+4x^3x'+6x^2x'^2+4xx'^3+x'^4$ is a function of $x+x'$. Now withdraw x^4, and the increment is expressed by all the remaining terms $4x^3x'+6x^2x'^2+4xx'^3+x'^4$. But the first fluxion is expressed by $4x^3x'$, the second term of the series, not because the following terms $6x^2x'^2+4xx'^3+x'^4$ are so exceedingly small as not to deserve notice, but because by the definition of a fluxion, just given, they do not enter into its expression. The doctrine of ultimate ratios and limits, applied to fluxions, is only a particular way of arriving at the second term of a binomial series, by which all the following terms are exterminated. The consideration of infinity, however, has spread over the theory a degree of obscurity and mystery, which is altogether unnecessary. For although the method of exhaustions, and of ultimate ratios, and the limits of variable quantities, are very useful in the solution of certain problems; yet they are not essential to the theory of fluxions. Without any scruples we may assume the second term in the binomial series, as containing all the elements, which are necessary to form a relation between the unknown quantity sought, and a known quantity, by means of which the value of that unknown quantity can be obtained.

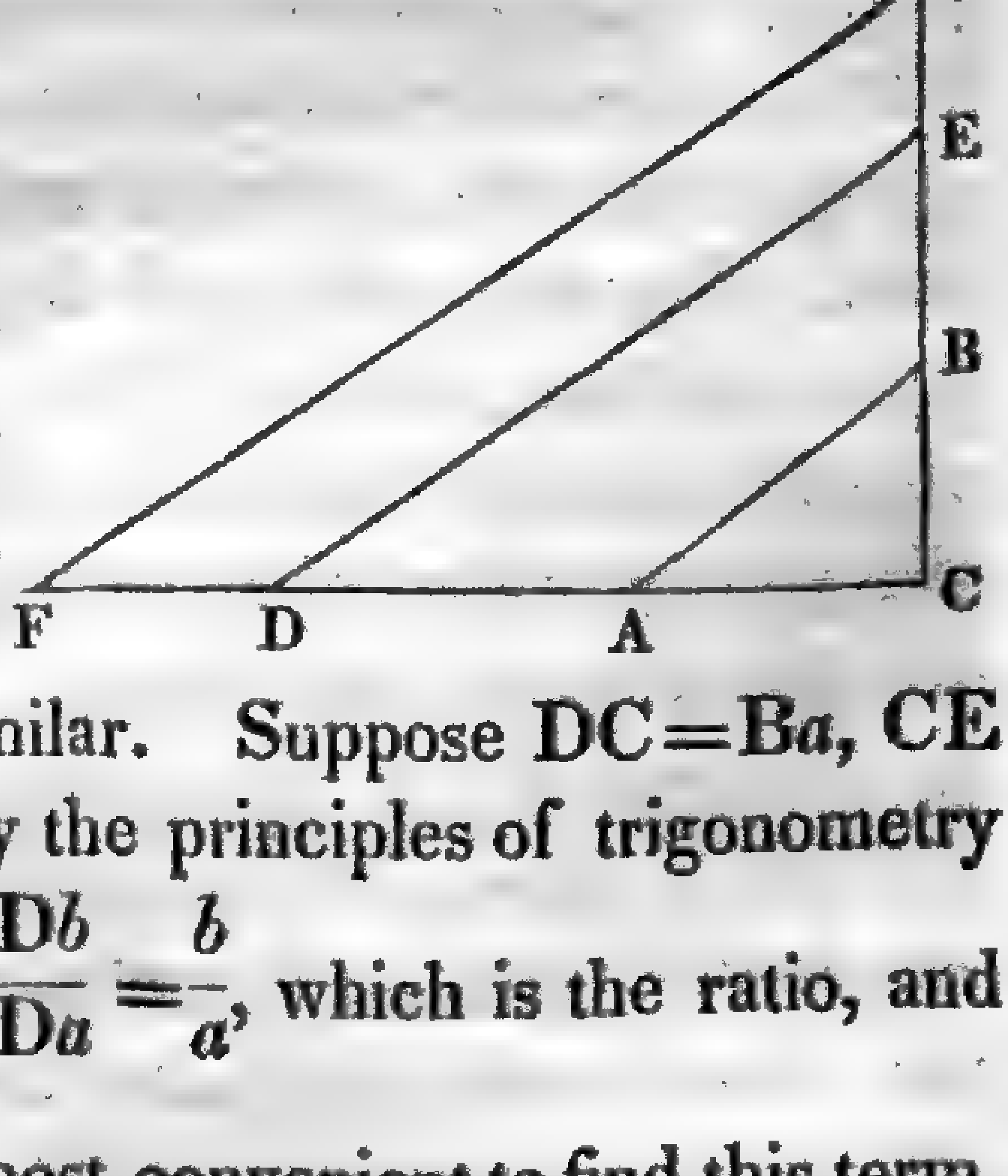
The foregoing remarks regard the determination of the fluxion itself. But the relation of the fluxion to its corresponding fluent is quite a different thing. Since this, in my apprehension, depends on a similar principle with the relation of the sides of two similar triangles to each other in trigonometry, it may perhaps receive some elucidation from a comparison. A ratio is the quotient of any number or quantity divided by another, and is either that of the antecedent divided by its consequent, or that of the consequent divided by its antecedent. When the ratio between any two quantities is equal to the ratio between any other two quantities, those four quantities are said to be analogous or proportional; and the two figures, which are compared, are said to be similar. When three of these proportional quantities are given; or when two are given, and one of them is the ratio, the fourth may be found. Figures are similar, when they may be supposed to be placed in such a manner, that any right line being drawn from a determined point to the terms that bound them, *the parts of the right line intercepted betwixt that point and those terms, are always in one constant ratio to each other;* and when, if all the parts, which the nature of the case admits of, are made to coincide, *all their homologous lines, that are rectilineal, either lie one upon another, or are parallel.** This similarity may be exemplified in the Parabola. Let BpCE, APDG, (Fig. 1.) be two parabolas, that are similar. By the definition, if the foci are both placed at F, and the parameters Fp, FP, are made to coincide, and any right lines FD, FG are drawn from the point F to the terms C, E, and D, G, that bound them; then the lines FC, FD, and FE, FG, are in the invariable ratio of Fp : FP, that is FC : FD : : FE : FG : : Fp : FP, and FC : FD : : HC : ID, and FE : FG : : KE : LG. Here the lines FC, FE lie upon the lines FD, FG; and although the curved lines BpCE, APDG are not parallel, but continually approximate toward each other, yet the homologous right lines HC, ID; KE, LG, are parallel.

Fig. 1.



In trigonometry, let AC$=a$ (Fig. 2.) be the base, and CB$=b$ be the perpendicular of a right angled triangle, taken from a table of sines, tangents, and secants. Also let DC be the base, and CE be the perpendicular of a second triangle; FC the base, and CG the perpendicular of a third triangle; and suppose they are all similar. Suppose DC$=$Ba, CE $=$Bb, FC$=$Da, and CG$=$Db. By the principles of trigonometry Ba : Bb : : Da : Db. Hence $\frac{Bb}{Ba}=\frac{Db}{Da}=\frac{b}{a}$, which is the ratio, and $\frac{BDab}{Ba}=Db$ the fourth term. It is most convenient to find this term,

Fig. 2.



* Maclaurin's Flux. Vol. I. Art. 122.

by multiplying the second and third terms together, and dividing the product by the first term according to the rule of proportion in common arithmetic. But it will lead to the same result, if we multiply the third term Da by the ratio $\frac{b}{a}$. Here a relation manifestly exists between the quantities Ba, Bb, and the quantities Da, Db, which is that of proportion.

Mathematicians, in explaining the nature of fluxions, have proceeded on the tacit acknowledgment, that a circle is a polygon of an infinite number of sides, (Brewster's Encyclopædia, Art. Fluxions) and have considered a fluxion to be an elementary part of its fluent. But, if we proceed ever so far in making the fluxion small, since it is a rectilineal quantity, a part, Cba (Fig. 1.) being the difference between the increment CHIb, and the corresponding fluxion CHIa, will still be left behind. In theory, therefore, something is lost. The rejection of this part renders the theory imperfect, and unsatisfactory, and creates a suspicion, that it may lead to some error. But in the application of the method no such error is ever found. This practical correctness depends on the fact, that fluxions are not the elementary parts of their fluents, but merely *proportional quantities.* Let the lines EF, FG, (Fig. 3.) commence an existence at the corner C, and proceed with a uniform motion generating the square ABDC. Now it is manifest, that, since the generating lines EF, FG are continually increasing, the superficies EFGC increases in a ratio, which is momently varying. Suppose that the lines MN, NO, (Fig. 4.) moving with a uniform velocity, generate the square HILK in the same time, that the lines EF, EG, generate the square ABDC. We have now the two fluents ABDC and HILK. Now if these fluents are produced by the lines AC (Fig. 3.) and HK, (Fig. 4.) moving with such velocity, that the area generated by AC is always equal to the area generated by EF, FG, and the area generated by HK is always equal to the area generated by MN, NO, it is evident that AC and HK must move with a velocity, which is accelerated. Hence ABDC and HILK may be considered as

Fig. 3.

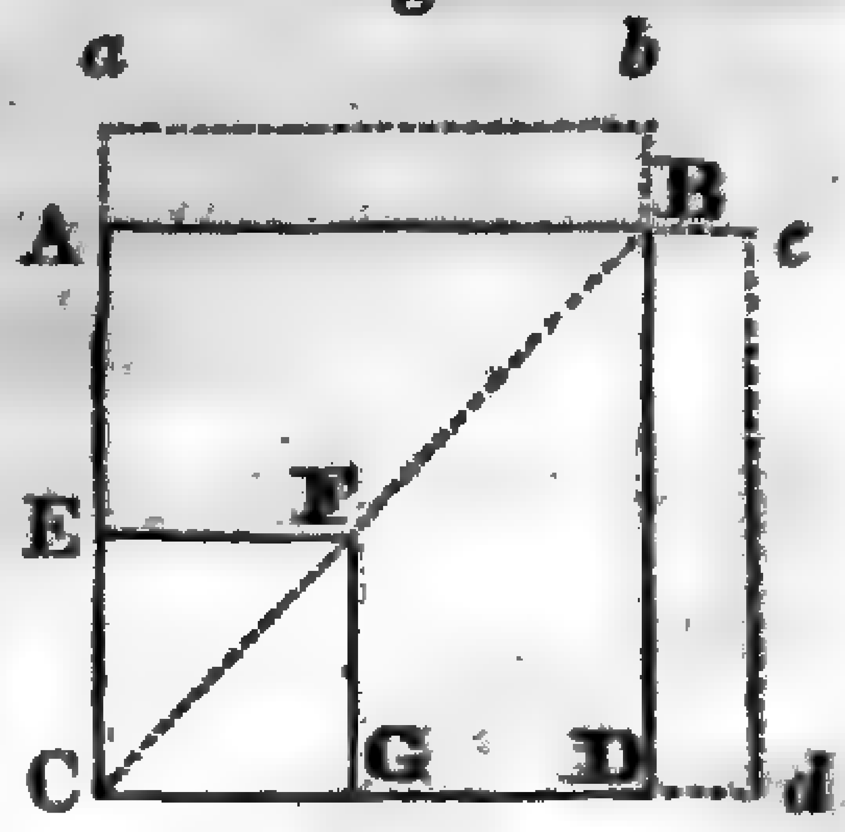
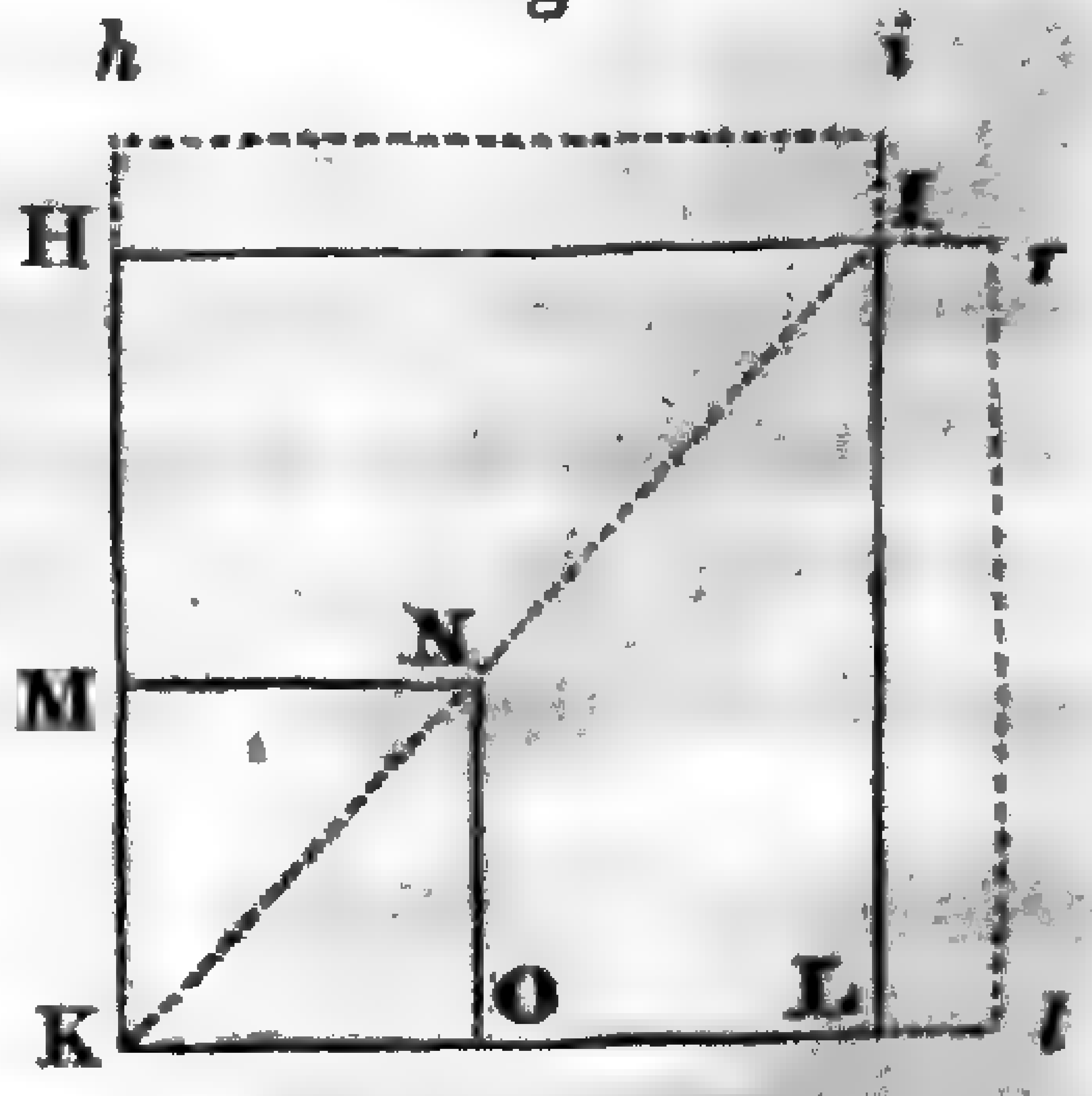


Fig. 4.



being produced by lines moving with an accelerated velocity. Again let the lines EF, FG and MN, NO, become invariable at the moment when they arrive at the situations AB, BD, and HI, IL. Proceeding with the same uniform velocity, which they before had, they will then generate the quantities AB*ba*, BD*dc*, and HI*ih*, IL*lr*, whose increase is uniform, because equal areas are generated in equal times. The quantities AB*ba*+BD*dc*, and HI*ih*+IL*lr* are the fluxions corresponding to ABDC, and HILK. From the manner in which these quantities are produced, it results that,

$$\text{AB}ba+\text{BD}dc : \text{ABDC} :: \text{HI}ih+\text{IL}lr : \text{HILK}.$$

We have now obtained the proportion between quantities generated by an accelerated velocity, and quantities generated by a uniform velocity, disclosing the relation between fluxions and their fluents.

This illustration may be rendered more general by assuming a principle, which bears a very near resemblance to motion. It is this. A variable quantity of any kind may be generated *by assuming, successively, and in a regular gradation, every possible value from* 0 *to* x^n. This will embrace the whole range of fluxional quantities. Let AB=AC be represented by Bx and HI=HK be represented by Dx, then,

$$2\text{B}^2x\dot{x} : \text{B}^2x^2 :: 2\text{D}^2x\dot{x} : \text{D}^2x^2.$$

If we take cubes, the proportion will be,

$$3\text{B}^3x^2\dot{x} : \text{B}^3x^3 :: 3\text{D}^3x^2\dot{x} : \text{D}^3x^3.$$

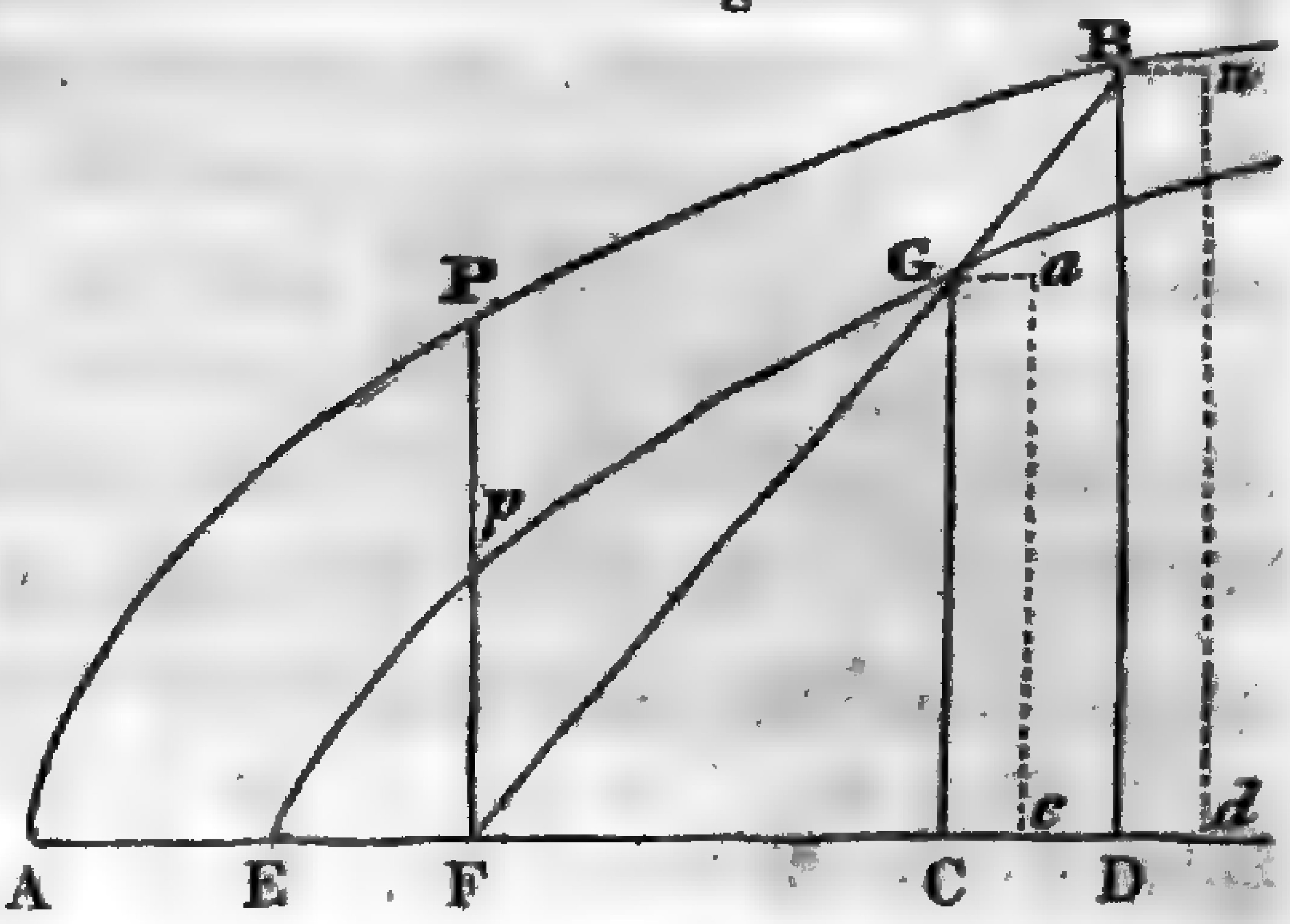
and generally,

$$n\text{B}^nx^{n-1}\dot{x} : \text{B}^nx^n :: n\text{D}^nx^{n-1}\dot{x} : \text{D}^nx^n.$$

hence $\frac{n\text{B}^nx^{n-1}\dot{x}}{\text{B}^nx^n}=\frac{n\text{D}^nx^{n-1}\dot{x}}{\text{D}^nx^n}=\frac{n\dot{x}}{x}$ the general formula of the fluxional ratio; hence $\text{D}^nx^n\times\frac{n\dot{x}}{x}=n\text{D}^nx^{n-1}\dot{x}$ is the general equation, by which the fluxion is derived from the fluent.

In this ratio, n represents the exponent of the power, and is obtained by adding 1 to the exponent of the variable part of the fluxional expression; x represents the root of the given power, and $\dot{x}$ represents the fluxion of that root. The existence of this ratio results from the peculiar nature of algebra. The fluxion $n\text{B}^nx^{n-1}\dot{x}$ consists of the fluent B^nx^n combined with the ratio $\frac{n\dot{x}}{x}$. In geometry, these two elements are blended together, and are expressed by the parallelogram G*ac*C. (Fig. 3.) But in algebra the ratio is preserved distinct during the process, and therefore, since $n\text{B}^nx^{n-1}\dot{x}$ is equivalent to $B^n x^n \times \frac{n\dot{x}}{x}$, the fluxion may be resolved into its constituent parts. Let APBD, EpGC, be two similar parabolas, the parameter PF$=a$, the parameter pF$=b$, the abscissa EC$=x$, the abscissa AD$=mx$, then the ordinate CG$=b^{\frac{1}{2}}x^{\frac{1}{2}}$, and the ordinate DB$=a^{\frac{1}{2}}m^{\frac{1}{2}}x^{\frac{1}{2}}$, the fluxional base C$c=\dot{x}$, the fluxional base D$d=m\dot{x}$.

Fig. 3.



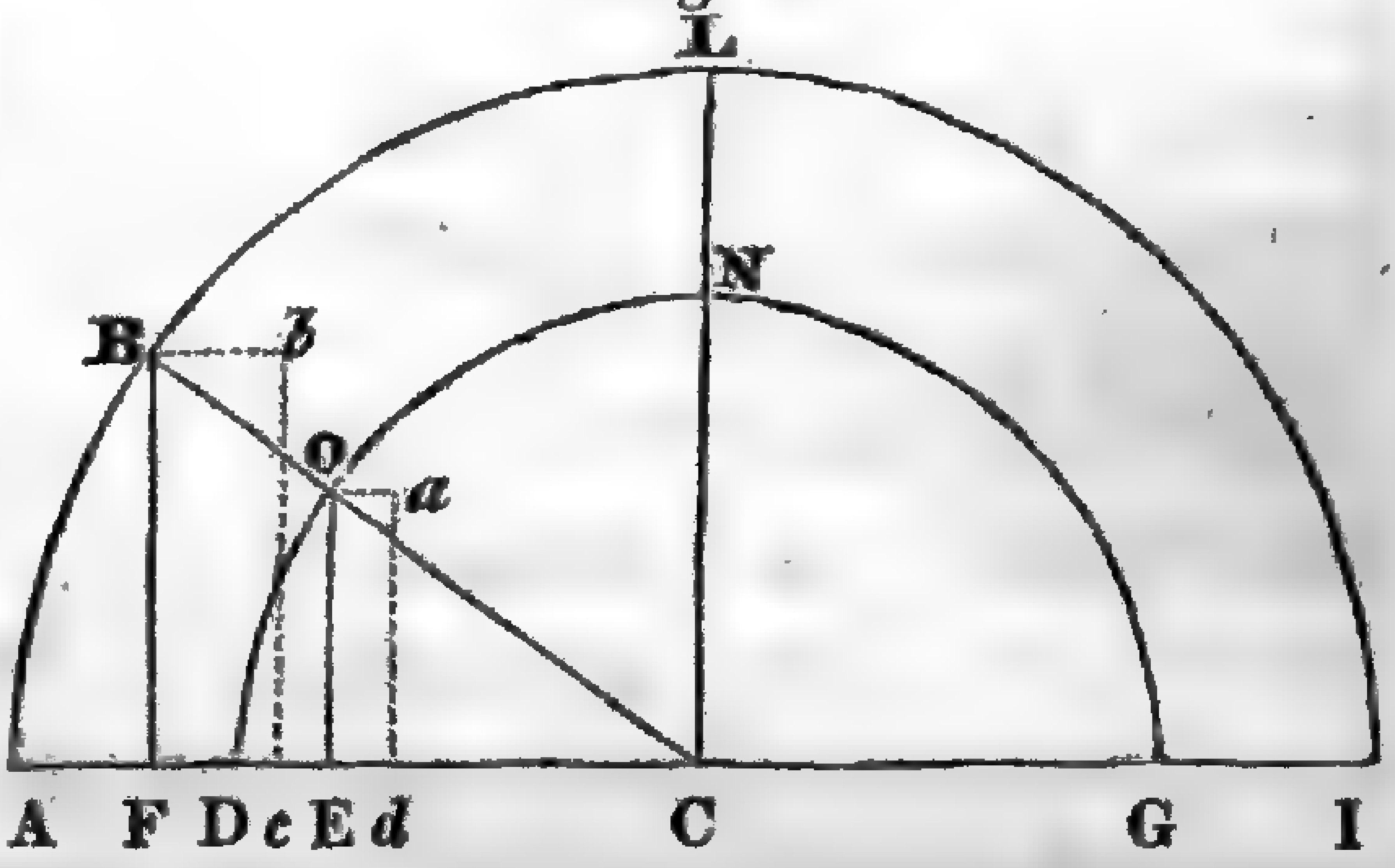
Since $\dot{x}$ and $m\dot{x}$ are supposed to be generated contemporaneously, and the ratio depends upon their relative, and not upon their absolute magnitude, we may assign to $\dot{x}$ any magnitude at pleasure. Conceive the two parabolas to be generated by the lines CG, DB moving uniformly from the points A, E, toward c, d. The parabolic spaces EGC, ABD increase with an accelerated motion, but the increments are continually diminishing, and the motion approximates toward a uniform motion. Suppose the two fluents to be taken when the generating lines arrive at the points C, D. By the definition of a fluxion before given, the increments are annihilated at the moment the generating lines arrive at C, D, and the parabolic spaces are left to increase uniformly. Hence the fluxions are represented by the rectilineal parallelograms BndD$=a^{\frac{1}{2}}m^{\frac{1}{2}}x^{\frac{1}{2}}\dot{x}$, and G$ac$C$=b^{\frac{1}{2}}x^{\frac{1}{2}}\dot{x}$. Then according to the foregoing proposition,

$$a^{\frac{1}{2}}m^{\frac{1}{2}}x^{\frac{1}{2}}\dot{x} : \text{APBD} :: b^{\frac{1}{2}}x^{\frac{1}{2}}\dot{x} : \text{E}p\text{GC}.$$

Here, although an expression for the first and third terms are obtained, yet the second term is not given, hence the fourth term cannot be obtained by the common rule, as is the case in trigonometry. But the ratio of the second term to the first can be had. As in trigonometry the ratio is $\frac{b}{a}$, so in fluxions, the general formula of the ratio is $\frac{x}{n\dot{x}}$. The great advantage of this ratio consists in this, that by multiplying the third term in the proportion by it, we arrive at the same result as by multiplying the second term by the third, and dividing the product by the first term. Now, in this example, the third term is the fluxion $b^{\frac{1}{2}}x^{\frac{1}{2}}\dot{x}$, and the ratio is $\frac{x}{n\dot{x}}=\frac{x}{\frac{3}{2}\dot{x}}$, hence $b^{\frac{1}{2}}x^{\frac{1}{2}}\dot{x}\times\frac{x}{\frac{3}{2}\dot{x}}=\frac{2b^{\frac{1}{2}}x^{\frac{3}{2}}}{3}=$ EpGC, the area of the parabola.

In the circles ALH, DNG, (Fig. 4.) let the diameter AH$=m$, the diameter DG$=a$, DE$=x$, AF$=\frac{mx}{a}$, the fluxional base E$d=\dot{x}$, the fluxional base F$c=\frac{m\dot{x}}{a}$, EO$=(ax-xx)^{\frac{1}{2}}$,

Fig. 4.



FB$=\frac{m}{a}(ax-xx)^{\frac{1}{2}}$, then the fluxion O$ad$E$=(ax-xx)^{\frac{1}{2}}\dot{x}$, and the fluxion B$bc$F$=\frac{m^2}{a^2}(ax=xx)^{\frac{1}{2}}\dot{x}$. It has just been stated, that the fluxion multiplied by the ratio will give the correspondent fluent sought. But the analysis requires some fluent, out of which the given fluxion has arisen, which by a contrary process is again made to appear. To this end it is necessary, that the ratio $\frac{n\dot{x}}{x}$ should be contained in the fluxional quantity, that the quantities represented by it may be eliminated by the multiplication of its reciprocal. But there is no quantity, which will produce $(ax-xx)^{\frac{1}{2}}\dot{x}$ for its fluxion; hence the ratio $\frac{n\dot{x}}{x}$ is not contained in it, and its fluent under its present form cannot be found. We are, therefore, under the necessity of transforming it into an infinite series. It will then be

$$(ax-xx)^{\frac{1}{2}}\dot{x}=a^{\frac{1}{2}}x^{\frac{1}{2}}\dot{x}-\frac{x^{\frac{3}{2}}\dot{x}}{2a^{\frac{1}{2}}}-\frac{x^{\frac{5}{2}}\dot{x}}{8a^{\frac{3}{2}}}-\frac{x^{\frac{7}{2}}\dot{x}}{16a^{\frac{5}{2}}}-\frac{5x^{\frac{9}{2}}\dot{x}}{128a^{\frac{7}{2}}}-\text{\&c.}$$

It is manifest, that this series presents as many distinct problems, requring different modifications of the ratio $\frac{x}{n\dot{x}}$, as there are terms. For the first term, $\frac{x}{n\dot{x}}=\frac{x}{\frac{3}{2}\dot{x}}$; for the second term, $\frac{x}{n\dot{x}}=\frac{x}{\frac{5}{2}\dot{x}}$; for the third term, $\frac{x}{n\dot{x}}=\frac{x}{\frac{7}{2}\dot{x}}$, &c. If the several terms are multiplied by their respective ratios, the series will become $\frac{2a^{\frac{1}{2}}x^{\frac{3}{2}}}{3} - \frac{x^{\frac{5}{2}}}{5a^{\frac{1}{2}}} - \frac{x^{\frac{7}{2}}}{28a^{\frac{3}{2}}} - \frac{x^{\frac{9}{2}}}{72a^{\frac{5}{2}}} - \frac{5x^{\frac{11}{2}}}{704a^{\frac{7}{2}}} -$ &c. Let the terms which compose the fluent ABF be represented by A, B, C, D, &c.

then BbcF : A : : O*ad*E : $\frac{2a^{\frac{1}{2}}x^{\frac{3}{2}}}{3}$

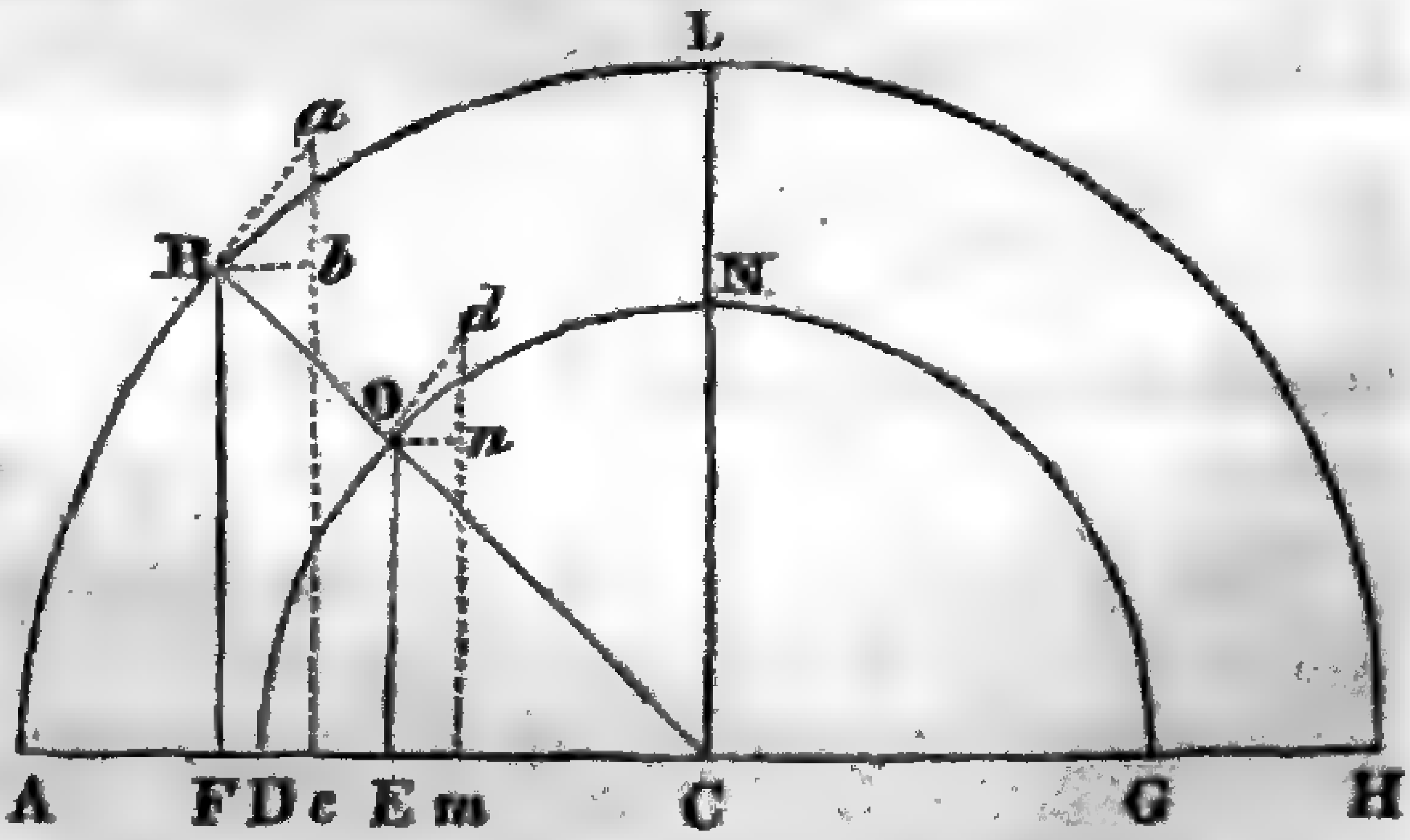
BbcF : −B : : O*ad*E : . . . $-\frac{x^{\frac{5}{2}}}{5a^{\frac{1}{2}}}$

BbcF : −C : : O*ad*E : . . . . . . $-\frac{x^{\frac{7}{2}}}{28a^{\frac{3}{2}}}$

BbcF : −D : : O*ad*E : . . . . $-\frac{x^{\frac{9}{2}}}{72a^{\frac{5}{2}}}$

hence (E.12.5.) BbcF : A − B − C − D : : O*ad*E : $2a^{\frac{1}{2}}x^{\frac{3}{2}} - \frac{x^{\frac{5}{2}}}{5a^{\frac{1}{2}}} - \frac{x^{\frac{7}{2}}}{28a^{\frac{3}{2}}} - \frac{x^{\frac{9}{2}}}{72a^{\frac{5}{2}}} -$ &c. = DOE.

Fig. 5.



If it is required to find the length of the arc DO, (Fig. 5.) called the rectification of the curve, let CO be represented by a, DE by x, EO by y, and the arc DO by z. While the point generating the line DE is supposed to move with a uniform motion, the points which generate the line EO and the arc DO move with a retarded motion; but at the instant in which they arrive at O, the decrements cease to exist, and the generating points are left to proceed on with a uniform motion. A necessary consequence of this change is, that a right lined triangle O*nd* is generated, in which O*n* represents the fluxion of x, *nd* the fluxion of y, and O*d*, which is the tangent of the circle, represents the fluxion of the arc z. CE : CO : : nd : Od : : $(a^2-y^2)^{\frac{1}{2}}$: a : : $\dot{y} : \dot{z} = \dfrac{a\dot{y}}{(a^2-y^2)^{\frac{1}{2}}} = (a^2-y^2)^{-\frac{1}{2}}a\dot{y} = \left(\dfrac{1}{a}+\dfrac{y^2}{2a^3}+\dfrac{3y^4}{8a^5}+\dfrac{5y^6}{16a^7}+\dfrac{35y^8}{128a^9}+\dfrac{63y^{10}}{256a^{11}}+\dfrac{231y^{12}}{1024a^{13}}+\dfrac{429y^{14}}{2048a^{15}}+\&c.\right)a\dot{y} = \dot{y}+\dfrac{y^2\dot{y}}{2a^2}+\dfrac{3y^4\dot{y}}{8a^4}+\dfrac{5y^6\dot{y}}{16a^6}+\dfrac{35y^8\dot{y}}{128a^8}+\dfrac{63y^{10}\dot{y}}{256a^{10}}+\dfrac{231y^{12}\dot{y}}{1024a^{12}}+\dfrac{429y^{14}\dot{y}}{2048a^{14}}+\&c.$

Now $\dot{y}\times$ratio $\dfrac{y}{\dot{y}}=y$; $\dfrac{y^2\dot{y}}{2a^2}\times$ratio $\dfrac{y}{3\dot{y}}=\dfrac{y^3}{6a^2}$; $\dfrac{3y^4\dot{y}}{8a^4}\times$ratio $\dfrac{y}{5\dot{y}}=\dfrac{3y^5}{40a^4}$; $\dfrac{5y^6\dot{y}}{16a^6}\times$ratio $\dfrac{y}{7\dot{y}}=\dfrac{5y^7}{112a^6}$; $\dfrac{35y^8\dot{y}}{128a^8}\times$ratio $\dfrac{y}{9\dot{y}}=\dfrac{35y^9}{1152a^8}$; &c.

Let the several terms of the fluent AB be represented by A, B, C, D, &c.

then Ba : A : : Od : y

Ba : B : : Od : . . $\dfrac{y^3}{6a^2}$

Ba : C : : Od : . . . . $\dfrac{3y^5}{40a^4}$

Ba : D : : Od : . . . . $\dfrac{5y^7}{112a^6}$

Ba : A+B+C+&c. : : Od : . . . . $y+\dfrac{y^3}{6a^2}+\dfrac{3y^5}{40a^4}+\dfrac{5y^7}{112a^6}+\dfrac{35y^9}{1152a^8}+\dfrac{63y^{11}}{2816a^{10}}+\dfrac{231y^{13}}{13312a^{12}}+\dfrac{429y^{15}}{30720a^{14}}+\&c.=$ arc DO. When $a=1$, and DO = arc of 30°, then the series becomes DO $=(.5)^1+\frac{1}{6}(.5)^3+\frac{3}{40}(.5)^5+\frac{5}{112}(.5)^7+\frac{35}{1152}(.5)^9+\&c.=.5235985$ which is equal to the arc of 30° when the diameter is 2; therefore the diameter of a circle is to the periphery as 1 : 3.14159+.

The general equation for the fluxion of any power is $D^nx^n\times\dfrac{n\dot{x}}{x}=nDx^{n-1}\dot{x}$, which will be applied in a few examples.

I. To find the fluxion of $(xx)^8$, which is termed the direct method of fluxions. In this example $D^nx^n=(xx)^8$, and in the ratio $\dfrac{n\dot{x}}{x}$, n represents the exponent 8, $\dot{x}$ represents $2x\dot{x}$, the fluxion of the root, and x represents xx, the root of the given power; hence $\dfrac{n\dot{x}}{x}$ answers to $\dfrac{8\times2x\dot{x}}{xx}$; therefore $D^nx^n\times\dfrac{n\dot{x}}{x}=(xx)^8\times\dfrac{8\times2x\dot{x}}{xx}=16x^{15}\dot{x}$.

II. To find the fluxion of $(x^2+x^3)^4$; in this example $D^n x^n = (x^2+x^3)^4$, and $\frac{nx^{\cdot}}{x} = \frac{4(2xx^{\cdot}+3x^2x^{\cdot})}{x^2+x^3}$; hence $D^n x^n \times \frac{nx^{\cdot}}{x} = (x^2+x^3)^4 \times \frac{4(2xx^{\cdot}+3x^2x^{\cdot})}{x^2+x^3} = 4(x^2+x^3)^3 \times (2xx^{\cdot}+3x^2x^{\cdot})$.

III. To find the fluxion of $(ax-xx)^{\frac{1}{2}}$; here $D^n x^n = (ax-xx)^{\frac{1}{2}}$, and $\frac{nx^{\cdot}}{x} = \frac{\frac{1}{2}(ax^{\cdot}-2xx^{\cdot})}{ax-xx}$, hence $D^n x^n \times \frac{nx^{\cdot}}{x} = (ax-xx)^{\frac{1}{2}} \times \frac{\frac{1}{2}(ax^{\cdot}-2xx^{\cdot})}{ax-xx} = \frac{ax^{\cdot}-2xx^{\cdot}}{2(ax-xx)^{\frac{1}{2}}}$.

IV. To find the fluxion of $\frac{a}{(a^2-y^2)^{\frac{1}{2}}} = a(a^2-y^2)^{-\frac{1}{2}}$; here $D^n x^n = a(a^2-y^2)^{-\frac{1}{2}}$ and $\frac{nx^{\cdot}}{x} = \frac{-\frac{1}{2}\times-2yy^{\cdot}}{a^2-y^2}$, hence $D^n x^n \times \frac{nx^{\cdot}}{x} = a(a^2-y^2)^{-\frac{1}{2}} \times \frac{-\frac{1}{2}\times-2yy^{\cdot}}{a^2-y^2} = \frac{ayy^{\cdot}}{(a^2-y^2)^{\frac{3}{2}}}$.

The fluxion of $\frac{a}{(a^3-y^5)^{\frac{1}{2}}}$ is $a(a^3-y^5)^{-\frac{1}{2}} \times$ ratio $\frac{-\frac{1}{2}\times-5y^4y^{\cdot}}{a^3-y^5} = \frac{5ay^4y^{\cdot}}{2(a^3-y^5)^{\frac{3}{2}}}$.

The fluxion of $\frac{1}{x}$ is $x^{-1} \times$ ratio $-\frac{1\times x^{\cdot}}{x} = -\frac{x^{\cdot}}{x^2}$.

The fluxion of $\frac{1}{ax^3}$ is $\frac{1}{ax^{-3}} \times$ ratio $-\frac{3x^{\cdot}}{x} = -\frac{3x^{\cdot}}{ax^4}$.

The fluxion of $\frac{2}{3}(ax-a^2)^{\frac{3}{2}}$ is $\frac{2}{3}(ax-a^2)^{\frac{3}{2}} \times$ ratio $\frac{\frac{3}{2}ax^{\cdot}}{ax-a^2} = a(ax-a^2)^{\frac{1}{2}}x^{\cdot}$.

The fluxion of $\frac{1}{n+1}(x^m+a^2)^{n+1}$ is $\frac{1}{n+1}(x^m+a^2)^{n+1} \times$ ratio $\frac{(n+1)mx^{m-1}x^{\cdot}}{x^m+a^2} = (x^m+a^2)^n \times mx^{m-1}x^{\cdot}$.

The fluxion of $\frac{(a^m+z^m)^{n+1}}{m(n+1)}$ is $\frac{(a^m+z^m)^{n+1}}{m(n+1)} \times$ ratio $\frac{(n+1)mz^{m-1}z^{\cdot}}{a^m+z^m} = (a^m+z^m)^n \times z^{m-1}z^{\cdot}$.

When the fluent is the product of two or more flowing quantities, as xyz, the fluxion of each is to be taken *seriatim*, the other remaining quantities being considered as a coëfficient; then the several quantities thus arising will be the fluxion sought.

Ex. to find the fluxion of xyz. Taking x, the ratio is $\frac{nx^{\cdot}}{x}=\frac{x^{\cdot}}{x}$, and $x\times\frac{x^{\cdot}}{x}=x^{\cdot}$, which is the fluxion of x; hence $yzx^{\cdot}$ is one part of the fluxion. Taking y, the ratio is $\frac{nx^{\cdot}}{x}=\frac{y^{\cdot}}{y}$, and $y\times\frac{y^{\cdot}}{y}=y^{\cdot}$, the fluxion of y; hence $xzy^{\cdot}$ is another part of the fluxion. Taking z, the ratio is $\frac{nx^{\cdot}}{x}=\frac{z^{\cdot}}{z}$, and $z\times\frac{z^{\cdot}}{z}=z^{\cdot}$, the fluxion of z; hence $xyz^{\cdot}$ is another part. Therefore, $yzx^{\cdot}+xzy^{\cdot}+xyz^{\cdot}$ is the whole fluxion of xyz.

Ex. to find the fluxion of x^3y^5. The quantity $x^3\times$ the ratio $\frac{3x^{\cdot}}{x}=3x^2x^{\cdot}$, the fluxion of x^3; and the quantity $y^5\times$ the ratio $\frac{5y^{\cdot}}{y}=5y^4y$, the fluxion of y^5. Hence $3y^5x^2x^{\cdot}+5x^3y^4y^{\cdot}$ is the fluxion of x^3y^5.

To find the fluxion of the fraction $\frac{x}{y}=xy^{-1}$. Taking x, the ratio is $\frac{nx^{\cdot}}{x}=\frac{x^{\cdot}}{x}$, and $x\times\frac{x^{\cdot}}{x}=x^{\cdot}$, the fluxion of x; hence $y^{-1}x^{\cdot}=\frac{x^{\cdot}}{y}$ is one part of the fluxion. Taking y^{-1}, the ratio is $\frac{nx^{\cdot}}{x}=-\frac{y^{\cdot}}{y}$, and $y^{-1}\times -\frac{y^{\cdot}}{y}=-y^{-2}y^{\cdot}=-\frac{y^{\cdot}}{y^2}$, the fluxion of y^{-1}; hence $-\frac{xy^{\cdot}}{y^2}$ is the other part of the fluxion; therefore $\frac{x^{\cdot}}{y}-\frac{xy^{\cdot}}{y^2}=\frac{yx^{\cdot}-xy^{\cdot}}{y^2}$ is the fluxion of the fraction $\frac{x}{y}$.

To find the fluxion of the fraction $\frac{x^3}{y^3}=x^2y^{-3}$. Taking x^2 the ratio is $\frac{nx^{\cdot}}{x}=\frac{2x^{\cdot}}{x}$, and $x^2\times\frac{2x^{\cdot}}{x}=2xx^{\cdot}$ the fluxion of x^2; hence $2y^{-3}xx^{\cdot}$ is one part of the fluxion. Taking y^{-3} the ratio is $\frac{nx^{\cdot}}{x}=-\frac{3y^{\cdot}}{y}$, and $y^{-3}\times-\frac{3y^{\cdot}}{y}=-3y^{-4}y^{\cdot}$ the fluxion of y^{-3}, hence $-3x^2y^{-4}y^{\cdot}$ is the other part of the fluxion. Therefore $2y^{-3}xx^{\cdot}-3x^2y^{-4}y^{\cdot}=\frac{2xx^{\cdot}}{y^3}-\frac{3x^2y^{\cdot}}{y^4}=\frac{2yxx^{\cdot}-3x^2y^{\cdot}}{y^4}$ is the fluxion of the fraction $\frac{x^2}{y^3}$.

Since a fluxion always implies a fluent from whence it is derived, the only way of obtaining a fluent from its fluxion is by an opposite process; this is called the inverse method of fluxions. Hence when the fluxion is derived from any power of a variable quantity, its fluent is found by multiplying the fluxion by $\frac{x}{nx^{\cdot}}$ the reciprocal of $\frac{nx^{\cdot}}{x}$.

The general equation is $nD^{n}x^{n-1}x^{\cdot}\times\frac{x}{nx^{\cdot}}=D^{n}x^{n}$.

I. To find the fluent of $27x^{26}x^{\cdot}$, we first find the value of n in the ratio $\frac{x}{nx^{\cdot}}$, and because $x^{26}x^{\cdot}$ is expressed in the general formula by $x^{n-1}x^{\cdot}$, therefore $26+1=27=n$, and $\frac{x}{nx^{\cdot}}=\frac{x}{27x^{\cdot}}$; hence $nD^{n}x^{n-1}x^{\cdot}\times\frac{x}{nx^{\cdot}}=27x^{26}x^{\cdot}\times\frac{x}{27x^{\cdot}}=x^{27}$ the fluent required.

II. To find the fluent of $5(x^{3}+x)^{4}\times(3x^{2}x^{\cdot}+x^{\cdot})$; here $4+1=5=n$, and $\frac{x}{nx^{\cdot}}=\frac{x^{3}+x}{5(3x^{2}x^{\cdot}+x^{\cdot})}$, hence $nD^{n}x^{n-1}x^{\cdot}\times\frac{x}{nx^{\cdot}}=5(x^{3}+x)^{4}\times(3x^{2}x^{\cdot}+x^{\cdot})\times\frac{x^{3}+x}{5(3x^{2}x^{\cdot}+x^{\cdot})}=(x^{3}+x)^{5}$.

III. To find the fluent of $\frac{ax^{\cdot}-2xx^{\cdot}}{2(ax-x^{2})^{\frac{1}{2}}}=\frac{1}{2}(ax-x^{2})^{-\frac{1}{2}}\times(ax^{\cdot}-2xx^{\cdot})$; here $-\frac{1}{2}+1=\frac{1}{2}=n$, and $\frac{x}{nx^{\cdot}}=\frac{ax-x^{2}}{\frac{1}{2}(ax^{\cdot}-2xx^{\cdot})}$, hence $nD^{n}x^{n-1}x^{\cdot}\times\frac{x}{nx^{\cdot}}=\frac{1}{2}(ax-x^{2})^{-\frac{1}{2}}\times(ax^{\cdot}-2xx^{\cdot})\times\frac{ax-x^{2}}{\frac{1}{2}(ax^{\cdot}-2xx^{\cdot})}=(ax-x^{2})^{\frac{1}{2}}$, the fluent required.

IV. To find the fluent of $\frac{ayy^{\cdot}}{(a^{2}-y^{2})^{\frac{3}{2}}}=(a^{2}-y^{2})^{-\frac{3}{2}}ayy^{\cdot}$; here $-\frac{3}{2}+1=-\frac{1}{2}=n$, and $\frac{x}{nx^{\cdot}}=\frac{a^{2}-y^{2}}{-\frac{1}{2}\times-2yy^{\cdot}}$; hence $nD^{n}x^{n-1}x^{\cdot}\times\frac{x}{nx^{\cdot}}=(a^{2}-y^{2})^{-\frac{3}{2}}ayy^{\cdot}\times\frac{a^{2}-y^{2}}{-\frac{1}{2}\times-2yy^{\cdot}}=a(a^{2}-y^{2})^{-\frac{1}{2}}=\frac{a}{(a^{2}-y^{2})^{\frac{1}{2}}}$, the fluent required.

V. The fluent of $(2-n)x^{1-n}x^{\cdot}$ is $(2-n)x^{1-n}x^{\cdot}\times$ ratio $\frac{x}{(2-n)x^{\cdot}}=x^{2-n}$.

VI. The fluent of $\frac{m+n}{n} z^{\frac{m}{n}} \dot{z}$ is $\frac{m+n}{n} z^{\frac{m}{n}} \dot{z} \times$ ratio $\frac{z}{\frac{m+n}{n}\dot{z}} = z^{\frac{m+n}{n}}$.

When the fluxion arises from the product of two or more variable quantities its fluent is found in the following manner. Suppose the fluxion to be $3y^5x^2\dot{x} + 5x^3y^4\dot{y}$. Taking the term $3y^5x^2\dot{x}$, the value of n is $2+1=3$, hence $\frac{x}{n\dot{x}} = \frac{x}{3\dot{x}}$, and $3y^5x^2\dot{x} \times \frac{x}{3\dot{x}} = x^3y^5$ the fluent of $3y^5x^2\dot{x}$. Taking the term $5x^3y^4\dot{y}$, the value of n is $4+1=5$, hence $\frac{x}{n\dot{x}} = \frac{y}{5\dot{y}}$, and $5x^3y^4\dot{y} \times \frac{y}{5\dot{y}} = x^3y^5$ the fluent of $5x^3y^4\dot{y}$. The sum $2x^3y^5$ divided by 2 the number of parts, is x^3y^5 the fluent required. To find the fluent of $\frac{2yx\dot{x} - 3x^2\dot{y}}{y^4} = 2y^{-3}x\dot{x} - 3x^2y^{-4}\dot{y}$. Taking $2y^{-3}x\dot{x}$ the value of n is $1+1=2$, hence $\frac{x}{n\dot{x}} = \frac{x}{2\dot{x}}$, and $2y^{-3}x\dot{x} \times \frac{x}{2\dot{x}} = x^2y^{-3}$ the fluent of $2y^{-3}x\dot{x}$ Taking $-3x^2y^{-4}\dot{y}$ the value of n is $= -4+1 = -3$, hence $\frac{x}{n\dot{x}} = -\frac{y}{3\dot{y}}$, and $-3x^2y^{-4}\dot{y} \times -\frac{y}{3\dot{y}} = x^2y^{-3}$ the fluent of $-3x^2y^{-4}\dot{y}$. The sum $2x^2y^{-3}$ divided by the number of parts, which is 2, becomes $x^2y^{-3} = \frac{x^2}{y^3}$, the fluent required.

To be continued.

ART. XII.—*On some improvements on Brunner's process for Potassium, and in the means of preserving that metal; by* R. HARE, M. D., Professor of Chemistry in the University of Pennsylvania.

WHEN I first went through Brunner's process for potassium, as modified and described by Berzelius, I conceived the idea of substituting, for the piece of a gun barrel between the iron bottle and receiver, an iron cylinder much larger in bore, and using an iron vessel without naphtha, instead of that recommended by the great chemist last mentioned. From the employment of this, much inconvenience was experienced; as in consequence of reiterated explosions, every one present was more or less bespattered with naphtha. Subsequently I found that in both of my conceptions I had been anticipated by Dr. Gale of New York. Agreeably to my later experiments, I find that the receiver may be dispensed with advantageously on every account. I have successfully employed a hollow iron cylinder of about two inches in bore, and fifteen inches in length; which is at one end fastened into the generating bottle by screwing, and at the other end receives a piece of a gun barrel to which a lead pipe is adapted, so as to be air tight. This pipe is recurved in such a manner, as to convey the gas and fumes into the ash hole of the furnace employed.

By means of a keg supplied with water, from which proceeds a lead pipe furnished with a cock, a stream of water is directed upon the iron cylinder sufficient to keep it cool. The water as it runs off from the cylinder, is caught in a flat dish, from which it is conveyed by another lead pipe. Thus refrigerated, the cylinder retains nearly all the condensible potassium. The receiver should not, however, be allowed at a minimum, to be below a boiling heat in the coldest part, as in that case aqueous matter is detained in it, and, I believe, re-oxidizes more or less of the potassium. Towards the close of the process to prevent the condensible matter from obstructing the narrow part of the receiver next the bottle, it must be kept in a state of incandescence.

Operating with the proceeds of seven pounds of bitartrate of potash, properly carbonized, I have obtained of the metal in question, seventeen hundred grains in pieces large enough to be conveniently lifted by forceps. But as in boring the metal out of the tube inflammation is liable to ensue, unless naphtha be applied, the potassium thus extricated is much imbued with this liquid, with which it always has a reäction productive of some loss. Besides, a considerable proportion of it, is always deposited in a state of mixture or combination, with a carbonaceous matter, from which it can be completely separated only by intense heat. Hence I deem it preferable, after removing the cylinder from the bottle, to close one end by screwing on an iron cap provided for that purpose, to adapt to the other a piece of a gun barrel duly recurved, and proceed to distillation. I have tried distillation *per descensum*, which has the advantage of allowing a portion of the metal to be extricated by simple fusion. The last portions however can only be obtained at a white heat. I must confess that I have not as yet been enabled to make up my mind as to the method, which may be upon the whole preferable in this part of the process. From actual trials it appears that it is possible to receive the potassium, as it comes over by distillation, in a bottle, replete with hydrogen desiccated by chloride of calcium. I have constructed an apparatus, by which I expect this method of operating will be rendered more easy and effectual, but I have not as yet put it into operation.

Notwithstanding its unusually large calibre the cylinder became repeatedly so clogged by the metal, and the carbonaceous deposit, as to occasion some difficulty in keeping the passage clear; and likewise some loss of potassium, of which a considerable quantity always accompanied the rod used for the purpose when retracted. In order to remedy these evils, as a substitute for the iron cylinder above mentioned, I have had another equally long receiver forged, of which the bore at each orifice is two inches in diameter but enlarges at a little distance from either end to two and a half inches. I hope that the cavity of this receiver will be adequate to receive all the condensible products without being obstructed.

I intend hereafter to furnish a more complete description of my process for potassium, illustrated by a cut.

I have made an improvement in the art of luting. It consists in using the shreds of iron, which are shaved off in making weavers' reeds of that material. These shreds are entangled together like the fibres of wool and constitute a mass which, by analogy, we have called iron wool. With these shreds fire clay blended with as much sand as is consistent with the necessary plasticity is intimately intermingled and stamped into a flat cake of a size sufficient to envelope the bottle completely. Being applied to the bottle, it is afterwards secured by a wire wound about it in a spiral, of which the rounds are not more than a half inch asunder, and the ends are duly secured by twisting them together.

The effect of this intermixture of iron fibres is surprising. The lute hardens on exposure to the fire without previous desiccation.

I rolled up two equal balls, one, consisting of fire clay alone, the other of the same clay intermingled with the iron wool. Both were thrown into an intensely heated part of an anthracite fire. The ball which consisted of clay alone, soon flew to pieces, while the other retained its shape and hardened into a mass having the firmness of a brick.

The plan proposed by Dr. Gale of keeping potassium in glass without naphtha, is one which I have pursued since 1818. I have been accustomed to seal a tube at one end, then to heat it at a convenient distance from the end, and reduce the diameter by drawing it down to about a quarter of an inch. Into the tube thus prepared, hydrogen is made to enter, so as to exclude the air. The potassium being then introduced, and the open end of the tube, closed by means of a spirit lamp, the metal may be fused, and with a little dexterity may be transferred in pure globules to that part of the cavity of the tube which is between the sealed end and the narrow part. This object being effected, the tube is divided at that part, and sealed by fusion.

In this case the potassium usually falls upon the glass and adheres to it, presenting a perfectly brilliant metallic coating, and preserves this appearance without diminution for years.

It is however liable to inflammation from slight causes when kept without naphtha. I had an ounce of it in a small phial for eighteen months which took fire on my venturing to divide the phial by means of a file.

An account of an explosive compound produced by the reäction of naphtha with potassium, by the author of the preceding article.

I avail myself of this opportunity of mentioning a circumstance which occurred in January, 1831, and which I should have mentioned before, had I not hoped to have had leisure to ascertain the cause of the phenomenon.

Having some globules of potassium of a size so small, as to be separated with difficulty from the naphtha with which they had been intermingled. I endeavored to get rid of the naphtha by heat. With this view I heated the whole mass in a sealed tube, properly recurved to act as a retort. The glass, when heated to the boiling point of the naphtha, became quite black so as to lose its transparency. When all the naphtha had been expelled, I inverted the tube in another of a larger size filled with hydrogen, and otherwise prepared as above mentioned. A few globules of the metal ran into the tube thus prepared, and were secured there; so that to this day their brilliancy is unimpaired, and they still have in some points, a striking degree of brightness. They are accompanied by a few drops of colorless naphtha, which is still unchanged.

Being dissatisfied with the quantity of potassium thus procured, I proceeded to examine the caput mortuum left in the tube used as a retort. With this view striking it with a hammer, I was startled by a violent detonation. From the circumstance that this result was the consequence of the reäction of potassium, naphtha, and flint-glass, it seems to be distinguished from the explosions which are well known to occur in the process above alluded to, by which potassium is obtained from carbonate of potash, according to Brunner.

I have already mentioned that in the first operation which I made after that plan, I used the copper vessels recommended by Berzelius. The inner vessel having been allowed to remain in connection with the gun barrel, which formed the means of communication between it and the iron bottle, for thirty six hours after the process was terminated, my assistant attempting to effect a separation, struck the neck of the receiver with a hard body. Immediately a detonation ensued, as violent as if a musket had been fired, and the receiver though open at one end, was bulged from a square nearly into a cylindrical form. In this case it might be imagined that naphtha had some agency, yet it could have had but little access to the part of the apparatus from which the explosion proceeded. Besides, Dr. Gale mentions that he met with explosions in removing potassium and its accompaniments from the interior of the tube, when no naphtha had been used, and he recommends the affusion of that liquid, as a preventive of explosion.

The rod employed to keep the passage through the iron cylinder free as above mentioned, coming out coated with potassium, I strove to detach it by scraping, and to save it by receiving it in naphtha. I succeeded in amassing in this way a quantity worthy of the trouble. In scraping the rod for this purpose by the edge of a square bar, explosions constantly took place as the latter came in contact with a bluish matter, the nature of which I could not ascertain. Berzelius ascribes these explosions to moisture; but they have occurred, as in the instance above mentioned of detaching the receiver, where moisture could not have contributed to the result.

Of a method of filling tubes with potassium, by the author of the preceding articles.

I have succeeded in filling glass tubes with potassium in the following manner. One end of a tube is luted to one of the orifices of a cock; to the other orifice, the neck of a gum elastic bag of a suitable size is attached. The open end of the tube is reduced in diameter by means of a flame excited by the blow-pipe, so as to have an orifice about large enough to receive a knitting needle. The gum elastic bag is filled with hydrogen, and the cock closed. Meanwhile the potassium is heated in naphtha, in a larger tube, till it lies at the bottom in a liquid state.

In the next place, the bag is grasped with one hand and subjected to pressure, at the same time introducing the small orifice of the tube into the naphtha, the cock is opened till the hydrogen begins to escape in bubbles. The escape of the bubbles is kept up to prevent the naphtha from entering the tube, and to evacuate the bag. Before this is quite accomplished, the orifice of the tube is to be approximated to the surface of the potassium as nearly as possible without entering it, and just as the last of the gas is expelled, is to be merged in the metal. The cock is at the same time to be closed, and the pressure of the hand on the bag discontinued. The cock being in the next place very cautiously opened, the elasticity of the bag counteracts the pressure of the atmosphere within the tube; and the liquid potassium is forced to rise into it. This effect may be controlled by the cock, which is to be closed when the column of the metal has attained a satisfactory height. After being removed, cooled and separated from the cock, the tube may be closed by a covering of sheet gum-elastic, such as is procured by the inflation of bags softened by ether. Any portion of the contents thus preserved may be extricated by cutting off and fracturing a portion of the tube, adequate to yield the requisite quantity.

In order to guard against accidents the apparatus was heated in this process by a bath of naptha; in a bath of hot water. For the object last mentioned, the vessels ordinarily used for the solution of glue were employed, the naphtha being placed in the inner vessel usually occupied by the glue.

I have long been in the practice of filling tubes with phosphorus by a similar process.

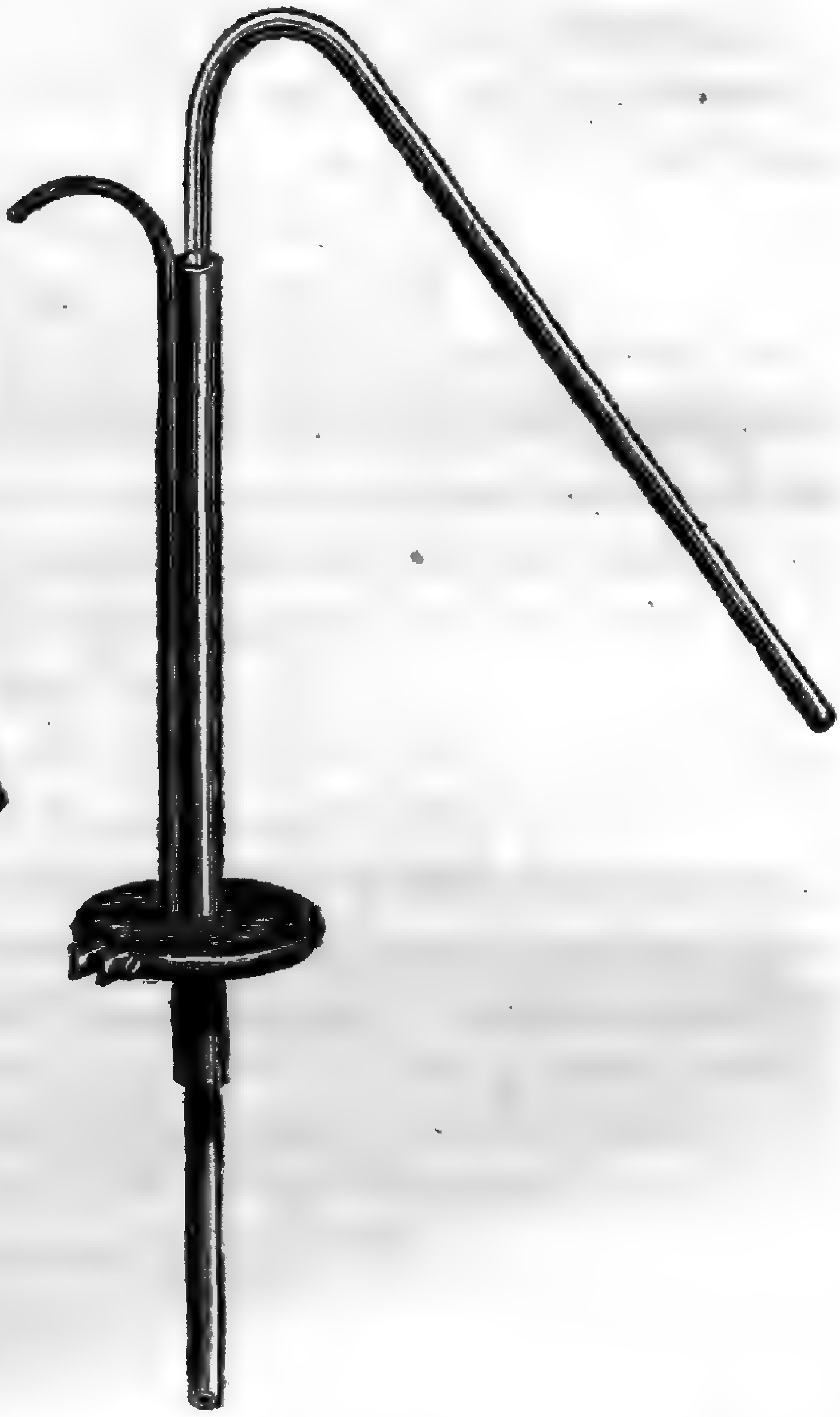
Art. XIII.—*Improved Syphons; by* R. Hare, M. D. Professor of Chemistry in the University of Pennsylvania.

Subjoined are engravings of two Syphons, which I have found useful in my laboratory. Of these, one represents the more complete method of execution; the other, that which can be more easily resorted to by Chemists in general, who have not easy access to skilful workmen.

The construction last alluded to, is represented by fig. 1. A cork is perforated in two places parallel to the axis. Through one of the perforations, the longer leg of the syphon passes: into the other, one end of a small lead tube is inserted. In order to support this tube, it is wound about the syphon until it approaches the summit, where a portion of about three or four inches in length, is left free, so that advantage may be taken of its flexibility, to bend it into a situation convenient for applying the lips to the orifice. About the cork, the neck of a stout gum elastic bag is tied air tight. The joinings of the tubes with the cork, must also be air tight. The lower half of the gum elastic bag is removed, as represented.

Fig. 1.

Fig. 2.



In order to put this syphon into operation, a bottle must be used, having a neck and a mouth of such dimensions as to form an air tight juncture with the bag when pressed into it. This object being accomplished, the air must be inhaled from the bottle, until the diminution of pressure causes the liquid to come over, and fill the syphon, After this, on releasing the neck of the bottle, the current continues, as when established in any other way.

Fig. 2, represents the more complete construction. In this are two metal tubes, passing through perforations made for them in a brass disk, turned quite true. Through one of these tubes, which is by much the larger, the syphon passes, and is cemented air tight. The other answers the purpose of the leaden tube described in the preceding article. The brass disk is covered by a piece of gum elastic, which may be obtained by dividing a bag of proper dimensions. The covering thus procured, is kept in its place by a brass band or clasp, made to embrace both it, and the circumference of the plate, and to fasten by means of a screw.

Before applying the caoutchouc, it was softened by soaking it in ether, and a hole, obviously necessary, was made in the centre, by a hollow punch.

There is no difference between operating with this syphon, and that described in the preceding article, excepting that the juncture of the syphon with the bottle, is effected by pressing the orifice of the latter against the disk covered with gum elastic.

Art. XIV.—*Stereotype Printing.—An original paper of the late Lieut. Gov. Colden, on a new method of printing discovered by him; together with an original letter from the late Dr. Franklin, on the same subject; and some account of stereotyping, as now practised in Europe, &c. by the Editors of the Register.*

We republish from the American Med. and Philos. Register, Vol. I, 1814, p. 439; edited by Profrs. Hosack and Francis an interesting paper on the origin of Stereotype printing. We are obliged to a friend for pointing out to us this curious document.—*Ed. of Am. Jour. of Science, &c.*

New Method of Printing.

"As the art of printing has, without question, been of very great use in advancing learning and knowledge, the abuse of it, as of all other good things, has likewise produced many inconveniences. The number of books printed on the same subject, most of which are nothing but unskilful and erroneous copies of good works, written only for ostentation of learning, or for sordid profit, renders the path to knowledge very intricate and tedious. The reader, who has no guide, and the greatest number have none, is lost in the wilderness of numberless books. He is most commonly led astray by the glaring appearances of title pages, and other artifices of the mystery of bookselling.

"It is likewise a common complaint, that a poor author makes nothing near the profit that the bookseller does of his labor; and probably, the more pains the author has taken, the more difficult the performance, and the more masterly it is done, the less profit to him; for the good books, like jewels, never lose their intrinsic value; yet they have fewer purchasers than Bristol stones, and the sale of them is slow.

"As the lessening or removing of some of these inconveniences, may be of use to the republic of letters, I hope to be excused in making the following attempt for that purpose, by proposing *a new method of printing*.

"Let there be made of some hard metal, such as copper or brass a number of types, or rather matrices, on the face of each of which one letter of the alphabet is to be printed *en creuse*, by a stamp, or such other method by which matrices for founding of types are commonly made. They must be all of the same dimension, as to breadth and thickness, with that of types, but half their length seems sufficient. Their sides must be so equal and smooth as to leave no vacuity between them when joined. There must likewise be a sufficient number of each letter or character, to compose at least one page in octavo, of any book.

"These matrices, I suppose, may be cast in a mould, or a plate of copper may be divided exactly into squares, and the letter or character be stamped into the middle of each square, and the squares afterwards cut asunder by a proper saw. The best method of making these will be easily discovered by those whose business it is to make founts for printing types.

"When a sufficient number of each letter and character is obtained, they are to be placed in the same manner that types are, when composed for printing, only that they must all stand directly as they are read, and as they will appear afterwards on paper.

"The composure of one page after it is carefully corrected, is to be placed in a case or mould, fitted to it, of the length and breadth of the page, and of such depth as to cast a plate a quarter of an inch thick, which will perfectly represent a page composed in the common manner for printing.

"As to the art of casting the plate perfect, founders and type makers must be consulted; for the composition of the metal, and for the flux for running it clean and clear, so that no vacuities be left; for which purpose, I am told, that the funnel, by which the melted metal is poured in, being made large and the filling it with the melted metal after the mould is full, is of use to make the letter every where full and complete. For, by the weight of the metal in the funnel, the liquid metal in the mould is pressed into every crevice. The funnel's extending the whole length of one of the sides, gives likewise free vent to the air.

"Or, after a page shall be composed, as before mentioned, and the types and matrices well secured in a frame upon a strong plate, they may, by a screw, be pressed upon a sheet of melted lead, and thereby a plate of lead be procured, representing as the former a page composed of types for printing. Which of the methods are most practicable artists can best determine.

"After the page shall be thus formed the matrices may be loosened and dispersed in their proper boxes, and may serve for as many other pages as types in common printing do.

"When a number of pages, sufficient for a sheet are thus made, they may be carried to any printing press, and such a number of sheets as shall be thought proper be cast off, and then be laid by till more copies be wanted.

"I choose an octavo page, because, if the page title and page number be left out, as likewise the directions and signatures at the foot of the page, by joining two pages together, it may be made a quarto, or by joining four a folio. Thus several editions in octavo, quarto and folio, may at once be made, to suit every buyer's humor.

"The page titles, number and bottom signatures may be cast in small moulds apart, and joined, as may be proper.

"The most convenient size of a page is that of small paper, so as to fill it up, and to leave very little margin; then by adding the page titles, or marginal notes, or notes at the bottom, all cast in frames separately, the large paper may be sufficiently filled.

"I believe that this method of printing, every thing considered, will not be more chargeable than the common method. A thousand, or some thousands sometimes, of copies, are cast off at once in the common method, and the paper and pressman's labor of what is not speedily sold may, or must lie dead for some years, whereas in this method, no more need be cast off at a time than may well be supposed to sell speedily. If I be not mistaken, the metal necessary for one sheet will not exceed the value of four hundred sheets of paper, and in the common method, several hundred sheets lie useless for sometimes, many years. If the book should not answer, there is a great loss in the paper, whereas the metal used in this method retains its intrinsic value.

"I shall instance some of the advantages in this method which induce me to communicate my thoughts to others.

"1. An author by this means can secure the property of his own labor.

"2. A correct edition is at all times secured, and therefore may be useful in the classics, trigonometrical tables, &c.

"3. A weak and ignorant attempt on the same subject will be discouraged, for as a new edition of a valuable book is continually secured, without any new expense, booksellers will not readily hazard the publishing of books of the same nature.

"4. But what I chiefly value this method of printing for, is from the advantages it gives an author in making his work perfect, and in freeing it from mistakes; for, by printing off a few copies of any sheet, and sending them among his friends, and by suffering them to fall into the hands of a malevolent critic, he may have an opportunity of correcting his mistakes, before they appear to the world. By the same means he may make his work more complete than he otherwise could, by the assistance which his friends may give him in several parts of it. It is for these reasons chiefly, that I propose the plates not to exceed an octavo page, and to have no signatures; for in case of a mistake, the loss of one page may correct the error, and where improvements or additions are necessary, as many pages may be intermixed as shall be necessary, without any inconvenience, and small explications may be made by the marginal notes.

"Lastly. The greatest advantage I conceive will be in the learned sciences; for they often require a long time to bring these to perfection, and require the assistance of others in many particulars. Many a valuable piece has been lost to the world by the author's dying before he could bring his work to the perfection he designed. Now by the assistance which he may have by this method from others, this time may be much shortened, and the progress he has made may be preserved for others to continue in case of his death. An author may publish his work in parts, and shall continue, in many cases, to complete and make them more perfect, without any loss of what was done before. By this method likewise, a man of learning, when poor, may leave some parts of his estate in his own way for a child, as mechanics often do for theirs.

"Whether the method I propose will answer the end designed, or whether it be practicable, I cannot with sufficient assurance say; because we have no artists in this country who can make the experiment, neither can they have encouragement sufficient to tempt them to make the trial. However, I hope to be excused, by the use of the design, and as it may chance to give some hint to a skilful person to perform effectually what I only aim at in vain.

"If the charge of lead or metal plates be thought too great, I know not but that the impression may be made on thin planes of some kinds of wood, such as lime tree or poplar, which have a soft smooth grain when green, and are hard and smooth when dry.

"Ever since I had the pleasure of a conversation with you, though very short, by our accidental meeting on the road, I have been very desirous to engage you in a correspondence. You was pleased to take some notice of a method of printing which I mentioned to you at that time, and to think it practicable. I have no further concern for it than as it may be useful to the public; my reasons for thinking so, you will find in the inclosed copy of a paper which I last year sent to Mr. Collinson in London. Perhaps my fondness for my own conceptions may make me think more of it than it deserves, and may make me jealous that the common printers are willing to discourage out of private interest, any discovery of this sort. But as you have given me reason to think you zealous in promoting every useful attempt, you will be able absolutely to determine my opinion of it. I long very much to hear what you have done in your scheme of erecting a society at Philadelphia, for promoting useful arts and sciences in America. If you think of any thing in my power whereby I can promote so useful an undertaking, I will with much pleasure receive your instructions for that end. As my son Cadwallader, bears this, I thereby think myself secured of the pleasure of a line from you by him."

Philadelphia, November 4, 1743.

Sir,

I received the favor of yours, with the proposal for a new method of printing, which I am much pleased with; and since you express some confidence in my opinion, I shall consider it very attentively and particularly, and in a post or two, send you some observations on every article.

My long absence from home in the summer, put my business so much behind hand, that I have been in a continual hurry ever since my return, and had no leisure to forward the scheme of the society. But that hurry being now near over, I purpose to proceed in the affair very soon, your approbation being no small encouragement to me.

I cannot but be fond of engaging in a correspondence so advantageous to me as yours must be. I shall always receive your favors as such, and with great pleasure.

I wish I could by any means, have made your son's longer stay here as agreeable to him, as it would have been to those who began to be acquainted with him.

I am, Sir, with much respect,
Your most humble servant,

Dr. Colden. B. FRANKLIN.

The mode of printing above described is now known by the term *Stereotype;* and it is a curious fact that the stereotype process, said to have been invented by M. Herhan, in Paris, and now practised by him in that city, under letters patent of Napoleon, is precisely the same as that spoken of by Dr. Colden more than sixty years ago.

It is more than probable that when Dr. Franklin went to France, he communicated Dr. Colden's "new method of printing" to some artists there, and that it lay dormant till about sixteen years since; when Herhan, a German, who had been an assistant to M. Didot, the printer and type founder of Paris, but then separated from him, took it up in opposition to M. Didot. We have conversed with gentlemen who have seen M. Herhan's method of stereotyping, and they describe it to be exactly what Governor Colden invented. This fact established, there can be no doubt that M. Herhan, is indebted to America for the celebrity he has obtained in France.

Since the above papers fell into our hands, we have endeavored to obtain information respecting the different methods of stereotyping now in use. The following is the result of our inquiries.

By a book published in Paris, about ten years since, by M. Camus of the French National Institute, we find that a Bible was printed in Strasburgh, by one Gillet, more than a hundred years ago, with plates similar to those now used by Didot and Herhan, but not by any means so perfect. Gillet's moulds were made of a fine clay and a particular kind of sand found only in the neighborhood of Paris. It is also stated that a number of other ingenious men had at various times produced plates tolerably perfect, by different processes, but we may safely infer, from the art having made no great progress until the time of Didot the elder, that their endeavors had not been crowned with much success.

At the beginning of the French revolution great quantities of paper money becoming necessary to supply the deficiency of specie either concealed or sent out of the kingdom by the rich, Didot was applied to by the National Assembly to invent some kind of *assignat* or bank bill, which should not easily be imitated; and at this period it was that M. Didot first directed his attention to the means of producing, *in relief*, a set of plates, to print on a common printing-press which were exactly *fac-similes*, and could not without much difficulty be falsified. This process was termed Polytyping;* as the mould in which the plates were cast was durable, and would produce any number of copies; the usual mode of stereotyping being, as the French term it, *á moule perdu;* it being necessary to make a new mould for every plate.

But as M. Didot's views were by degrees extended to the casting of pages for book printing, he found it unnecessary to use durable moulds, and therefore, after a year's experiment invented a composition, which, like the sand used by brass-founders, might be wrought over again for different casts. The elegant editions produced by M. Didot and sons, are the best proof of his success.

When the fame of M. Didot's invention reached England, Lord Stanhope, an ingenious and wealthy nobleman, whose time and fortune are principally devoted to the advancement of the arts, made propositions to Mr. Andrew Wilson, of Wild Court, Lincoln's Inn Fields, proprietor of the Oriental press, to assist him in such experiments as might bring to perfection a new mode of stereotyping, of which his lordship had obtained some ideas. Mr. Wilson, embraced the proposal; and after four or five years of incessant labor, they attained nearly all the advantages they had contemplated. Mr. Wilson, in the year 1802, built his foundry in Duke street, Lincoln's Inn Fields, and in the following year disposed of the secret for six thousand pounds sterling, and some future advantages to Mr. Richard Watts, for the use of the University of Cambridge. In the year

* We have seen some beautiful specimens of this art produced by Mr. John Watts, of this city; of whose undertakings we shall hereafter speak more at large.

following he disposed of it on similar terms to the University of Oxford.*

About two years ago a brother of Mr. Watts of Cambridge, began a course of experiments in this city for a more cheap and easy manner of stereotyping, than any hitherto discovered; and in spite of innumerable disadvantages has succeeded beyond his utmost expectation. We have seen plates of his casting of the greatest perfection and beauty. The chief difficulty he has experienced arose from the jealousy and illiberality of the common type founders, who refused to lend the little aid he required of them. It is agreeable to us, however, from our own observation to be able to state that by uncommon perseverance through accumulated obstacles, Mr. Watts, has invented a method of casting the common types much more perfect than those made in the usual way; and now will proceed with his plates without the assistance of other artists.

The principal defects in M. Didot and Lord Stanhope's processes, arise from the softness of the moulds they employ, which are composed of plaster of Paris and some other ingredients. In taking them from the page, of which they are intended to cast a perfect copy, some part of the composition will always remain in the type, and leave the mould imperfect. After the plates are cast, there is consequently much work for an engraver, to make them fit for use. Mr. Watts's mould, being of solid materials no such inconvenience can arise.

Art. XV.—*Notice of the most simple means of employing dead animals; by* M. Payen, Manufacturer, Professor of Chemistry.

Remarks.—The translation from the French, of the following memoir, on the use of dead animals, was sent to us by a valued correspondent. Our hesitation (created by some of its revolting details,) as to the propriety of publishing it was at length, overcome not only by the consideration that it presents facts, *some of which* may be useful in this country, but also by the very remarkable exhibition which it presents, of a state of society, (so foreign from any thing existing here,)

* The two Universities of England, have the exclusive right of printing Bibles and Prayer Books. Twenty or thirty presses are generally employed in that business alone; the classic departments requiring many others.

in which such employments can be regarded as desirable. The physiological facts are also very surprising, and such as we should very little expect. Who, without decisive evidence, would believe, that the flesh of an animal which can communicate a fatal infection by mere contact, can be safely eaten by man! Those of our readers, whose nerves are delicate, may as well pass over this memoir without perusing it, while to those who appreciate curious and useful results, without regarding the pleasantness of the path by which they arrive at them, it will prove a valuable acquisition to their stock of information.—*Editor.*

In many places, the laborious inhabitants of the country carefully gather different remains of little value, such as stubble, leaves and twigs of wood, which they collect in forests for their fuel; the manure of horses, which they scrape up from the roads to increase their scanty store. They often deprive themselves of part of their own food to raise dogs and cats; while they allow the greater part of their dead animals to be lost, which they might without much trouble turn to great advantage, either by applying them to their own wants, or selling them to manufactures, who, almost every where in France, are in want of animal materials necessary for their operations. The value of these dead animals, according to the uses to which they may be applied will be much greater than that of many objects which they are accustomed as we have said, to glean with trouble.

When an animal dies in the country either from disease or accident, they generally hasten to bury it very deeply, thus throwing away all the profit which they might obtain from it. They cherish an aversion to their dead carcasses, from the idea, universally prevalent, that they are unwholesome; that there is danger in approaching and handling them, if they had been ever so little affected with disease, or the flesh has commenced giving out a little bad odor. Before we point out all the uses to which dead animals may be applied it will be necessary to destroy these false ideas; we shall doubtless effect this by informing them that none of the numerous individuals employed in different manufactories near large cities, where are slaughtered all diseased animals, where are cut up all animals that have died of diseases of any kind (one only excepted, which we shall clearly make known;) that none of the laborers in work houses where they manipulate with animal matters experience any particular indisposition, or are subject to any disease which can be attributed to these substances.

It is therefore a great error to regard these professions as unwholesome. Numerous reports of learned men; of physicians, and administrative authorities, have proved that the most infected establishments, where are employed animal matters often in a state of putrefaction, and especially catgut manufactories, slaughter houses for horses, and the shops of glue makers, are in general not at all unwholesome. But we are to understand that it is entirely different with regard to vegetable matters (remains of plants) in fermentation, alone, or mixed with animal matter; thus the pits in which hemp is steeped; muddy marshes; deposits of soap suds; clearings of ponds, gutters, or canals, may give rise to disease even at considerable distances.

We have said that one distemper alone, after having caused the death of animals may be dangerous to those who flay their carcasses, independently of the accidents which happen by a puncture or wound aiding the communication of the disease. The distemper of which we speak is known by the name of Carbuncle because it often gives rise to tumors, which when they are accompanied with sores are covered ordinarily with *blackish* crusts. Animals attacked with carbuncle evince a deep sadness, their sides are greatly agitated; we observe in different parts of their bodies, especially on the breast and near the sides, swellings or tumors, which cause them a great deal of pain, and which sometimes when they are touched sound like dry skin; death sometimes ensues in twenty four hours. The tongue is then black, and the blood and flesh very brown. Finally, for fear that there should be any uncertainty, even when we think that carbuncle could not be recognized by the preceding indications, it will be proper always to consult a veterinary surgeon, and in case there should remain any doubts concerning the nature of the distemper, we should abstain from cutting up the animal. In the latter case, and if the contagious nature of the disease should be apparent we should bury the dead animal two feet under ground. In order to convey it to the grave, a hurdle or an old door should be used, and a hook fixed in the end of a long handle in order to prevent the blood and exuviæ from being scattered over the soil during the passage, and to avoid touching the carcase. The place of interment, should be marked in some particular manner. Grain may be conveniently sown over it in order to profit by its powerful subterranean vapor. At the end of two years the grave may be opened, the bones will be found completely denuded of flesh, and fit for the uses which we shall point out hereafter.

In the same manner may be employed animals which have become more or less softened by incipient putrefaction; in the latter case, they may be made to serve a more useful purpose as manure, by tearing off the flesh with long handled instruments as hedging bills, pitch-forks, &c. then, mixing it with dry earth it is spread, after having extracted the bones, in thin layers upon ground to be cultivated, or in small heaps among the feet or tufts of different plants at a distance from each other, such as corn, potatoes, tobacco, vines, olive trees, &c. All this manure should be covered with earth which absorbs and retains the products of the fermentation and gradually transmits them to the plants.

Animals which have been bled and sold to the butchers soon after the invasion of non contagious diseases, have never caused any accidents either to those who have flayed them or cut them up, nor to those persons who have eaten them. We may cite as examples the oxen and cows slaughtered in great numbers during an epizoötia, sheep affected with the rot (a kind of small pox,) all those animals which die rapidly after having been attacked with swellings in meadows of wet clover, or in consequence of excessive fatigue: this latter case is besides very analogous to what happens so frequently to those animals which are driven hard in the chase. Animals killed by lightning like those destroyed by disease or fatigue should be very soon skinned and dissected; the former particularly are subject to putrefaction much more rapidly than those whose deaths may be owing to other causes.

As to those animals which are not commonly subservient either to the nourishment of man, or other animals; such as horses, dogs, cats, rats and even polecats, their flesh is not in any manner unwholesome; we have often seen workmen feeding upon it, merely adding to it a little more pepper and other spices, in order to disguise the peculiar taste of some one of these animals. Polecats in particular have so strong an odor that few persons could be induced to taste them, whatever the seasoning; but we can bear witness that they may be eaten, without the least danger.

The greater number of animals should be skinned and dissected in the same manner; commencing by dividing the skin of the abdomen throughout its whole length and thickness, from the lower jaw along the neck, the breast and the belly, as far as the tail; a cross cut is then made along each leg as far as the foot: the skin is cut all around the limb, and is then detached from all parts of the animal, by pulling it with one hand, at first in the middle of the belly, and making with the other hand a great number of strokes with a knife, the edge of the blade being directed more towards the flesh, for fear of cutting the skin.

An acquaintance with this operation may be obtained by imitating the manner of the butcher boys, and skinners by profession. It would be better to apply to one of these, if he is to be found in the neighborhood. In places near manufactories where they work in skins (tanneries, taweries, &c.) the skins can be sent to these establishments quite fresh, after which the ears, flesh and bones contained in the tail are removed; skins are sold by weight. If on the contrary the skins are to be sent to some distance, or kept some time until there is occasion to transport them, it will be necessary to remove carefully all the remaining flesh, and which may cause them to spoil: it will be proper even in this case to remove the tail.

When the skin has been separated from the animal in the manner just related, all the bowels and other viscera are to be drawn from the abdomen and chest, the whole placed in a pit dug in a mound of earth as dry as possible; all the soft parts must be torn apart by two persons pulling in contrary directions by means of pitchforks or strong rakes, then to be mixed with a sufficient quantity of earth to form, not a paste, but a moist powder; the manure thus obtained may be employed immediately by being spread over the earth under culture, by being divided in small portions between the billocks of different plants as we have before stated; or finally by being spread in furrows dug between rows of plants sowed in lines and covered with earth.

If the animal is capable of serving as nourishment for man or animals, as it is in the greatest number of cases, the most advantageous use it can be put to, it will be proper to cook it that it may be consumed before it spoils, or to salt it that it may be preserved during the time necessary for a prolonged consumption. To this effect, we are to put up in one vessel or more, large stone pots for example, all the parts which spoil the soonest; these are the *liver*, the *heart*, and the *spleen;* if they cannot be consumed at once, they are to be put in a pot, by placing at the bottom a little salt at first, then adding successively all the pieces after rolling them over a table covered with salt. We then set aside, and salt in the same manner, in order to be consumed, the head cut in two, the neck divided into five or six pieces, and the end of the sides; all the rest of the animal is to be divided into portions that may be easily introduced into the stone pots, where they are to be placed in layers, between which is to be strewn a bed of salt; care is to be used to cover the pots as tightly as possible, either with parchments, slates, or stone plates and mortar of loam mixed with cows' hair, and to keep them in a cool place.

The raw flesh of animals may likewise be easily preserved by cutting it in very small slices, and keeping it immersed for an hour in a ley of soda rendered more caustic by lime mixed with salt and a little saltpetre; it will be sufficient to expose these slices to the air to dry them, or to keep them in a dry place. If, in killing the animal, a certain quantity of blood should be collected, it may be employed directly for the nourishment of hogs;* it will suffice then to dilute it with water, and to mix it with the aliments commonly given them; there is even no inconvenience in making it serve for the nourishment of man, as is done in Sweden, by kneading it with dough, or adding it to fat hashed up and seasoning it properly to make a sort of black pudding.

We know that there need be no fear of any of the affections of which the animals may have died to those who feed upon the flesh of them; we may be assured of this from very numerous examples, both in the provisioning of armies, and in the sales made by the keepers of cattle to the butchers, during the prevalence of very fatal affections among animals. These different facts prove that the food from animals dead of diseases has never occasioned the least evil to persons who have eaten of it. The fact has even been proved, that the flesh of animals dying of contagious diseases, and which we have before advised to inter without skinning them, has done no injury to those who have been nourished by it, although these animals had

* It is pretended that hogs, when they have been some time fed upon blood or flesh, become prone to run after children, chickens, &c.; but there need be little fear of these accidents, since hogs should always be separated from other animals of the farm yard, and, for a stronger reason, from children: besides, the animal matters will become mixed with many ordinary aliments: finally, if there is any fear of these results, it will be easy to boil the blood with water, before mixing it all with bran, potatoes, &c.

communicated a mortal affection to people who had dissected them.* Thus, then, we should never renounce the use of the flesh of those animals which have died from accident or disease, for the nourishment of man, from the fear of being injured by it; but it often happens that the flesh will be at once tough, soft and distasteful; in this case, it should still be preserved in the manner stated above, for the nourishment of dogs, hogs, and even poultry; if stewed a sufficient length of time, and in a quantity of water nearly equal to that used in boiling, it may be very easily cut up or hashed, and mixed with five or six times the quantity of potatoes, bran, &c. This mixture produces much more profitable nutriment to the domestic animals of which we have just spoken, than if there had been no mixture; it may be as good for them and more nourishing than the best wheat bread: we cannot, therefore, too earnestly advise the inhabitants of the country to avail themselves of their dead animals, excepting only, we repeat, those whose contagious diseases, before described, should be dangerous to the persons engaged in skinning them, and

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* We find, in a memoir published in the year VIII, by M. Huzard, member of the Institute, a great number of facts, conclusive on this head, and from among which we will cite the following.

During the contagious disease among cattle of 1770, and of the year VI, which had a much more dangerous character than the preceding, the number of beasts sold to the butchers was very great, yet without any of the diseases having been spread among the people.

The physicians charged with the care of visiting the indigent, (who would have been more exposed, if there had been any real danger from the use of these base viands,) being consulted have only been able to cite examples tending to prove the harmlessness of this food.

The opening of animals killed in the chase, presents the same pathological phenomena, as that of animals who have died of carbuncle. This disease is sometimes, indeed, occasioned by forced and violent marches.

The use of game, partly putrefied, does not occasion any distemper.

The chief physicians of the French armies of Sombre and Meuse, Rhine and Moselle, of Italy, have witnessed, as M. Huzard has, a great part of their armies nourished for a long time on the flesh of beeves and cows, which had died of the distemper which prevailed in the year IV, without any disease resulting to the numerous consumers of it.

Many observations, like those related of the two butchers of the Invalides, cited by M. Huzard, prove that diseases have been contracted, and even that death has supervened, among persons who had skinned animals affected with contagious diseases, while none of those who had been fed upon the flesh of these animals had been indisposed.

The almost general use, among the poor inhabitants of Paris, of the flesh of horses, which died during the famine of the year VII, was not followed by any special affection.

those which, already in a state of putrefaction, would be useful only for manuring the earth. In whatever way the flesh of animals is employed for nourishment, it will be proper to separate the bones, to be used as we shall point out further on.

Recipe for converting dead animals to a useful purpose.

The following means will permit the employment of dead animals as nourishment, in places even where there may be no person capable of skinning them.

Commence by opening the abdomen of the animal, and drawing out all the viscera, which may be used for manure, in the way before described; the animal is then to be cut into pieces of such a size that each may be put into a pot or kettle, which is to be half filled with water and then heated until the water begins to boil; one of the pieces is then placed in it, and allowed to boil until the skin can easily be removed; this scalded piece is then taken out, care being taken promptly to remove the skin by seizing it between the blade of the knife and the thumb, afterwards scraping off the hair with the same knife. Each time that a piece is removed, it will be necessary to add a little water, to replace that which has evaporated, and to keep it boiling for the reception of another part. When all the portions have been scalded in this manner, they may be salted for preservation, or stewed, in order to be employed in feeding dogs, hogs or fowls. The water in which all the parts of the animal have been boiled, should be passed through thin linen, to separate the hair, and mixed afterward with bran, &c. for feeding hogs.

When the skin of an animal may have been damaged, or cannot be sold to the tanners, either on account of the distance or any other reason, we may make use of it by scalding it in the manner just related, in order to separate the hair, cutting it afterward into very small portions, and cooking it by a small fire, in about six times its volume of water, (two quarts of water to a pound of skin, thus divided;) after seven or eight hours cooking, salt and seasoning may be added; the liquor is then to be strained through a cloth; when cooled, it forms a very nutritious and agreeable jelly.

We may likewise easily preserve the meat dressed for food; to this effect, place beforehand some stone pots in a good position; these are to be rinsed out, the moment before being used, with boiling water, and then are to be filled with the stewed meat, hot, and seasoned with salt, thyme, laurel, &c.; then reduce rapidly, over the fire, to one quarter of its volume, the liquor or broth in which the food has been cooked, and turn it upon each of the pots filled with the meat, well heaped up.

If the cooked meat should be too lean to form a bed of fat in each pot, it will be well to add any other fat matter which may be at hand; pot grease or any old fried meat, for example, which may be melted for this purpose.

The pots thus filled must be closed with their covers, or with plates, bound around with strips of old linen, covered with a paste of flour and water. These pots are to be kept in a cellar or any other cool place, and when one of them is commenced upon it is to be consumed as quickly as possible, to avoid its being spoiled, especially if in the summer.

An excellent method of preserving either the gelatinous liquor obtained from cooking the meat or skin, or the flesh cooked and hashed up, or finally the blood, consists in mixing these substances, sufficiently salted, with the dough of bread; the day following the baking, the bread is to be cut into slices of from six lines to an inch in thickness, these slices to be returned into the oven whence bread has just been taken, the door of which is to be left open to facilitate the drying. These slices, thus well dried, will keep many years, when put up in dry barrels, and stowed in a granary. We may thus form very good provisioning, either for men or animals; it is useless to add, that for these latter, we may employ, in making the dough, the cheapest flour, and even bran. In order to make use of this bread, it may be treated with water, in the manner of obtaining a soup of ordinary consistence.

As it is probable that, notwithstanding the preceding directions, it will not be at once determined in the country, to use the flesh of dead animals for nourishment, and besides all the parts not being applicable thereto, we point out the other most simple means of deriving advantage from their remains.

Skins.

When the skin cannot be sent to a tanner while fresh, it will be easy to preserve it for some time by scraping off with a knife all the flesh remaining upon it, then exposing it to the air, stretched upon a line or nailed against the wall. If it be necessary to wait some months for opportunity to send them to the tanners, it will be necessary to soak them two or three days in water, to which has been added about a quarter of a pound of slacked lime for every pailfull of water, to turn them several times a day in this liquid and stretch them afterwards in order to dry them. This simple operation will answer equally well for the preservation of the tendons, (vulgarly called *nerves*,) the clippings of the skin, tails, &c. which may be kept to sell to the glue makers.

The skins of horses, oxen, cows and goats may be treated thus; as to those whose hair is valuable, the skins of sheep, hares and rabbits, they may be preserved by salting; for this purpose, take as much water as will suffice to soak them in, to which is added common salt in the proportion of a large handfull to a pint of water; soak the skins in this mixture, turning them occasionally, for seven or eight days in winter, and two days in summer; at the end of this time, stretch them in the air to dry.

Bristles, Hair, Wool and Feathers.

To whatever use we may wish to put these substances, it will be necessary to dry them, that they may not spoil; for this purpose we spread them in an oven after baking bread, when it has been well swept out and we are assured that the heat is sufficiently abated that no risk will be run of burning them. In order to be still more certain of preserving these matters a long time, it will be well, before taking them from the oven, to place in the midst of them, after separating them a little, a flower pot supported between two pieces of brick, in order that the air may have access at the hole in the bottom, in which the half or quarter of a sulphur match should be burned; while the match is burning the door of the oven should be shut, and a quarter of an hour after we may remove the materials from the oven, and pack them up in boxes, cases, barrels, or any other vessel, in which they can be well closed. Horse hair may be preserved without any preparation; the longest is usefully employed in making cords for spreading linen upon, which last a long time, and are not apt to produce spots in wet weather, as cords of hemp or raw flax. The short hairs will serve to stuff furniture, saddles, &c. With respect to the short hair and the fur, by mixing them with an equal volume of moist earth they form an excellent manure, which acts mildly and for a long time; their mixture with a sandy earth or with good garden mould is perfectly suitable for shrubberies as I have proved by many trials, they smoke and air the soil, and on this account, are proper for all vegetables. Feathers mixed with moist earth form likewise a good manure, and they may be used for this purpose, when they can be used for no other.

Shoes and Nails.

When oxen, horses, asses or mules die or are killed, their feet often remain shod with shoes and nails; these should be torn off with strong pinchers; the nails are useful to masons, to fasten stucco plaster and mortar spread upon wood. In many provinces, and especially in Auvergne, these nails are kept to put in wooden shoes, which render them more durable; they are likewise useful to pale up fruit-trees along walls, by fastening their branches, with the aid of little strips of linen which support them.

Horns, Hoofs, Spurs, &c.

In order to separate these parts of the animal from the bones which fill them, it will suffice to allow them to soak in the same water, until they can be easily detached by passing between them the blade of a knife.

Spurs, horns and hoofs are formed of the same matter; those which are sufficiently large, without defects, and of a light shade, can be sold to the toymen; as to their value, the countrymen who live in the environs of large cities, may inform themselves by applying to the persons who exercise these professions; it varies in different localities. The price of those which are of a clear color, and have defects, or may not be sufficiently large, may be increased by reducing them by rasping, before sending them to the toymakers. Those which cannot be disposed of thus, as well as those which are very brown, and which have very prominent defects may be sold to the establishments for making prussian blue—they are worth from ten to fifteen franks for one hundred kil., or they will serve to form excellent manure; but for this purpose it is necessary to divide them very fine, the best means being to rasp them with a coarse rasp; the powder thus obtained may be spread over meadows, or beds of vegetables over all the earth under culture, or at the feet of different plants. This manure is so powerful, that the quantity obtained from four hoofs of a horse, ordinarily produces almost as much effect as a small load of dung, and indemnifies sufficiently for a labor, very hard it is true, but which may be performed by women or children, often but little occupied in the country. This powder sold as manure for the colonies, is valued at about twenty francs the hundred kil. For want of a rasp, the horns may be cut in small pieces by means of a knife well sharpened after softening them in boiling water; horns, thus cut are less effective than when reduced by rasping, but their action lasts longer.

Fat.

When an animal which cannot serve as aliment, is cut up, we should carefully collect, and set aside all the fat which we can find; it is to be cut up in small portions and melted, by heating it slowly over the fire, when it is entirely liquid, and does not froth any more it is to be left some minutes away from the fire, passed through a cloth which is to be strongly twisted, and then poured into very dry pots, to be kept cool and well covered. The fat thus prepared is very useful for greasing the axletrees of wheels, the harness of carriages, leather of shoes, &c.

Bones.

In localities at a distance of five leagues or more (unless at greater distances these transportations can be cheaply effected by return loads) from factories of ivory black and of toys, bones, collected in sufficiently large quantities, may be transported and sold advantageously, in these establishments; as in many places we may be deprived of this resource, and even of that of a mill to reduce them to a course powder, it will be necessary to divide them as well as possible, by cutting with a hatchet on a block, all the flat bones, and the softer parts, such as the bones of the head, neck, shoulders, sides and the round ends of the large bones; as to the large bones themselves they may be broken by means of a marline. When they have been thus all broken in pieces, as small as possible, they may be made to serve as manure, particularly on moist meadows; their good effects will be experienced five or six years afterwards. It will be necessary to be careful not to spread these bones upon a sandy or very dry soil, for if they should not be sufficiently divided to be entirely decomposed in fifteen or twenty years, their effect would scarcely be perceived.

Blood and Flesh.

When it should be decided not to employ by the means which we have before pointed out, these two substances for the nourishment of men and animals, an excellent manure may very easily be obtained from them. As to blood, it will be necessary to heat it in a kettle, or iron pot, stirring it incessantly with a wooden ladle, or better, with a rod of iron until it is reduced to a sort of a humid powder.

Then it is taken from the fire and allowed to cool when it is to be divided by rubbing it between the hands and mixed with two or three times its volume of dry earth; this mixture produces an excellent manure very easy to be spread very thinly upon cultivated earth, or between the tufts of different plants. Relatively to flesh, it may be stewed up, without taking out the bones, in large kettles or pots in which it should be completely immersed in water and closed completely with a cover well pressed down upon the edge of the pot or kettle, by means of three or four large stones. (In order to close it still better, it will be well to put between the edge and the cover some old pieces of linen.) After having thus, slowly, boiled the whole for seven or eight hours we may try whether the meat has become very tender by thrusting into it the blade of a knife. If it still remains tough, we should continue to heat for an hour or two; then removing the meat from the pot we can extract all the bones from it, to be employed as before said, and the meat is to be hashed up as fine as possible; it is to be mixed with dry mould, when it will answer for manuring the earth, as we have just said of the blood.

We may employ the raw meat as manure, by placing it near the hillocks of plants; but in this case it will be necessary, in order to spread it in small quantity at a time, to hash it or cut it up in small portions—a rather tedious operation—and it will be proper to cover it with earth, that it may not be too easily perceived and devoured by rats and other little field animals. This latter precaution will be proper in all cases; especially as it is easily accomplished. Raw meat is however less advantageous for manuring the earth than when it is cooked, because, in the former state, it is too quickly decomposed, and a great quantity of the gas which it produces is lost. This observation applies equally to blood which is employed without cooking. The flesh, as well as all interior parts, the blood, and empty bowels, may likewise be used in summer to produce maggots or little white worms; those are employed with much advantage, and sell sufficiently dear in pheasant walks, because they form a substitute for the eggs of ants, for the nourishment of young pheasants. In Paris, a bushel (the eighth part of a hectolitre) of maggots sells for from four to six francs, for the royal and private pheasant walks. The production of these little worms is so lucrative, that in order to obtain them, there is employed during the favorable seasons almost all the flesh and intestines of three or four thousand horses, which are killed at Montfaucon during this space of time.

The following is the manner of obtaining the maggots. A bed of flesh and entrails, five or six inches thick, is to be spread upon the ground and lightly covered with eight or ten inches of straw or litter. Soon a great number of flies pass through the straw and deposit their eggs upon the animal matter. Some days after, the worms, hatched and developed, replace almost all the animal matter which they have devoured; we find them mixed with a sort of mould and some morsels of flesh or tendons; these are to be separated with the hand, and all the mass of white worms and the mould with which they are mixed, collected with a shovel and put into sacks, to be sent either to the pheasantries or to the yards where they are employed.

In the great heats of summer, it is useful to protect the bed of remains, where the maggots are forming, from the warmth of the sun, by means of straw matting or litter supported upon sticks a few feet above the beds.

Maggots take the place very advantageously of the eggs of ants, not only for young pheasants, but likewise for raising turkies, little chickens, and divers other domestic birds.*

With these little worms may be raised nightingales, linnets, and other birds which are fed upon insects.

Fishers with the line consume great numbers of them in certain localities, and often pay very high for them. One of the most useful employments to which these maggots may be put, is to throw them into fish ponds, where they are quickly devoured, and the fish fatten very quickly upon them. With this aliment, two or three times the number of fishes can be kept in the same pond, and eight or ten times the produce obtained, for the want of nourishment alone diminishes the number of fishes, when amongst them there are not found any voracious ones, and they are besides protected from the different animals which eat them.

In order better to show the profit which the inhabitants of the country may obtain from dead animals, we will give, as example, the total value of a horse, by the easy operations which we have pointed out. We have placed in the same table the indication of the value of the same parts of a horse of rather large size, and in good condition, as is often found in the country, which has perished by accident. The weights of these dead bodies, result from a sufficient number of experiments which we have had occasion to make upon horses killed by the horse killers of Paris.

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* It is not proper to feed hens exclusively with them, as the eggs may contract a bad taste. This inconvenience need not be feared, if we are careful to mix them with grains or other vegetable aliment.

The value which we have placed upon the different products which may be obtained from them, is what they yield some leagues from Paris, consumed on the spot or sold in commerce; in a great number of places in France, which are indeed within reach of cities or sea-ports, the same prices may be obtained, and in almost all other places, the agriculturists collect from them as much and more profit for their own consuming.

The dissection of these two sorts of horses, has given, in fresh materials, the following mean quantities.

	Horse of medium size.		*Horse of good condition.*	
	kil.	gr.	kil.	gr.
Skin, - - - - -	34		37	
Blood, - - - -	18	500	20	810
Short and long hair, - -		100		220
Shoes and nails, - - -		450		800
Hoofs, - - - -	1	500	1	860
Viscera and appurtenances, bowels, liver, brains,	36		39	
Tendons, - - - -	2		2	100
Fat, - - - - - -	4	150	31	500
Muscular flesh, (viande,) -	164		203	
Bones, completely cleared after cooking, - - - -	46		48	500
Total weight of the dead bodies,	306	700	384	790

The preparation of these matters costs but little more than the combustibles (wood, fagots, turf, &c.) which is used, in winter for heating, cooking &c. The other expense is nothing but the labor and in the country there is so much time lost by children and young people during the winter evenings, and at times when there is nothing to be done in the fields, that these new occupations would not often disturb other work and would lessen the danger of idleness.

The cutting up of dead animals would be more profitable than we have supposed in the preceeding table, if we were to employ the blood and flesh in feeding hogs; indeed we should obtain still more profit by employing them for the nourishment of man.

Country people may then obtain at least the value of 60 francs from the use of the dead body of a horse of medium size. How often are they ignorant that with so little expense they may obtain a much greater price from an ox or a cow, whose weight often amounts to more than 450 kilogrammes.

No animal, however small, should be neglected; for even though they would not be of any other use, we may in a few minutes cut them up into small portions upon a log, with the aid of a hedging bill, run a furrow between the ranges of different plants, and deposit these portions in it at 15 or 18 inches apart, and cover them with earth; the increase of the product of the surrounding plants, which may be remarked often many years afterwards, will indemnify very amply, for the little trouble we may have had to obtain it.

Many times, at the gates of Paris, where work is very dear, the horse killers have found it advantageous to skin rats and dry the skins in the air to sell to the furriers at 3 francs, 75 cts. a hundred. Mole skins are sold as high as 10 francs the hundred.

In the horse yards, the skins of cats and dogs are used in the same manner; the fat of these animals is melted, as we have said, and sold very dear; and finally the flesh of horses, dogs and cats, when it is of a fine red color, and presents no brown or livid spots, is destined, secretly, for the nourishment of men.

All the industrious people who are occupied in curing these animal substances, are in want of the former materials in France, or procure them at great expence from foreign nations; in scarcely any place are these substances sufficient for manuring the earth, and every where, without exception, they may be very advantageously employed.

Nevertheless these matters so useful, and so incompletely collected in places where there is a dense population, are totally lost in most small towns, villages, and hamlets.

Let us hope that in future it will not be so; country people who know so well how to employ objects of the least value for the wants of their families, should not neglect these useful substances, the least advantage of which is to fertilize the earth, increasing thus the product of the harvest which, contributing to the supply of their particular necessites, concurs at the same time to promote the general good.

Since such important results were worthy of the attention bestowed by the royal and central society of agriculture, they will doubtless excite the solicitude of the enlightened administrators of our departments, who know how to encourage all the means of obtaining them.*

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* The memoir from which this notice is extracted points out a great number of means of a more elevated order for the employment of animal matters in various arts; it will form a part of the *Memoirs of the royal and central Society of Agriculture for* 1830.

ART. XVI.—*An Essay on Gypsies; abridged from the Revue Encyclopedique, Nov.* 1832; by J. GRISCOM.

THERE are few questions in Anthropology or Ethnography which have more closely engaged the attention of philologists, geographers and historians than that of the origin and character of this singular people. A race of men which presents the most extraordinary phenomenon in social life, has existed nearly four centuries in Europe; and yet remains almost unknown. Neither time, climate, politics nor example have produced any change in their institutions, their manners, their language or their religious ideas. The Israelites are the only people, who have preserved, like them, their primitive character in foreign lands, but with far less distinctness and discrimination.

Names by which they are known in the different countries in which they reside.—The Arabs and Moors call them *Harami* (robbers); the Hungarians, *Cinganys* and *Pharaoh Nepek* (people of Pharaoh). The latter name is also given them in Transylvania; the English have adopted the name of *Gipsies*, an alteration of the word *Egyptians*; the Scotch, that of *Caird;* the Spanish call them *Gitanos;* the Portuguese, *Ciganos;* the Dutch, *Heidenen* (idolaters); the Russians, *Tzengani;* the Italians, *Zingari;* the Swedes, *Spakaring;* the Danish and Norwegians, *Tatars;* the Wallachians, Bessarabians, Moldavians, Servians and Sclavonians, *Cigani;* the Germans, *Zigeuner;* in France they received at first the name of *Egyptians* and more recently that of *Bohemiens*, because the earliest of the tribe came into France from Bohemia. Historians of the middle ages, designate them by the name of *Azinghans;* the modern Greeks, under that of *Atinghans;* in *Adzerbaidjan*, they are called *Hindou Karach*, (black Hindoos); in Persia, *Louri;* the Bucharians and inhabitants of Turkistan, call them *Tziaghi* which appears to be the root of *Tchingeni* the term given by the Turks to this wandering race. I have been acquainted in Europe with three of their *Rabers* or chiefs, who assure me that they call themselves *Roumna-Chal*. These two words belong to the Mahratta language, and signify *men who wander in the plains*. I consider *Tzengaris* as their primitive name and which is still preserved in their mother country.

Different writers have assigned to these people a very different origin—one from the eastern part of Tunis,—another from Zanguebar—one from Mount Caucasus;—one considers them as German Jews—and others bring them from Egypt, Colchos, the Ukraine, &c.

We know of but three writers who have placed this question in a true point of view. The two first, whose opinion is admitted by the learned generally are Grellmann and David Richardson who consider India as the cradle of the Tzengaris; the Abbe Dubois places them among the Kouravers of Mahissoun, but in our opinion the country of the Mahrattas is their original position, and there they are still found united in tribes.

The primitive tribes of the Tzengaris is a subdivision of different tribes of Parias or men out of caste. The origin of Parias is very ancient. This sub-caste is formed by the union of individuals driven from different castes for offences committed against the religion and laws and includes a great number of tribes, among whom may be reckoned the *Vallouvers,* the *Chakilis,* the *Moutchiers,* &c. and lastly the *Tzengaris* the primitive tribe of our Bohemians and Egyptians or the Zingari of the nations which term still resembles the original name.

The tribe of *Tzengaris,* called also *Vangaris* on the coast of Concan and of Malabar is nomadic. I have met them often in whole bands near the ancient and magnificent city of *Visapour* and in the vincinity of *Bangalore* and *Mahissour,* which we call *Mysore,* from a habit of disfiguring eastern names. They are in general of a dark complexion which justifies the Persian appellation of black Hindoos. Their religion, institutions, manners, and language, differ from those of other tribes of Hindoos. During a war they are addicted to pillage, carry provisions for the armies, and fill them with spies and dancers. During peace they make coarse stuffs, and deal in rice, butter, salt, opium, &c. Their women are as handsome and agreeable as the generality of Hindoos, but are very lascivious. They often carry off young girls whom they sell to natives and Europeans. They are accused of immolating human victims to their Demons and of eating human flesh. They every where follow the trade of errand runners and procurers; the women are fortune tellers, a business which they practice by striking on a drum in order to invoke the Demon, then pronouncing with the air of a sibyl and with rare volubility a string of mystical words, and after having gazed at the sky and examined the lineaments of the hand of the person who consults them, they gravely predict the good or evil which is to be his destiny. The women also practice tatooing, and the figures of stars, flowers, animals, &c. which they imprint upon the skin by puncturation and vegetable juices, are ineffaceable. They live in families, and it is not rare to see father and daughter, uncle and niece, brother and sister living like beasts together. They are suspicious, liers, gamblers, drunkards, cowards, poltroons and altogether illiterate; they despise religion and have no other creed than the fear of evil genii and of fatality. They originated in the province of *Mahrat* among the eastern Gauts.

The celebrated *Cherif Eddin*, assures us that Timur sullied his conquests by the massacre of 100,000 prisoners, Persians and Hindoos. The Monguls spread such terror in all parts of India, that great numbers abandoned that unhappy country. The Hindoos of the three first castes indeed, remained firm to their country;—their religion made it a duty; but no place could retain the Soudras and Parias. They are such vagabonds that I have myself seen them in Abyssinia, in Arabia, at Tzouakem in the Persian Gulf, at Penang, at Singapore, at Malacca, at Manilla, at Celebes, at Anyer and even in China.

Is it not natural to believe that the Tzengaris, who are so accustomed to a camp life, and excluded from Hindoo communion, should practice or feign to practice religion which offered them so many advantages, that they should act as spies and purveyors to the Mongul armies, and that a portion of them should accompany Timur in his long traverse through Kandahar, Persia and Bukahra; and after passing through the Caspian and Caucasian regions and leaving behind them a train of detached families, they should have come to a stand, some in Russia, others in Asia Minor; that a second column should have passed from Kandahar into Mekran, and Irak-Arabia, and a third strayed into Syria, Palestine, and Arâbia-Petrea and should have reached Egypt by the Isthmus of Suèz and thence should have passed into Mauritania.

Is it not probable that these rude travellers landed from the Black Sea and Asia Minor in Europe by the intervention of the Turks during their wars with the Greek empire; and it is equally probable that the first of them who came to Europe, sojourned in European Turkey as Aventine informs us and proceeded thence to Wallachia and Moldavia. In 1417, they were found in Hungary and at the conclusion of that year they were seen in Germany and Bohemia, the next year in Switzerland, and in 1422 in Italy. Pasquier carries their origin in

France to 1417 and says that they styled themselves Christians from Lower Egypt, expelled thence by the Saracens, but that in reality they came from Bohemia. From France, they passed into Spain and Portugal, and afterwards under Henry VIII, into England. Their hordes commonly consist of two or three hundred persons of both sexes.

Although it is difficult to explain how they acquired the name of Gypsies or Egyptians, it is certain they neither have an Egyptian origin, nor came from Egypt to Europe, as Crantz and Munster have proved.

Countries in which the Tzengaris are now found.

These people constitute a part of the population of all the countries of Europe and of a large portion of Asia. In Africa, they are found only in Egypt, Nubia, Abyssinia, Soudan and Barbary. They have never appeared in America.

They are most numerous in Spain, Scotland, Ireland, Turkey, and Hungary, but especially in Transylvania, Moldavia, Wallachia, Sclavonia, Courland, Lithuania and the Caucasian provinces.

In England they are still pretty numerous, but are found only in distant places, seldom coming into the towns excepting in small companies of two or three persons. In Germany, Sweden and Denmark, they have become rare, as also in Switzerland and the Low Countries. In Italy, their numbers are diminished. In Spain, it is said that there are fifty or sixty thousand of them, and in Hungary, according to the best information, about fifty thousand. In Transylvania, they are the most numerous, for in a population of 1,720,000 souls there are reckoned 104,000 Tzengaris. I have no fear of exaggeration in estimating the Tzengarian population of Europe at nearly a million, in Africa, at 400,000; in India, at 1,500,000 and about 2,000,000 in all the rest of Asia, for except in Asiatic Russia, China, Siam, Annan and Japan, they are every where to be found. Hence we may deem the total population of these people to be five millions.

What a painful subject of reflection is it to think of so large a portion of the human race, thrown as it were beyond the common rights of nations; so many men wandering about without any claims which can attach them to the soil, encamping in places remote from civilization: living by theft and deception, and every where diffused, notwithstanding the persecutions and contempt which are heaped upon them. —*G. Louis Domeny DeRienzi.*

ART. XVII.—*On the Collision of two Comets, and the Comet of July,* 1831; *by* J. J. LITTROW. (Zeitschrift für Physik.)

OF all the comets which are known to astronomers, that of Biela is the only one whose orbit is such as to admit of its ever coming in contact with the Earth. This is a circumstance which renders that body an object of deep and peculiar interest to the inhabitants of our globe. Another very remarkable fact, in relation to Biela's comet, is, that its orbit passes very near to that of Encke's comet, so that in course of time, it will not only make its appearance in the vicinity of our Earth, but will also pass very near, perhaps even come in contact with the comet of Encke. This possibility of a collision between two of the bodies of the solar system does not appear to have engaged the attention of astronomers hitherto, and is, so far as our knowledge extends, an anomaly in the celestial motions.

The point of space at which it is possible for this encounter to happen, is situated at a distance from the nearest point of the terrestrial orbit of little more than half the semi-diameter of this orbit: it is then by no means impossible that it may fall to our lot to witness the interesting spectacle of the conflict of these two comets in the heavens, and at a distance which is inconsiderable when compared to that of some other bodies in the solar system. Should such an event not result in the destruction of the two comets, it would at least occasion a great derangement in their motions, indeed a total change in their orbits; so that we should perhaps have little cause to fear, for the future, the long dreaded encounter of Biela's comet with the Earth.

The following calculation, founded on the elements given by Encke and Damoiseau for the year 1832, will serve to show the possibility of the event alluded to: the elements are as follows:—

	Encke's comet.	Biela's.
Longitude of the ascending node,	334° 32′ 5.2″	248° 12′ 24″
Inclination to the ecliptic,	13° 22′ 12.3″	13° 13′ 13″
Semi-transverse axis,	2.222212	3.53683
Angle of eccentricity,	57° 43′ 6.3″	48° 44′ 30.4″

From these data we find, by the well known formulæ of spherical trigonometry, that the common intersection of the planes of the two orbits, makes with the line of the nodes of Encke's comet on the ecliptic an angle of 47° 15′ 52.4″, and with that of Biela's comet an angle of 132° 2′ 27.2″, and that these two planes are inclined to each other at an angle of 18° 6′ 10.6″.

It now remains to ascertain the point in which the line of intersection of the two planes is cut by each of the orbits respectively. For this purpose we will take for the aphelion longitude of Encke's comet 337° 21′ 2.4″, the value determined by Encke himself, with great accuracy. The aphelion longitude of Biela's comet is not known with so great a degree of precision. Olbers gives 292° 39′, Clausen 296° 38′, Damoiseau 289° 56′. Great exactness is not necessary in this element, which is subject to considerable perturbations, particularly from the action of the planet Jupiter. We will take then for the aphelion longitude 293° 4′ 20″, the mean of the three values given above, and we shall then have, for the instant in which the comets pass the common intersection of the planes of their orbits, the true anomaly reckoned from the aphelion,

44° 26′ 55.2″ for Encke's comet,
87° 10′ 31.2″ for Biela's,

and according to known formulæ, the distances from the sun's center are

1.59881 for Encke's comet,
1.59868 for Biela's.

Thus, it appears that the distance of the two comets, at the instant of their passing the common intersection of the planes of their orbits, is only 0.00013 of the semi-diameter of the terrestrial orbit, or about 12350 miles.

A slight change in the elements, which, especially those of Biela's comet, are subject to great disturbances, may greatly diminish, and even totally annihilate, this distance, in which case the collision of the two comets would take place in the direction of the line of the centers.

It follows from the preceding investigation, that the point of space in which this collision might occur is determined by the following coordinates, referred to the center of the sun.

Heliocentric longitude,	$l=21° 0′ 50″$
Latitude north,	$b=9° 49′ 46″$
Distance,	$r=1.5087$

The distance of this point from the nearest point of the terrestrial orbit, is readily found to be equal to $\sqrt{1+r^2-2r\cos. b}$, or 0.6349 of the semi-diameter of this orbit. Consequently, if at the moment of contact, the earth should be in the vicinity of this part of its orbit, in other words, if this remarkable event should occur about the middle of October, it would take place within such a distance as to admit of its being observed by the unassisted sight.

Comet of July, 1832.—Eugene Bouvard has recently calculated, at the observatory of Paris, the following elements of the parabolic orbit of this little comet, from the observations of M. Gambart at Marseilles, continued from July 19, when he discovered it, to the 27th of August.

Instant of the comet's passage of the perihelion—1832, September 26.028058—mean time reckoned from midnight at Paris.

Perihelion distance,	1.183603
Longitude of the perihelion,	227° 55′ 35.9″
Longitude of the ascending node,	72° 26′ 41.9″
Inclination of the orbit,	43° 18′ 3.1″
Heliocentric motion, retrograde.	

These elements, which have been communicated to us by Eugene Bouvard, will be inserted in the Connoissance des Temps for 1835. They are interesting as the first advances of this young astronomer, in a career so usefully and honorably marked out by his uncle. The subjoined comparison of the positions observed by M. Gambart with those resulting from the elements of M. Bouvard, appear, in our view, by their very small differences, to justify the highest confidence in the exactness of their elements.

	Difference in			Difference in	
	Longitude.	Latitude.		Longitude.	Latitude.
July 20,	+0.1″	0.0″	Aug. 13,	−17.9″	−7.5″
22,	+7.7	−3.3	16,	−5.9	−2.6
25,	+7.0	+2.6	20,	+2.1	−3.7
29,	+2.4	−9.4	21,	−8.3	−19.9
Aug. 1,	−2.4	−30.0	26,	−8.6	+1.1
8,	0.0	−0.4	27,	+0.1	−0.2

Bib. Univ. Oct. 1832.

Art. XVIII.—*Description of the Bare Hills near Baltimore*; by H. H. Hayden, M. D.

In the year 1810 and at the particular request of the Editor of a Periodical Journal ("the Baltimore Medical and Philosophical Lyceum") I undertook to give a Mineralogical and Geological description of the country surrounding Baltimore, to the extent of about nine miles. This, although an imperfect sketch, embraced that interesting region, commonly and very appropriately called, the Bare Hills, the description of which was subsequently republished in Dr. Bruce's Journal.

As my knowledge of this region was, at that time, superficial, and as I have since repeatedly visited, and carefully examined almost every part of it and have discovered some interesting minerals, not before known to exist there; and moreover, as this district, on account of the variety and character of its minerals, has excited no small degree of interest among American mineralogists, I have ventured to offer you another, and I trust a much more perfect description; in the hope, that those who may hereafter visit this district, may, with this aid, find the several localities, without fatigue and trouble.

With this view I send you a sketch of the district, as correct, I believe, as could well be made without an actual survey. Upon this sketch I have endeavored to designate all the interesting points, and should you deem it in any degree valuable, it is at your disposal.

The district which I propose to describe, has, I believe, long been known as the Barrens, or Barren Fields; but, for many years past, it has been called the "Bare Hills."

Until the year 1808 or 1810, little was known of the mineralogical character of these hills, and little else was obvious to the traveler besides their repulsive aspect. About this time, the chromate of iron, in small irregular or rolled masses, was discovered in one of the deep ravines, by Mr. Henfrey, a gentleman who it is believed, was the discoverer of chrome, titanium, and several other interesting minerals, in this part of the country. Subsequently, and particularly since the commencement of regular operations for obtaining chromate of iron, this district has excited, especially among mineralogists, a degree of interest not surpassed, perhaps, in the case of any locality in the United States.

The district in question, lies upon the northern slope of a range of irregular hills, running a little north of east, and south of west. This northern slope is composed, principally, of serpentine rocks, and is in extent from east to west, about one mile, and from north to south, or from the summit to the base of the hills, nearly half a mile.

The Falls turnpike road, running north from Baltimore, passes directly over the ridge, dividing the district into two nearly equal parts.

The approach to the Bare Hills, from Baltimore, is by a gentle ascent up the southern slope of the hill, which commences a few rods north of the passage of the Susquehannah rail road across the Falls turnpike road, six miles from Baltimore. In ascending the hill, the surface presents but little to interest the mineralogist or geologist, beside the view of the surrounding country; this, with the exception of the narrow inter-vale upon the borders of Jones's falls, is composed chiefly of high, bold, and picturesque hills, which, at certain seasons are covered with a luxuriant vegetation. The hill under consideration, is not, however, without interest to the mineralogist. The first appearance of a rock-formation is on the left hand, in rising the hill, and this was first exposed to view in making the turnpike road. It is of mica slate (or what some would call gneissoid) ruuning in a N. W. direction (contrary to most of the leading ridges) and having a dip to the south west. The extent of this formation to the north west is not exactly known; it has, however, been traced several miles, although it seldom appears above the surface.

The grounds, on the right hand, descend into a valley in which runs a small stream of water, supplied by springs which flow at the head of the valley. At, and in the neighborhood of this point, and on the slope of the hill upon the east side of the valley, we observe the first appearances of the magnesian formation, viz. steatite variously modified. Arriving at the summit, we see on the right hand, the commencement of the serpentine formation, which extends northwardly to the base of the hills. On the descent, which is gradual, the entire district opens to view, both to the right and to the left, presenting to the eye, a series of hills of regular and pretty uniform surfaces, but upon which sterility seems to have established its uniform and unyielding sway; for, with the exception of a few stinted shrub oaks, which have taken root and derive a scanty nourishment from a thinly scattered soil, that in time has been formed in a few of the low depressed places, scarcely a shrub or bush of any kind is seen to interrupt the view, or change the barren aspect of this solitary waste.

About midway from the summit to the base of the hills, on the north, an excavation was commenced in the rocks, in making the turnpike road, and which, as we descend the hill, deepens and exposes the rocks upon the right hand, to a considerable depth, thereby affording an excellent opportunity of examining their structure and composition, which is, perhaps, as interesting as that of any other place, that has hitherto been exposed to view in this district.

At the base of the hill, where the serpentine formation terminates, the road passes over a small stone bridge of one arch, and under which runs a brook or small stream of water that comes from the hills to the west, constituting an auxiliary branch of Jones's Falls, with which it unites at a short distance east of the bridge. Thence the stream pursues an easterly direction, at the base of Bare Hills, and so passes around the eastern slope in a semi-circular course, until it crosses the turnpike road at the base of the southern slope, near the point at which the rail road intersects the turnpike.

I have remarked, that on arriving at the summit of the hill, we observe the commencement of the serpentine formation. As such, it has hitherto been considered, and is uniformly well understood. But, in order to avoid exceptions which may hereafter be made to the character given to these rocks, it seems necessary that I should be a little more explicit as to their true character. With this view, I venture the opinion that the aggregate formation of the rocks of Bare Hills is not strictly serpentine. It is true, that real serpentine exists in this district, and that even noble serpentine, in small specimens has been found here; but, the aggregate mass of the rocks of these hills, according to the classification of Brongniart, to which I know of no one that is preferable, falls under the denomination of ophiolite, which he describes as being "a paste of serpentine enveloping oxidulous iron and other accessory minerals disseminated:"—Hence Brongniart describes as "principal varieties," ferriferous ophiolite, chromiferous ophiolite, diallagic ophiolite and garnetic ophiolite—all of which, with the exception of garnetic ophiolite, are found, at nearly every point of the Bare Hills. The chromiferous variety seems most abundant; for the rocks, in nearly the entire district, on being broken, present the granular chromate of iron, as a component part.

Besides, there are several other kinds of "accessory minerals" entering, as will appear hereafter, as constituents, into the composition of almost the entire mass of these rocks, and which may be seen by a superficial observer.

Having noted the general features of the Bare Hills, I shall proceed to designate and point out, upon the accompanying sketch, the localities of all the different minerals which, as far as I know, have been found in this district. To effect this object, and to determine their relative distances, it becomes necessary to establish a certain fixed point or points of departure, from which the several admeasurements were taken, in yards or paces.

My first point of departure is at the southern extremity of the wall of the bridge on the east side at A. From this point south at the distance of twenty yards, a small foot path leads from the road down the hill in an easterly direction. At the distance of ninety yards from the turnpike road, and at the base of the hill by the side of the path mentioned, the rocks jut out of the hill, and present a remarkable instance of the admixture of "accessory minerals," which constitute ophiolite. It is composed, principally of serpentine and granular felspâr.

At B, twenty four yards south from A, an excavation was made at the base of the rocks, as they break out of the hill, to carry away the water that descends from the hill in a trench cut by the road side. At the *point* where the water turns from the road to pass off down the hill, and at the bottom and sides of the excavation, we find, on removing the debris and sand that have been deposited by heavy rains, an interesting locality of the schistic ophiolite. It is composed of interrupted layers of serpentine felspar and magnesia. On removing carefully the laminæ of serpentine, the surfaces both of the felspar and serpentine exhibit, upon a white ground, a very beautiful arborescence, probably of manganese.

Some of these specimens are not surpassed in delicacy, and beauty of delineation, by any thing of the kind that has been found in this State. These arborescent appearances are common among the rocks of Bare Hills; but this locality furnishes the greatest number of beautiful specimens. Still ascending the hill to the south, on the east, or left hand side of the road at C, and distant from A, sixty two yards, we discover running into the hill, a vein, or almost a dyke, of beautiful white acicular asbestos, four or five feet in thickness. This locality is rendered the more interesting, as in breaking open a mass of the mineral, we discover occasional cavities or depressions, filled with small dendritic formations, discolored, and sometimes, rendered almost black, by manganese, and having the appearance of minute shrubbery.

Pursuing the same course, upon the margin of the trench or ditch by the road side, at D, and distant ninety two yards from A, and so onward to E one hundred and twenty six yards, we meet with another striking example of "accessory minerals disseminated" in serpentine and constituting ophiolite. The rocks between these two points, appear, on a close examination, to have been perforated with innumerable holes of an acute rhombic form. At the surface of the rocks, I have never discovered any appearance of the mineral that once occupied these holes. But on breaking the rock, and obtaining a fresh fracture, we observe numerous crystals of the above form, enveloped in the mass, and from $\frac{1}{8}$ to $\frac{3}{16}$ of an inch in width. It is this substance that has by exposure, been decomposed, and has left the cavities open. What it is, I have not been able, satisfactorily, to determine. The crystals are often well defined, and of a pale greenish color; it resembles in a degree, some of the varieties of actynolite and epidote. But I am not aware that either of those minerals is so liable, on exposure, to decomposition and total disappearance from its gangue.

Proceeding south in the same line to F, two hundred and twenty seven yards from the point of departure A, we discover in the rocks upon the left hand, a vein of semi-opal, running in a S. E. direction. This mineral is often found upon the surface, in various other places in this district. But in no one have I found it so pure and transparent as at this place.

Ascending the hill still farther to G, distant two hundred and forty yards from A, and near the point where the road-makers commenced excavating the rocks upon the side of the hill, we find a small vein of very fine "quartz rezinite" or Pitch stone, inclining to the N. E. This locality is the only one I believe, that has been discovered, in this district. It is highly probable, however, that the same mineral may be found at other points of the same formation. The above vein has yielded, at different times, very fine specimens, seldom however, of a greater thickness than $\frac{1}{2}$ or $\frac{5}{8}$ of an inch. The mineral is enveloped in a greenish talc chlorite, and is, in its present state, quite thin, and appears as if running out; consequently it is not easily found. It is more than probable, however, that by breaking up the rocks, it would reappear, and afford finer and better specimens than have yet been found.

Besides the minerals which I have pointed out on this line, there is scarcely one yard of the whole distance, in which something does not occur to interest an admirer of mineralogy.

Returning from this locality to the bridge, we assume the second point of departure or admeasurement from the foot or foundation of the wall, at the N. W. corner at H. The measurements from this point, were traced upon the margin of the Brook, on the north side, the grounds on the south side (its course being W. S. W.) being broken. At the point I, distant from H one hundred and twenty yards, on the south or opposite side of the brook, near the edge of the water, the white Lithomarge may be found in a vein under a small ledge of rocks projecting South Westerly. At this place a little search may be requisite, as the vein is sometimes buried by the debris, that is deposited over it during the swollen state of the stream, occasioned by heavy rains.

This mineral, it is well known, absorbs a large quantity of water, and in the situation in which it is found at this point, it is usually saturated. In order to preserve the specimens entire, it is necessary to wrap them in several folds of wet, or moistened paper, and, as soon as possible, to lay them in the shade, that the water may evaporate slowly—otherwise they fall into numerous small angular pieces.*

At the distance of one hundred and thirty two yards from H, we are opposite to the gorge or opening of a deep ravine that comes in from the south, and at the head of which flows a small spring of water. The commencement of this ravine is on the west side of the Turnpike road, near, and opposite to the locality of the pitch stone. The descent from this point to the bottom is precipitous, but is, nevertheless, rendered interesting by the fact that the rocks are completely exposed to view, and contain a variety of the magnesian substances lying in situ. In descending this ravine still farther, we observe in the side of the hill on the right hand, numerous veins of the semi-opal cropping out upon the surface, but much weathered and fragile. The cacholong is occasionally found upon the sides of this hill, and in the ravine.

* For the most accurate description of this mineral, See Bergman, Vol. ii, page 161.

Returning again to the point H and tracing off, upon the margin of the brook as before, the distance of one hundred and eighty seven yards from H to J, we discover immediately opposite, or across the brook, and under a shelving projection of rocks near the water's edge, a thick vein of the red Lithomarge, of a pure and beautiful quality. In obtaining specimens from this locality, the same precautions are necessary as in the former instance.

At the distance of two hundred and thirty yards from the point H, we come to the opening of another deep ravine that stretches away to the south. Between the bridge and this point, we observe a remarkable instance of "accessory minerals disseminated" through the entire mass of the rocks; for, independently of the granular chrome, oxidulous iron, &c. there are numerous crystals or spiculæ, of a substance resembly hornblende intermixed with, and running in all directions through the rocks.

Of the *gisement* or geological situation of the rocks of this district I have hitherto said nothing, by reason of the ambiguity, or difficulties that exist at almost every point. In general, they seem to be promiscuously thrown together in utter confusion. In some places, something more like order is manifested in their relative position, and at this place they appear to incline to the North West.

Resuming again our position at the opening of the ravine, and tracing it upon the margin of the small run of water that flows from its head, we find much to interest the mineralogist, in the variously modified substances that are presented to view, as the rocks are, in many places, exposed in situ. As the particular localities upon the sides of this ravine and those to be hereafter mentioned are so readily found, and easy of access, it is considered unnecessary to make any further references, to actual admeasurements or points of distance.

Upon the slope of the hill on the east side of the ravine just mentioned, and but a few rods from the brook at K, extensive operations have been carried on for the purpose of obtaining chrome, of which large quantities, of an excellent quality, were raised. The works, I believe, were carried to the depth of about eighty feet, but have, for some time, been abandoned. In the prosecution of these works, many interesting specimens of minerals were thrown upon the surface, such as the red and white lithomarge, green foliated talc, steatite, silicate of magnesia, and other magnesian substances. A little farther up the ravine on the west side at L, are extensive excavations, the result of the first attempts to obtain the chromate of iron, and the quantity here obtained was considerable. The course of the vein of chrome, at this point, seemed to correspond with the slope of the hill, and was at the depth of about ten feet. The greater part of it lay between the rocks, in a gangue of indurated talc steatite, mixed with talc, and variously colored by the oxide of chrome, or, perhaps the chromic acid, as some parts were of a pale, others of a beautiful deep green, others still of a pink, or deep crimson, variegated by, or invested, on one or more sides, with the silicate of magnesia. It was, from specimens obtained at this locality, that I ascertained, some years since, the existence of what has been called vermicular talc. This curious substance is not easily detected in the examination of a specimen, although, I have reason to believe, it is very prevalent in the rocks of Bare Hills. Yet it was only by directing the flame of the blow pipe upon the deep pink colored talc, that it was observed, by a kind of intumescence, similar to that of borate of soda under the blow pipe; with this difference, however, that the talc is thrown off in the form and with the motions of small worms. Hence, probably, the name given it, and which appears by no means, inappropriate.

Passing now over the hill to the west, or returning down the ravine to the brook, and ascending it forty or fifty rods, we come to a third ravine stretching away to the south, to the skirt of a wood where it commences.

Upon the brow of the hills, both upon the right and left hand, in ascending the ravine, excavations have been made at M N, and O, in search of chrome, but the prospect being unfavorable, they were abandoned. There may be obtained, however, at these points, in abundance, beautiful specimens of the granular chromate of iron, in a compact indurated talc steatite, of a whitish or straw color, which, contrasted with the black grains of chrome, gives the specimen an agreeable aspect. Several interesting minerals, as red and white lithomarge, white and green foliated talc steatite, silicate of magnesia, &c. were here thrown out.

This ravine, in particular, has been rendered interesting, (and is no less so at present) in other respects. In traversing up the stream from the bridge, a number of years since, and at the point at which the little run of water in the ravine forms a junction with the brooks, I found a singular piece of granite, composed of white quartz, white and flesh colored feldspar, handsome spiculæ of green hornblende, rhombic tables of pearly mica (the mica binaire, of Haüy, See fig. 206) and well defined crystals of titan silico calcaire. On breaking open the mass, I discovered a fine piece of the aventurine feldspar. As this piece of granite was evidently out of place, being surrounded, on every side, by a magnesian formation, I thought it possible that it might have been brought down the ravine from the heights to the south. With this view I commenced a search up the ravine, and upon the sides, and in the small run of water that winds its way down the hill, I found several pieces of the same granite, in some of which small specks of aventurine were apparent. Near the head of the ravine, at T, where the ground was less broken or but slightly excavated by the rains, I found several pieces more, one of which seven or eight inches long, and two inches thick, contained numerous well defined crystals of titan silico calcaire. Another of the same kind of granite contained a substance resembling the phosphate of manganese, but which is still undetermined. Encouraged by these specimens, I pursued my course higher into the skirt of the forest trees, where I found, exposed to view by the heavy rains, the northern border or out cropping of the mica slate ridge (or gneissoid formation) before mentioned. Between the strata of these rocks, I observed small beds or veins of the same granite, from which the pieces, found near that point, and along the ravine, had been detached and carried by the currents of water. I have been thus particular in describing this locality, which in my estimation possesses unusual interest, in hopes that should any excavations be made hereafter at this point, the attention of some mineralogist may be directed to it. Independently of the other minerals found in this granite, the aventurine feldspar alone (one of the most beautiful and interesting substances in the mineral kingdom, and found at no other place in America, except by Dr. Bigsby, on the borders of Lake St. Joseph,) is a sufficient inducement to undertake a vigorous search, where there is a prospect of obtaining it in such perfection.

Passing from this ravine to the west, on the margin of the brook, and distant forty or fifty rods, we come to the opening of another ravine that stretches, like the others, to the south. At the head of this in the skirt of the wood, fine specimens of the ligniform steatite have been found, and perhaps may still be discovered upon the surface. On the brow of the hill, on the west side of the ravine at P, also at 2 R and S, other excavations have been made in search of chrome, but I believe without success.

A little to the west of this point, the serpentine formation disappears. In this neighborhood are several springs, which are evidently the sources of the small stream so often mentioned.

Several interesting minerals have been found, both in and on the margin of this brook; e. g. the beryl crystallized, and in fragments of crystals without facets; masses of quartz, containing well defined and large crystals of black tourmaline, and masses of rolled, or waterworn steatite, in which is a beautiful display of the asbestiform steatite running through them. The masses of rocks and stones that have been hurried downwards by the swollen current of the stream, and deposited in its bed and on its banks, almost from its source to the bridge, are well worthy of an examination by those persons who are not familiar with formations of this kind.

On the north side of the stream is a hill, or ridge, extending to the east and terminating almost in a point, at the turnpike road, a few rods north of the bridge, which is of the same formation as those already described. But as there are in it no excavations or ravines, by which the minerals which it contains might be exposed to view, nothing definite is known of them.

Having pointed out the most interesting localities known upon the road, and upon the hills to the west, our attention will next be directed to the eastern section of the district.

From the southern extremity of the stone bridge, we descend the hill, from the road side by the foot path already mentioned, and continue along eastwardly at the foot of the hills. By this route, an opportunity is afforded of examining the rocks as they are presented to view in the side of the hill facing the north. Arriving at the bend of the hill we ascend and pass over it into the valley at U.

This valley or ravine (for there is usually no water in it) extends to the south and south west nearly half a mile, and has several lateral branches that fall into it from the hills at different points. These several ravines receive the water that falls upon the neighboring hills, and which passes off through the principal one to the north, where it is discharged into Jones's Falls.

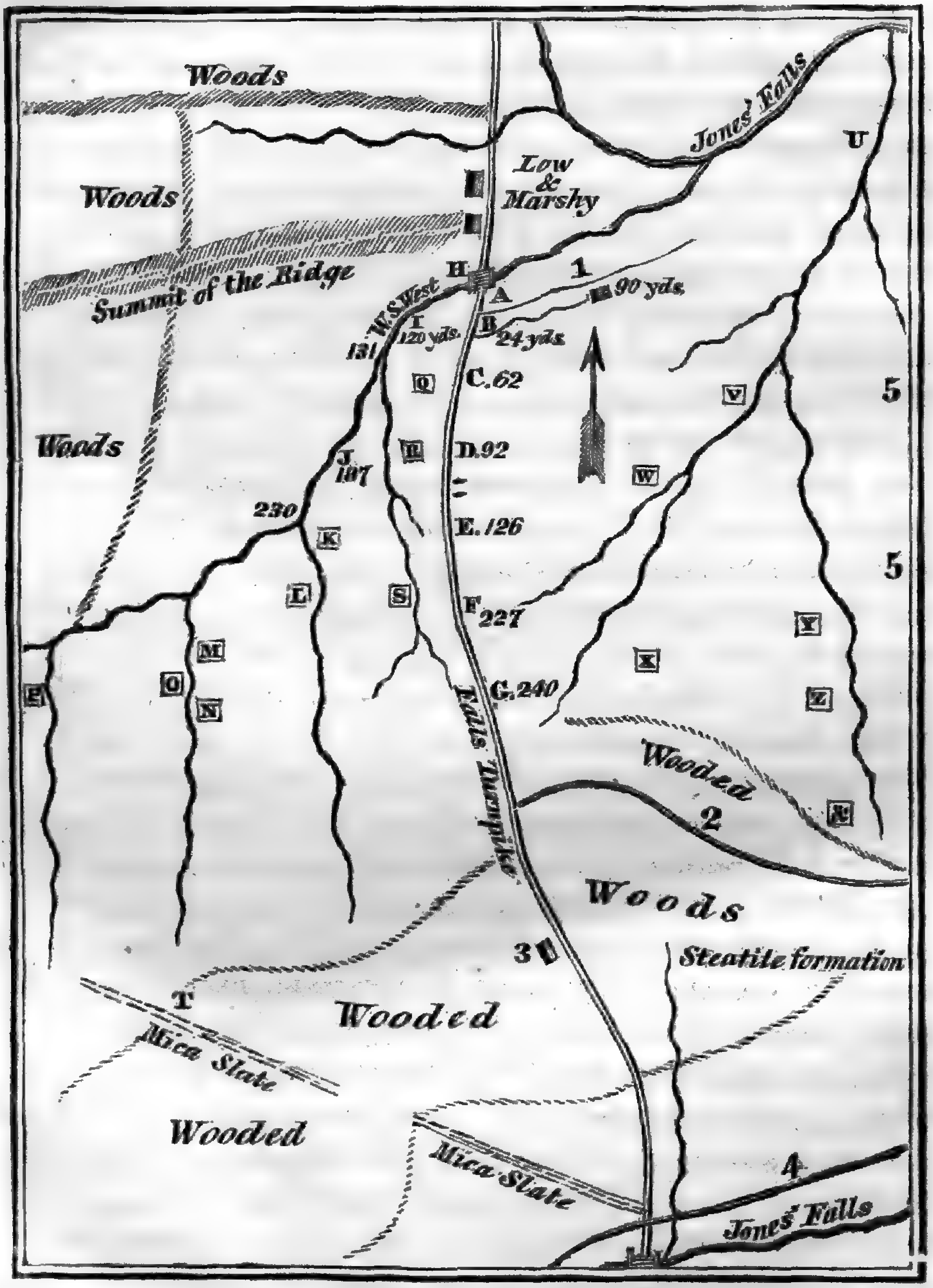
The bottom of these ravines does not differ materially in appearance from that of the ravines in the western sections of the district, as they pass through a formation essentially the same. They are, nevertheless, sufficiently interesting to pay for the trouble of tracing the principal ravines from their sources to their termination. The granular and crystallized chromate of iron may be obtained in all these ravines, but more especially above and below, or north of U, where it is deposited in abundance in the crevices, and depressions in the rocks in the bottom of the ravine. In the ravine that extends to the south west, several fruitless excavations have been made for chrome. Chrome was found at the several excavations at V W X Y Z, and in the hills on the right and left of the ravine, but not in quantities sufficient to justify a prosecution of the works. The veins of chrome are so intimately blended with the gangue, (most of which is a very compact indurated talc steatite) that it is almost impossible to separate the one from the other, and hence the specimens, obtained from the surface about the pits, are traversed by veins of chrome of a greenish color, from one half of an inch to two inches thick, which gives them a pleasing aspect. Ascending the hill on the south, to its summit, we find an unfrequented road (running down the eastern slope of the Bare Hills, to the gun-powder works, and to the turnpike road) which may be said to be nearly the dividing line between the serpentine and steatite formation.

In describing, thus far, the prominent features of the Bare Hills, I have embraced but a part, of the many points or objects that are interesting to the Mineralogist. My design has been to give a correct sketch of the district, with such a description of the principal localities as would enable a transient visitor to avail himself of its advantages, without the fatigue and trouble of what might otherwise prove, an unprofitable search.

I might have extended my views to the varied features of the districts that lie contiguous to the Bare Hills, a few of which it may not be amiss to mention viz.—the two small houses on the west side of the road, are situated in a narrow valley, formed on one side by the abrupt slope of the serpentine ridge already mentioned, and on which one of the houses stands; through this valley flows a small stream of water supplied by a copious spring, or springs, that rise a short distance in the skirt of the woods. From this, onward, there is, at certain seasons, a very copious deposit of ferruginous and other substances, indicating a mineral impregnation of the water.

Immediately on the north side of this run, the hills rise abruptly. The first rock formation that appears, and that too by the road side, is a coarse granite, in which the mica, that occurs in large plates, is of a beautiful emerald green. The rock, that succeeds next, is a very much contorted mica schist. A few rods further north, the rocks present a bold front of mica schist in which small crystals of staurotide and garnet are abundant. Indeed, the entire distance of one mile and a half north of the bridge presents more or less of interest, both in a geological and mineralogical point of view.

A Sketch of the Bare Hills near Baltimore.



References.—1, Foot path.—2, Road leading to the gunpowder works on Jones's Falls.—3, Small house in the woods by the side of the road.—4, Baltimore and Susquehanna Rail road.—5, Eastern slope of Bare Hills.

NOTE.—*From the Stone Bridge to the Rail road one mile.*

Art. XIX.—*Meteorological Table; by* Gen. Martin Field.

Extracts from a Meteorological Journal of Observations, made at Fayetteville, (Vt.) from the 30th day of April, 1832, to the 1st day of May, 1833, in lat. 42° 58′ N. and lon. 4° 20′ E. from Washington.

1832 and 1833.	THERMOMETER.											WEATHER. No. of days of diff. variation.				WINDS.								MISCELLANEOUS.					
M'ths.	Mean temp. at sun rise.	Mean temp. at 2 o'clock, P. M.	Mean temp. at 9 o'clock, P. M.	Aggreg. of mean temp. each month.	Maximum of temperature. Day.	Hour.	Highest degree.	Minimum of temperature. Day.	Hour.	Lowest degree.	Range of Therm'r.	Fair.	Cloudy.	Rainy.	Snow & hail.	N.	N. E.	E.	S. E.	S.	S. W.	W.	N. W.	Inches of water in rain, snow & hail in day time.	Inches of water in rain, snow & hail at night.	Aggregate of water each month.	Inches of snow & hail.	Lightning & thunder. No. of days.	Aurora Borealis. No. of nights.
May	41.	60.5	48.5	50.	13	3 P. M.	84°	6	5 A. M.	34°	50°	17	14	6	2	2	5	3	1	2	4	5	9	1.6	2.7	4.3	2.	2	—
June	50.5	73.5	61.	61.7	15	2 .	88	1	4 .	34	54	19	11	5	—	2	—	2	1	4	7	5	9	1.3	1.7	3.	—	3	1
July	57.8	78.	63.	66.3	6	3 .	93	28	4 .	44	49	21	10	10	—	1	2	—	1	6	6	6	9	2.6	.6	3.2	—	10	—
Aug.	55.8	75.5	63.5	64.7	14	3 .	90	26	5 .	37	53	19	12	10	—	—	4	1	—	5	10	4	7	2.9	3.	5.9	—	6	2
Sept.	51.5	65.7	54.2	57.1	19	2 .	84	14	6 .	30	54	21	9	6	—	1	1	1	2	4	5	4	12	2.1	.7	2.8	—	1	—
Oct.	41.7	56.5	46.3	48.2	21	2 .	70	27	6 .	22	48	18	13	8	—	—	—	2	2	7	8	2	10	2.1	2.5	4.6	—	1	2
Nov.	30.8	42.	34.4	35.6	2	3 .	60	16	7 .	10	50	17	13	5	2	1	2	1	1	4	5	8	8	1.5	2.5	4.	8.	—	2
Dec.	17.8	28.5	22.5	22.8	31	2 .	46	30	7 .	–14	54	18	13	2	3	1	7	—	—	2	5	3	13	2.5	1.6	4.1	20.	—	—
Jan.	12.	29.4	22.3	20.2	4	2 .	50	19	7 .	–18	68	19	12	2	3	1	3	1	—	3	9	7	7	1.5	2.8	4.3	14.	—	1
Feb.	9.2	26.	13.	16.1	18	3 .	48	26	7 .	–16	64	17	11	2	4	2	4	1	—	3	6	2	10	2.6	1.8	4.4	16.	—	—
March	18.5	35.	26.5	26.6	31	4 .	60	3	6 .	–20	80	21	10	2	3	1	1	—	—	7	6	2	14	1.	1.7	2.7	10.	—	3
April	35.	58.3	45.4	46.2	30	3 .	80	27	5 .	28	57	22	8	4	1	—	2	2	1	5	7	2	11	.5	1.7	2.2	1.	2	—
Ag.tem	35.5	52.4	41.7	43.2		*Recapitulation.*						229	136	62	18	12	31	14	9	52	78	50	119	22.2	23.3	45.5	71.	25	11

Remarks.—The foregoing table exhibits nothing, which is very unusual in the seasons during the twelve months past. The mean temperature of the year was 43.2°, which was a few degrees below that which is usual in Vermont. The temperature of the summer months was 64.2°, that of the winter months was 19.7°, difference 44.5°. The highest temperature within the year was on the 6th of July and was 93°; the lowest was on the 3rd of March and was 20°, below 0. Range of the thermometer 113°. The temperature was above 90°, six days in July, and below zero, six nights in December, four nights in January, five nights in February, and four in March. The aggregate of degrees, which the thermometer exhibited the temperature to be below zero during the winter, was 168°.* We had seventy one inches of snow and hail during the year, which was forty five inches less than that which fell within the year preceding. The quantity of water, which fell in rain, hail and snow was 45.5 inches, of which 22.2 inches fell in day time, and 23.3 at night. February was the coldest month within the year. The temperature of the first fifteen days of the month of March was 6° below that of December, 3° below that of January, and about the same as that of February. The Aurora Borealis was seen only on eleven nights during the year, which was forty five less than within the twelve months preceding the 1st of May, 1831.—Why such a vast difference of this phenomenon should thus occur within the term of three years, is truly inexplicable. Sudden changes and extreme temperature of the atmosphere have occurred more frequently than usual during the last year. On the low lands we had frosts every month, during the year. There were frosts on the 28th of June, on the 28th of July, on the 26th of August, and on the 14th of September, the latter of which was very injurious to the late crops. Insects, of all kinds, were rarely ever more numerous, or more injurious to the crops, especially on the highlands in Vermont. The season was unfavorable for fruit of any kind—plumbs and peaches we had none; and most of the trees of the latter were destroyed by the severity of the winter of 1831-2.

On the 18th day of August we had a celestial exhibition of Mushroom clouds, which was so interesting to me, at the time, that I will briefly notice it.

On that day I was on high land, in Vermont, where I had a full view of the western horizon. The morning was unusually clear and pleasant. About 10 o'clock A. M. bright *cumulous* clouds of a very slender form, arose from north west to south west. When these clouds had risen to the height of about 20° above the horizon, nearly at the same time, *strata* clouds were formed, which lay horizontally upon, and capped the cumulous, and they immediately assumed the forms of Mushrooms. At one time, there were to be seen more than twenty of these Mushroom clouds, which were nearly of the same height and form. As soon as these aërial mushrooms were completely formed, they appeared to become stationary, in their

* As the number of days, over which these degrees are spread, is not specified, we cannot know the average daily depression below zero.—Ed.

progress upwards, and their stems lost their bright and cumulous appearance. But their *caps* still continued to approach each other, till at length, they all became united in one, uninterrupted stratum, extending from north to south, and reposing on about twenty beautiful columns, which appeared to stand on the horizon. From appearances those clouds produced no rain. At the time the mushrooms were formed, their appearance was beautiful, but the closing scene was grand and sublime beyond description. The cloud remained in the situation above described, and nearly stationary, for about thirty minutes, when it gradually disappeared.

Mushroom clouds are of frequent occurrence, in calm weather, in the latter part of summer, and the fore part of autumn, and mnst have been observed by most people; but I have never seen them when they were so numerous and extensive, as on the day above mentioned. There was no wind at the time; and the thermometer stood at 70°. On the night and day following we had a storm of rain, in which there fell about three inches of water.

Art. XX.—*On Hybernation and other topics of Natural History; by* Judge Samuel Woodruff.

Windsor, March 6, 1833.

To Professor Silliman.—*Dear Sir*—Under the general head Zoology, I know of no subject more engaging to the student of nature, than what relates to the hybernation of various animals in our latitude.

I have lately read, with very great pleasure, a short but excellent treatise on this branch of zoology, by Mr. Lea, of Philadelphia, inserted in your Journal of Science, Vol. ix, p. 75. He quotes Dr. Reeve's description of hybernation, "a continuance of life under the appearance of death, a loss of sensibility, and of voluntary motion, a suspension of those functions most essential to the preservation of the animal economy."—Without attempting to enter upon a discussion of this most interesting and somewhat intricate subject, I shall content myself with stating some facts connected with it, hoping, if you should think them deserving of publication, they may elicit from others, more able and better qualified than myself, such remarks and reasoning as may serve to extend the science of natural history.

About the year 1756, some mining operations were commenced and carried on to a small extent, in Meriden, on a farm then belonging to Mr. Hough. The miners began their excavation at the foot of a high ridge formed by a ledge of rocks, rising fifty or sixty feet above the level of the land in its vicinity, and covered with a superstratum of earth two or three feet in depth. The miners, disappointed in their expectations as to the products of the ore, discontinued their labors within a few months after their commencement, leaving an aperture, at the place where they began digging, of about six feet in breadth and the same in depth. In this situation, the excavation, including the aperture, continued, according to the recollection of Mr. Hough, from whom this information is derived, till March, 1760 or 1761, when, by the agency of a thaw, attended by a copious, warm rain, an extensive avalanche of earth and loose stones shot down from the brow of the ridge, which completely filled and choked up the aperture. For about thirty years from this period, every thing about the mine had continued apparently in *statu quo.*

Having some business at the house of Mr. Hough, about the middle of January, 1791, I there met Capt. J. Shaylor, of Meriden, a gentleman with whom I was intimately acquainted. He informed me that two or three days previously to that time, curiosity had led him to explore the *old mine;*—that knowing it had been closed for many years by earth, &c. he furnished himself with an iron crow and other implements suitable for the purpose, and after half a day's labor in removing earth and stones to the depth of five or six feet, he had succeeded in making an entrance into the cavern left by the miners; and invited me, without giving any description of it, to go with him and take a view of it. I readily complied. Upon our entrance we lighted candles. The length of the room we found to be about fifty feet, the breadth varying from eleven to fifteen, and the height from seven to nine; the lateral walls and ceiling of solid rock.

Hybernation of the Bat—(Vespertilio.)

My attention was attracted, principally, by the many hundreds of bats which we found suspended from the ceiling with their heads downward. No part of them was in contact with the rock except the soles of their hind feet, which appeared as if glued to the surface of the rock. No others were found either upon the mural rocks nor in any other part of the cavern. They were all covered with a sort of white mould, appearing like frost. Far from being emaciated, they all appeared to be *embonpoint*. Each one was furnished with a large drop of clear water suspended at the nose and covering both nostrils. I placed a lighted candle nnder one of them, at such a distance, that the fume of the candle enveloped the whole head. This produced no visible effect. I then raised the candle and let the flame act upon the head. This soon effected a cringing and other indications of sensation. I took one of them between my thumb and fingers, but could perceive no motion, either of respiration or pulsation. I presume, however, that although the action of their digestive and respiratory organs was suspended, yet that a feeble and languid circulation of the blood must have been carried on through and about the heart, to prevent a total extinction of animal life. No excrementitious matter could be found either about their bodies, or on the ground under which they hung. I felt desirous to ascertain, whether after their long repose, they could be resuscitated. For this purpose, I placed one of them in the palm of my hand under my glove. Within about fifteen minutes I felt a sensible motion of the bat, and within half an hour he appeared to be restored to his full strength and activity. After returning with Capt. S. to the house of Mr. H., I placed the bat on a table in a warm room where the family and several visitors were sitting. In about ten minutes the bat began to stretch and shake its wings, and, after making a few efforts, took wing and flew about the room. Business detained me at the house of Mr. H., till eight or nine o'clock in the evening; and when I returned, I regretted that my bat could not be found, as I intended to have him placed in my cellar for the remainder of the winter, with a view to learn what his condition would be at the approach of the following summer. Having business again in Meriden about the last of the February following, I called at the house of Mr. H. to inquire about my bat. Mrs. H. stated to me, that the next day after I left it there, about the middle of the day, the room being warm, the bat came out from behind the clock case, very actively flew about the room for several minutes, and then retired to the same place, and that this exercise had been repeated, almost daily, in clear weather, when the room was warm. We searched for it but it could not then be found.—If, from the length of time these bats are supposed to have continued in this uninterrupted state of torpor, any doubt should be entertained, whether after the close of the aperture as before stated, they might not have found some other place through which they had ingress and egress, I can only say that, from the information I received from Capt. Shaylor, and from my own careful examination of the cavern and all attending circumstances, I was fully satisfied of the impossibilly of any such ingress or egress, after the closing of their domicil by the avalanche. Is it to be supposed that the frog, immersed in water, and snugly lodged in his bed of mud at the bottom of a pond, or other body of stagnant water, experiences any less inconvenience or inquietude during the continuance of our winter months, than he would do, provided the same temperature of atmosphere and state of the weather should be protracted for fifty or a hundred years?

Moulting of Birds and casting of Horns.

Mr. Lea, after speaking of the hybernation of various and different kinds of animals, says, page 80, "the moulting of birds, as well as their migration, is a species of hybernation. The first is a preparation for winter, and their change of color, adapting itself to the season, frequently perplexes the ornithologist and causes spurious species."

In addition to this I would mention another species of retirement, which might be called hybernation, if it were not performed in the *summer.* I allude to the annual casting off, or, as it is vulgarly called, the *shedding* of the horns of the male elk, and of the buck, which has some analogy with moulting. It is well known by all huntsmen, and other woodsmen in the western part of our country, that these animals, about the first of June, instinctively retire alone to some solitary, close thicket by the side of a spring or small stream of water, environed by low brushwood and brakes. In this retreat, they continue their abode till sometime in July, during which time they take little, if any other nourishment, than what the water affords them. This is known from their emaciated state, at the time they leave their retreats. After casting off the old horn, the new immediately sprouts out, the first appearance of which is, (of the buck,) about three fingers in breadth and about two in thickness, consisting of a soft, spongy, flexible substance filled with blood vessels, and covered by a cuticle, clothed with a thick velvet coating. During the ten or fifteen days of the first growth of the *greenhorn,* which is very rapid, the animal moves but little, as though sensible of the danger of rupturing the blood vessels should they be brought into contact with a tree or other hard substance. As the new growth becomes more indurated, the cuticle or scarf skin cracks, and by degrees cleaves off. This is called, by hunters, "the velvet state." During this period, and to the time the horn attains its full growth, being about two months, the induration increases with surprising rapidity.

Incubation, &c.

There seems to be, in the animal economy, a wonderful adaptation of the animal itself to its exigencies; and also a coincidence, equally surprising, in all the attending circumstances necessary to the main design.—The turkey hen, toward the close of her incubation, has frequently been known to continue on her eggs, without intermission, for seven days, and in some instances nine, without food or nourishment of any kind. She becomes greatly emaciated indeed, but animal life is not extinct, whereas had she been confined, under any other circumstances, and without nourishment, but for five or six days, she must have perished by starvation. No excrementitious matter is ever found either in or by her nest. Hence, it is evident, that during the term of her incubation, the action of the digestive organs, if it be not nearly or wholly suspended, must be, in a great measure under the control of the bird. It is also a fact, observed by many, that the turkey cock, when his hen commences her incubation, often leaves her society and retires to an obscure and lonely station, usually in the corner of a fence, surrounded by a thick growth of weeds, and there sits on the ground three or four weeks, taking no other food than what he can reach in his sitting posture. The moulting season with turkies, is about the usual time of incubation; and perhaps this may have some influence in his retirement.

Hybernation of the Racoon, (Procyon Lotor, *L.*,) *and Woodchuck,* (Arctomys Monax, *Gmel.*)

In our latitude, the racoon and woodchuck who lay up no food for their winter stock, hybernate in dens among rocks, and in deep burrows, below frost. The former, it is true, sometimes in February, taking advantage of a thaw and short term of warm weather, sallies forth from his winter quarters for a night or two, although never in pursuit of food: but the latter is awakened from his repose only by the return of confirmed warm weather.—I am credibly informed that the late Col. Jeremiah Wadsworth, of Hartford, with a view to experiment, procured a young woodchuck to be petted at his house. Upon the approach of winter, the animal, impelled by instinct, took up his abode for hybernation behind a row of casks in the cellar,—not by burrowing in the ground, but by making for himself a small excavation on the surface, in which he placed himself in a circular form, a position the most accommodating to his condition. Many times during the winter, Col. W., to gratify the curiosity of his visiting friends, directed the woodchuck to be brought up. The torpid animal, after lying fifteen or twenty minutes on the carpet, before a cheering fire in the keeping room, would begin to yawn, then stretch out one limb after another, open his eyes, slowly raise himself on his feet, and walk rather awkwardly from the immediate influence of the fire, appearing uneasy till returned to his bed in the cellar, uniformly refusing nourishment, of any kind, during the time of his hybernation.

Hybernation of the Swallow, (Hirundo.)

Respecting the question so long agitated, and with conflicting opinions of ornithologists, whither the common swallow (Hirundo Americana, W.,) hybernates in our country by immersion in water and mud, or migrates to more southern latitudes, Mr. Lea expresses his opinion, decidedly, in the following sentence, page 83, "On reviewing the subject, I think we may safely conclude, that a torpid swallow never yet has had an existence." In support of this opinion he adduces, among other things, the following authorities. "Capt. Henderson, of the British army, relates that he saw myriads in Honduras where they remain from October to February," and in a note at the bottom of p. 83, "My friend, Mr. Ord informs me, he has seen the swallow in the south of France in December, and was assured they remain there all the winter. It is strange this fact should not have been observed by the naturalists of Europe."

To this it might be replied, that in the latitude of Honduras there could be no necessity for hybernation either by immersion or migration; for in that warm climate, there would be a constant supply of food by insects which continue, through the winter months, in an active state. Respecting the statement of Mr. Ord, the correctness of which I feel no disposition to question, I will only say, that, I fully agree with Mr. Lea, "it is strange this fact should not have been observed by the naturalists of Europe."

I have now only to add, that in the year 1828, during the months of July, August and September, I saw many of the same species of the swallow in Greece, and from the 4th to the 11th of October at Smyrna and Clazomenæ, and on the 21st about the Goletta, at Carthage, and the bay of Tunis, but at Port Mahon, from the 23rd of

October to the 19th of November, and at Malaga, from the 23rd of November to the 2nd of January, I saw none.

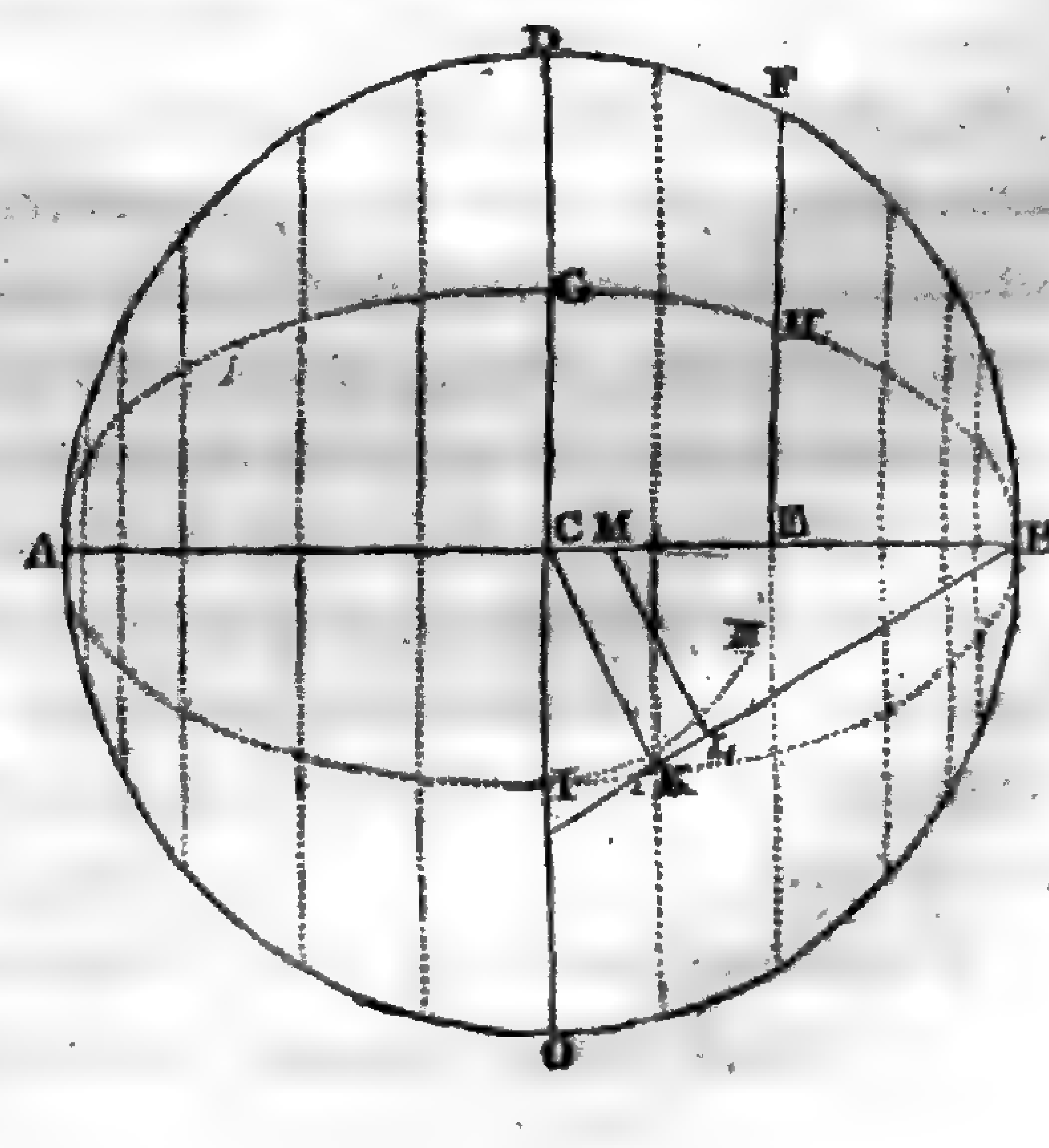
From my limited reading on this subject, and my own observation for many years, I felt inclined to a different opinion from that expressed by Mr. Lea, and I cannot but consider all the statements of facts here exhibited, as inconclusive, especially as relative to the higher latitudes.

Art. XXI.—*Mode of drawing Ellipses; by* S. DeWitt.

TO PROFESSOR SILLIMAN.

Some years ago, having occasion to draw elliptical figures, I devised, for that purpose, the following method, which I believe is not described in any book. As I have found muoh convenience from it, and as it may be useful to others, the publication of it may contribute an item, though small, to our stock of useful knowledge. The rule is founded on this proposition; as the semi-diameter of a circle is to the semi-conjugate diameter of an ellipse, inscribed in the circle, so is any semi-ordinate of the circle to the semi-ordinate, (rightly applied,) of the ellipse, at the same place: which is thus proved.

In the annexed figure, $AC \times CB : \overline{CG}^2 :: AE \times EB : \overline{EH}^2$, from the properties of the ellipse; but $AC \times CB = \overline{CD}^2$ and $AE \times EB = \overline{EF}^2$, from the properties of the circle; then, by substituting $\overline{CD}^2$ for $AC \times CB$ and $\overline{EF}^2$ for $AE \times EB$, we have $\overline{CD}^2 : \overline{CG}^2 :: \overline{EF}^2 : \overline{EH}^2$ and $CD : CG :: EF : EH$.



Let AB and GI be the transverse and conjugate diameters of the ellipse to be drawn. On AB describe the circle ADBO; continue the conjugate diameter to D, and, parallel to it, on each side of the centre, draw equidistant lines across the circle. From the center C, with the distance CI, draw the arc IN, and from B, draw BK, a tangent to it;

then will CK, drawn perpendicular to BK be equal to CG. Make BM=EF and draw ML at right angles to BK; then from the properties of similar triangles, BC(=CD) : CK(=CG)::BM(=EF) : LM(=EH).

To find the points on the ordinates drawn across the circle, through which the periphery of the ellipse will pass, the simple operation is this. Take EF between the points of the compasses and set off that distance from B to M; then, keeping one point of the compasses on M, close them until the other point sweeps the tangent BK, and set off that distance from E to H; H will then be a point through which the periphery of the ellipse will pass. Do the like on all the lines drawn for ordinates across the circle; and through the points, thus found, draw, by the eye, the periphery of the ellipse. This operation is expeditious, and saves the labor of calculating the ordinates of the ellipse arithmetically, and then plotting them; besides it is less liable to error, excepting when an ellipse is to be projected on a large extent of ground, as for the enclosures of court yards, &c. in such cases an accurate calculation of the lengths of the ordinates is advisable; but for projections on paper, the rule above given is preferable.

Albany, April 10, 1833.

MISCELLANIES.

FOREIGN AND DOMESTIC.

Extracted and translated by Prof. J. Griscom.

CHEMISTRY.

1. *Preparation of pure nitrate of silver*; by M. Bradenburgh.—Dissolve in nitric acid the common alloy of silver and copper. Evaporate to dryness, and heat the salt in an iron spoon till it ceases to boil. Dissolve, then, a very small portion in water, and try it with ammonia to see if any copper remains. If there is, heat it again a few seconds, and make a new trial: as soon as the nitrate of copper is decomposed, pour it on an oiled plate, or dilute the mass in water, and filter it to separate the deutoxide of copper set free by the decomposition of the nitrate.

2. *Decomposition of the chloride of silver in the moist way.*—Take a small zinc or cast iron pot; put the chloride into it, in pieces, and cover it about an inch with water. If the zinc, or iron be per-

fectly clean, the decomposition goes on pretty rapidly of itself, but if not entirely clean and fresh, it may be slow, and in that case, a little muriatic or sulphuric acid must be added. This addition is, besides, necessary for washing the silver and having it pure. The operation is rapid and curious to observe. The reduction penetrates from the surface to the center. The temperature rises, if the mass be considerable, and contributes to accelerate the operation. It may, if too weak, be aided by artificial heat.

The chloride of silver may be reduced also by heating it with a mixture of lime and charcoal in the following proportions.

Chloride of silver, - - -	100.
Dry quick lime, - - -	19.8
Charcoal, - - - -	4.2

But to prevent loss the chloride must be in powder.

3. *Action of ether on sulphate of indigo*; by M. Cassola.—If one part of indigo be dissolved in four parts of sulphuric acid and diluted with twenty parts of water and an equal quantity of sulphuric ether be added, the liquid becomes discolored in about half an hour, if it is kept constantly at a temperature of 100° F. in a well stopped bottle. The blue color cannot be restored by oxygen, or metallic oxides.—*Kartsner, Arch. t.* 16, *p.* 126.

4. *Memoir on starch;* by M. Guibourt.—We are indebted to M. Raspail for the interesting discovery that starch is not a homogeneous substance,—that each granule is a real organ, consisting, 1st of a shining envelope or tegument, inattackable by water and acids at common temperatures, susceptible of being highly colored by iodine; 2nd, of an interior substance, soluble in cold water, liquid, even in its natural state, and when evaporated loses the property of being colored by iodine, and which possesses all the properties of gum. He further states, that the coloring of starch blue by iodine is owing to a volatile substance, but my own experiments are contrary to this assertion.

Potatoe starch is quite insoluble in cold water. When rubbed in a dry state on a stone, it loses its white shining appearance, and if it be moistened with water it forms a tenacious paste which becomes very hard, when dry. Pounded in a mortar, it produces a mucilage analogous to gum tragacanth. Starch, in mass, acquires a sky blue color with iodine, but slowly, without losing its transparency. When rubbed and diluted with cold water, it forms a solution which holds in suspension the teguments which served as a covering to the grains of fecula. Iodine colors the fluid a sky blue, and the integuments a deep blue, almost black. The portion soluble in cold water, subjected to a protracted ebullition, does not lose the property of being colored by iodine. Evaporated rapidly, so as to form gelatinous pellicles and a gummy liquid, it is no longer entirely soluble in cold water; but neither the gelatinous matter nor the transparent liquid, loses the power of being strongly colored by iodine.

Soluble starch, therefore, when dry is not a gum, as M. Raspail imagined.

On the whole, we cannot avoid the conclusion that the teguments and the soluble substance differ more in form than in their chemical qualities, and that they constitute an immediate principle of vegetable matter.

The *amidine* of De Saussure is nothing but the tegumentary part of starch rendered soluble by long boiling.—*J. de Ch. Med. t.* 5, *p.* 97.

5. *Action of potash on organic matters;* by Gay-Lussac.—A great number of vegetable and animal substances, treated with caustic potash or soda, at a temperature much below redness, are transformed into oxalic acid, and at a higher heat, into carbonic acid. Such are saw dust, cotton, sugar, starch, gum, the tartaric, citric and malic acids, silk, uric acid, &c. Many vegetable substances yield hydrogen and carbonic acid at the same time, and animal substances, in addition to these two, give ammonia and cyanogen. It is remarkable and extraordinary, that with tartaric acid, scarcely any hydrogen is disengaged, and the material does not blacken.

Tartar may be transformed into oxalate of potash by a very elegant process, which consists in dissolving tartar in water, with a suitable quantity of potash or soda, and forcing the solution, by means of a pump, into a thick tube of iron or brass heated to about 400° F. The pressure would be but about twenty five atmospheres, as no gas is disengaged.—*Ann. de Ch. t.* 41, *p.* 398.

6. *To test the purity of chromate of potash,* by S. Zuber.—Add to a solution of the chromate, a great excess of tartaric acid. The fluid acquires, in about ten minutes, a deep amethystine color, and gives no precipitate, either by nitrate of barytes or nitrate of silver,

when pure; but, however small the quantity of sulphate or muriate, it may contain, it is rendered turbid by the addition of barytic or silver salts.—*Bul. de Mulh. No.* 6, *p.* 58.

7. *Use of mica in chemical analyses on a small scale.*—As mica is not fragile, and does not change in the flame of a taper, it may be employed with much advantage, as a support to substances which we wish to expose simply to the flame of a lamp or candle; take a thin plate of mica, which may be easily separated from the mass by a knife, and after each experiment, wipe it with a moist cloth.—*Arch. de Brandes.*

8. *Changes of volume on a mixture of alcohol and water,* by F. Rudberg.—The maximum of contraction is 3.775 per cent, of the mixture, and this takes place in a mixture containing 0.53929 of absolute alcohol—the rest water; and it is composed of 3 atoms of water and 1 atom of alcohol. The lower the temperature, the greater the contraction.—*Ann. de Chim. t.* 48, *p.* 33.

9. *Indelible coloring.*—In impregnating, in an even manner, the surface of cloth with a solution of nitrate of silver, and after drying it, immersing the cloth in a solution of hydrochlorate, or of chloride of lime, chloride of silver is formed, which adheres strongly to the fibre, and if afterwards the cloth is exposed to the light, it immediately acquires a bluish gray tint, very clear and agreeable, which resists the action of chlorine, ammonia, &c. In order that it may be perfectly uniform, the whole piece must receive the action of the sun's rays at the same time.—*M. Robiquet, Jour. de Pharm.*

10. *Artificial ultramarine at a moderate price.*—Since M. Tassaert made the curious observation of the blue color of soda furnaces, and Vauquelin proved the identity of this coloring matter with that of lapis lazuli, the hope has been cherished that, sooner or later, ultramarine would be manufactured in sufficient abundance. The Society of Encouragement having offered a premium on this subject, M. Guimet presented a beautiful blue of an azure reflection, and the premium was adjudged to him. M. Robiquet, who had also engaged in this research, thought it right to publish the process which had succeeded best with him, and which, without giving so beautiful a blue as that of Guimet, will nevertheless furnish the color at a lower price, and applicable to paper staining.

Take one part of kaolin, one and a half of sulphur, and one and a half of pure and dry sub-carbonate of soda; mix them carefully and introduce the whole into a coated earthen ware retort, and heat the mixture gradually until the vapor has entirely ceased. On cooling, it forms a spongy mass, which reflects, at first, a green tint, but on exposure to the air, it becomes more and more blue. Leach this mass: the excess of sulphur is dissolved, and there remains a powder of a good blue. It is to be washed by decantation, dried, and calcined to a cherry red, to drive off the excess of sulphur.

The greatest defect of the color thus obtained is want of intensity. The purple shade, which the natural ultramarine does not possess, at least in so marked a degree, may well owe its distinctness to substances employed in refining it. It is certain that when the Guimet blue is heated, it loses in a great degree its azure tint, and if the experiment is made in a tube, oily streaks issue from it, which must necessarily proceed from organic substances.—*Rev. Encyc. Dec.* 1832.

11. *Opium.*—M. Pelletier has just discovered (announced to the Academy on the 24th of December,) in this very complex material, a new crystalline substance, analogous (isomère) to morphine, (*paramorphine,*) which had escaped his first researches. It differs, essentially, from morphine in its chemical properties, although its elementary composition appears the same. It cannot be confounded, either with the *Codéine* of Robiquet, or with other substances found in opium. Its savor is like that of *pyrètre;* its solubility in alcohol and ether is infinitely greater than that of narcotine, from which it differs also in crystalline form and fusibility. From an experiment made by Magendie, it has a powerful action on the animal economy—a very feeble dose killed a dog in a few minutes; it acts on the brain and produces convulsions.—*Idem.*

12. *Combinations of azote.*—M. Despretz announced to the Academy, at its session on the 5th of November, that he has ascertained that azote combines directly with iron and copper. The products are analogous to those on which he read a memoir two years ago. The azote which he employed, came either from the decomposition of ammonia by chlorine, or from that of the deutoxide of azote by iron or copper. In both cases, the gas, in reaching the metal, was dry and deprived of foreign matters which might have influenced it. It is, as he thinks, the first example of azotic combi-

nation, formed directly,—that is to say, determined by the power alone of the elements which compose it.—*Rev. Encyc. Nov.* 1832.

13. *New Febrifuge.*—Among the vegetable bitters found in France, *Verdé-Delisle* and *Cottereau* have discovered that the leaves of the Ypréau or White Dutch Poplar hold the first rank. The fresh leaves of this tree are endowed with a bitterness which approaches to that of the Cinchonas. They have been ascertained to possess, in a high degree, both in infusion and in maceration, the property of counteracting the periodicity of fevers.

MINERALOGY AND GEOLOGY.

1. *Analyses of Fer Titané of Baltimore, Maryland; by* M. P. Berthier.—This mineral is found in very considerable quantities in gneiss. Attempts have been made, unsuccessfully, to melt it in high furnaces. It is sometimes in pure masses, and at others intimately mixed with gneiss. The pure mineral is compact, fracture unequal, shining, and has magnetic polarity. Specific gravity 4.9. Powder grey, but very often has a decided tinge of red, owing to an obvious mixture of peroxide of iron. The mixed mineral often has a schistose texture. Its gangue exhibits shades of red and green.

This mineral is acted upon slowly by aqua regia. When reduced to an impalpable powder by porphyrisation, it dissolves readily in boiling concentrated sulphuric acid. By adding tartaric acid to this solution, (perhaps diluted,) the iron and titanium are separated by following the process of H. Rose. Concentrated sulphuric acid dissolves nearly all minerals composed of oxide of iron and titanium, when the latter is not in too great proportion.

As the Baltimore mineral does not contain the least trace of manganese, it is possible to dose the two elements of which it is composed, with much exactitude, by means of a simple process in the dry way:

20 gr. of the mineral, - - - -	20.00
10 calcined argil, - - - -	10.00
7 marble, = lime, - - - -	3.94
	33.94 gave

Cast iron, - - - -	12.00	Total,	29.62
Scoria, - - - -	17.62		
Fluxes added, - - -	13.74	Oxygen,	4.32

Foreign matters with the iron, 3.68=0.184.

These 0.184 of foreign matters are oxide of titanium and quartz. The proportion of quartz having been found to be 0.020 by the wet process, there remain .164 of oxide of titanium; by sulphuric acid, the quantity was .166: thus, the two methods agree remarkably well, especially as we know that by contact with charcoal, oxide of titanium loses a certain quantity, very small, it is true, of its oxygen.

The iron was white, and a little crystalline, but very tenacious, flattening under the hammer before it broke. The scoria was vitreous, of a shining black, and opake, with a copper colored surface.

12 gr. of iron would take 3.54 gr. of oxygen to convert it into protoxide, 4.70 gr. to change it into magnetic oxide, and 5.31 gr. to peroxide. The loss in the assay having been 4.32 gr. it follows that the iron, in the mineral, is partly protoxide and partly magnetic oxide. This mineral is therefore composed, like other varieties of titaniferous iron, of titanate and ferrate of protoxide of iron; it contains,

Metallic iron, - - - - - -	.600
Oxygen, - - - - - - -	.214
Titanic acid, - - - - - -	.166
Quartz, - - - - - - -	.020
	1.000

A specimen which produced a red powder, gave on trial .23 oxygen to .556 metallic iron, shewing that in this *fer titané* was mixed with peroxide of iron.

It would be interesting to science to have fresh trials of this mineral made in a smelting furnace, to ascertain what proportion of titanium would remain in a state of protoxide in the scoria and of that which might be reduced to the metallic state.—*Annales des Mines, tom.* 3, *p.* 39.

2. *Mines of Freyberg in Saxony.*—The mines of Beschertglück and Himmelfürst, which have been for a long time, among the most important resources of Saxony, are now greatly reduced; but, on the other hand, new mines have become flourishing.

The execution of a great project of drainage is at present depending on the determination of the states, now in session.

There has been discovered, a league from Freyberg, a bed of alluvium of *rutile* or titanic oxide, so abundant that preparations are making to obtain it by washing, (Seisenwerck.) It is intended to employ this titanium in the dyeing of cotton fabrics.

There is now obtained, near Schwarzemberg, very fine emery, (corundum,) the quality of which is as good as that of Naxos. It is now worked to a considerable extent.

Note on the Emery of Saxony.—The emery of Ochsenkopf and Morgenleithe, near Schwarzemberg, is found in grains, or small, bluish, kidney-form agglomerations, mixed with blende and other minerals, in a yellowish, talcose or jade rock, constituting a bank in a stratum of micaceous schist passing into slate. Formerly this rock was employed in mending roads; in 1714, it was found to be useful in sawing and polishing hard stones.—*Idem.*

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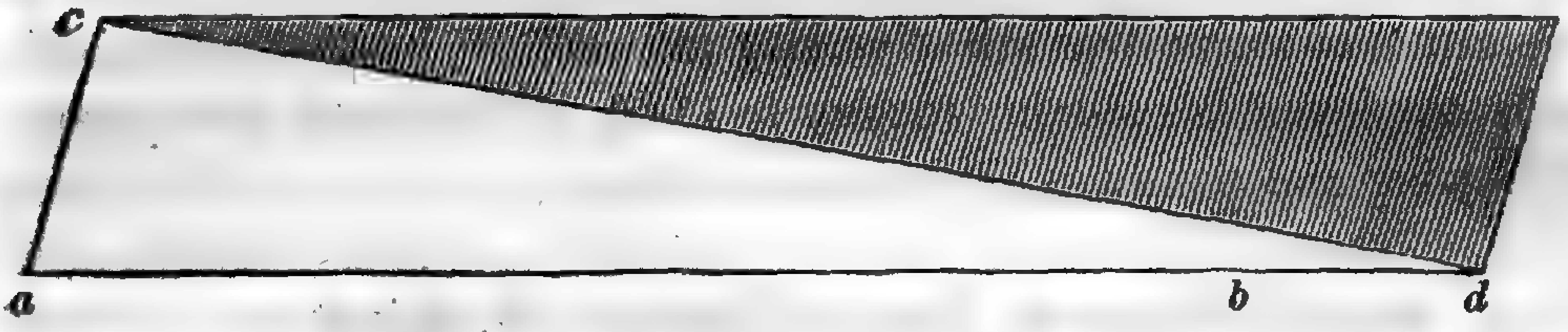
3. *Water spout on the Lake of Geneva.*—M. Mayor, who resides Molard place, Geneva, in looking through his window, which faces the lake, saw, to his astonishment, on the 3rd of December last, about a quarter before eight in the morning, in the direction of *Pâquis* and *Sécheron*, a vertical column of water, at least sixty or eighty feet high, and several feet in diameter, larger at its base than its summit, of a grey color and appearing animated with a gyratory motion. The column rested on the lake below, and was bent towards the top in the form of a bow. It remained nearly two minutes without any sensible change of place; and then sunk, by degrees, from above by diffusing itself in a shower of rain. At this juncture a south west wind ruffled the surface of the lake; the sky was entirely covered with thick vapors, which occupied the upper regions, while there were, properly speaking, no clouds in the horizon.

This not the first spout seen on Lake Leman. One, which occurred in 1741, was described in the French Academy. It lasted several minutes. Another was seen in 1764, in the month of August which continued nearly an hour.

In the spout witnessed by M. Mayor, the top of the column had no communication with thick clouds, as is sometimes the case, no trace of any such cloud was to be seen, neither above the column nor in its neighborhood,—hence there were no indications of electrical attraction to which the effect could be attributed, and there seems no means of accounting for the prodigious force then exerted to sustain a column of water of such height except that which ascribes it to a current or whirlwind of excessive intensity.—*Bib. Univ.* 1833.

NATURAL PHILOSOPHY.

1. *Description of a Photometer, designed for comparing the splendor of the stars;* by Count Xavier De Maistre.—This instrument is composed of two cuneiform prisms, one of blue and the other of white glass, which, when placed one on the other, form a parallelopiped. The aperture of the angle of the prisms is 11°, and their length nine English inches. These dimensions admit of variation.



The beak of the blue prism is so thin that it transmits the light of the smallest stars, whilst its other extremity, which is eight lines thick, is not permeable to their light. In moving it along, by degrees, the different stars will disappear at different distances from the point, according to their splendor. The refractions of the oblique surfaces of the compound prism compensate each other, which affords the means of looking for the star by a finder in making use of large telescopes, the narrow end only of the blue prism being adjusted before the eye glass, and the blue prism moveable on the line *cd*.

By increasing the angle of the prism or the intensity of its color, it may be applied to more luminous objects.

This photometer has an advantage rarely possessed by instruments used for this purpose; it is perfectly comparable. In taking the light of some one star of the first magnitude for a maximum, the point on the prism where it disappears must be marked, and the distance between this point and the beak divided into an hundred equal parts, which would of course always be proportional to each other in every prism, (as are the degrees on the scales of different thermometers,) and thus the exact relation of the light of any star to that of another may be determined.

This instrument may be substituted for smoked glass in solar observations by the facility of altering at pleasure the intensity of the light, and taking the most favorable point; thus, for example, it affords the degree of light most advantageous for seeing at the same time the borders of the sun and the threads of the micrometer which are not yet on his disk,—an advantage not always had with uniform dark glasses, in variable states of the atmosphere, unless we have a great number of them, and even then much valuable time must be lost in the adjustment of them to the instrument.—*Bib. Univ. Nov.* 1832.

2. *Optical properties of saccharine juices.*—M. Biot read, on the 10th of December, a memoir on an optical character by which those vegetable juices which produce sugar analogous to that of the sugar cane, may be immediately distinguished from those which only yield sugar similar to that of grapes.

This character consist in the direction in which a polarized ray is turned, on the one hand, by the juice of grapes, pears, apples, gooseberries, and other fruits which furnish sugar that will not crystallize; and on the other, by the juice of cane, beets, parsnips, turnips, carrots, &c. Liquids of the first class, turn the light to the left in every degree of concentration, until solidification takes place. It is at this point only that by a sudden change they may turn it to the right. Juices of the second class, on the contrary, always give it the latter direction. The phenomena observed by M. Biot in the juice of beets, induce him to think that ten per cent. of sugar may be obtained from it, as M. Pelouze has already stated. He thinks also that it would be advantageous to cultivate parsnips to a greater extent, which, on account of the great quantity of sugar they contain, would make excellent food for cattle. He has observed certain characters which, he thinks, may serve, in a general point of view, to determine whether a substance, obtained by a chemical operation, existed prior to that operation, or whether it results from it. Finally, the sudden changes which he has remarked in the direction, by solidification, induce him to refer these phenomena, to molecular and dissymmetrical forces.—*Idem.*

3. *New air pump.*—M. Thilorier has invented an air pump, without any valves or stop cocks to interrupt or complicate its action. The air of the receiver passes into a Torricellian vacuum, and by the motion of the machine, the Torricellian tube is reversed—the air escapes into the atmosphere,—a new vacuum is formed into which an additional portion of air passes from the receiver, and so on until

the exhaustion is complete. A premium of three hundred francs was awarded to the inventor.—*Rev. Encyc. Nov.* 1832.

DOMESTIC ECONOMY AND THE ARTS.

1. *Experiments on coloring matter for the purpose of dyeing or printing.*—M. Persoz, manipulator to the chemical courses in the College of France, announced to the Academy that he had discovered in a great number of coloring substances, such as indigo, madder, cochineal, lac, quercitron, Brazil wood, &c., a commom property; the knowledge of which, enables him to extract, by the same process, the coloring portion of these substances. Thénard, D'Arcet, and Chevreul, appointed by the Academy to judge of the effect in dyeing, of the coloring matter prepared by M. Persoz, subjected them to the following experiments. M. Persoz having taken two pieces of cotton cloth, on which designs had been impressed by a mordant, for red, rose and violet from madder, colored them for a comparative trial by his preparation and common madder. The cloth, when taken from the bath, was passed through hot soap suds. The specimen colored with the new preparation was incontestibly of a purer rose red color than that by the usual process. Besides this, the ground of the first specimen was almost white, while that of the second was tinctured with the reddish color which the madder had given to the portion of the cloth which had not received the mordant. M. Persoz also showed the commissioners a blue preparation from indigo, which he applied to cotton, and which sustained the action of a boiling solution of potash. Having thus proved the solidity of the colors of these specimens, the committee did not hesitate, although ignorant of the process of M. Persoz, to propose to the Academy to encourage this chemist to pursue researches which may be of great importance to manufacturing industry.—*Rev. Encyc., Nov.*, 1832.

2. *Blowing of glass.*—The effort of the lungs requisite to this process is incompatible with a weak state of those organs, and the exercise is sometimes attended with injurious consequences. A workman whose name is Ismael Robinet has invented what he calls an air pump, an instrument by which air is forced through the tube with greater power than that of the lungs. This has been found to be very advantageous, especially in moulding, the workmen being enabled to force the glass more perfectly into the crevices and devices of the mould, and thus not only to blow larger pieces and employ

larger moulds, but to rival, in perfection, the beauty of cut glass.—*Rev. Encyc. Nov.*, 1832.

3. *Pasteboard roofs.*—Roofs of out buildings in Holland have been covered with pasteboard cut into squares, and dipped repeatedly in boiling tar, until thoroughly covered and impregnated with it and then dried in the sun. The pieces are then placed smoothly on the roof, lapping at the edges, and fastened with nails. It is stated that these roofs are a great security against dampness, and that they last longer than shingles.—*Bib. Univ. Nov.*, 1832.

4. *On saponaceous vegetables.*—A report was made, by M. Bussy, on a root long employed in Persia and the East for cleaning cashmere shawls and other stuffs. Several French manufacturers have also used it for years with much advantage. They call it *Saponaire d'Egypte.* It probably belongs to the genus *Gypsophila*, very analogous to *Gypsophila Struthium.* This root, when reduced to powder, occasions violent sneezing, like Euphorbia and certain acrid resins.

It communicates to water, by decoction or even by mixture, a particular softness and unctuosity, and the property of frothing like soap without occasioning too great viscosity. This quality is ascertianed to reside in various degrees in several plants. It depends on the presence of a peculiar substance, which causes water to lather by agitation.

The bark of *Quillaia saponaria* which is sold in the public markets in Peru, as a substitute for soap, is remarkable for this property.

When soap is added to water, there is, in addition to the solvent power of the water, the chemical action of the alkali of the soap, but this is much less important than is generally supposed, for in soap the alkaline properties of potash and soda are almost entirely neutralized, by the acids of the fat. Simple alkaline solutions, either caustic or carbonated, we know will not well answer as a substitute for soap. The action of alkalies or of soap, in common washing, is not therefore, simply to saponify the greasy or resinous matters with which the cloth is impregnated, but only to render them *miscible* in water, not soluble, but miscible, that is, to bring them into such a state of division as to occasion their easy and free suspension in the water as oil is suspended in milk of almonds, or butter in milk. Every substance which increases the viscosity of water, produces this effect, such as soap, gum, and mucilage of all kinds, and of course plants which contain them.

In the washing of woollens, shawls, and other animal matters, which become stiff and hard by the action of alkalies, mucilaginous matters are preferable to soap. In dyeing, also, mucilages have the property of preventing the precipitation of calcareous salt and terrene matters, so important often to the shade, beauty and splendor of colors.—*Bull. D'Encour. Nov.* 1832.

ANIMAL PHYSIOLOGY.

Montyon premiums for discoveries in physiology.—The committee appointed by the French Academy to adjudge the premiums, having received this year, no work which appears to have merited the prize, and considering also that there are other works, not addressed to them, but which have come to their knowledge, which comprehend discoveries either in anatomy or microscopic researches on intimate structure, and the development of organs, that cannot fail, independently of their particular objects, to enlighten physiology by their results, concluded it right, by way of encouragement, to grant a gold medal of the value of three hundred francs to the following persons:

1. M. Carus, for his work on the motion of the blood in the larvæ of certain species of neuropterous insects.
2. M. Muller, for his researches on the structure of secretory glands.
3. M. Ehrenberg, for his work on the organization, and systematic and geographic distribution of infusory animals.
4. MM. Delpech and Coste, for their anatomical researches on the evolution of embryos.
5. M. Lauth, for his anatomy of the human testicle.
6. M. Martin Saint-Auge, for his researches on the circulation of blood in the embryo and fœtus of man.

The line of conduct pursued by the committee, was approved by the Academy, although the sum necessary for the medals is double that mentioned in the programme.—*Rev. Encyc. Nov.* 1832.

DOMESTIC.

1. *Extract from the MS. of an unpublished narrative of travels and observations in South America, furnished by the author, at the Editor's request.*—Galloping over the arid and dusty plain of Guachi, we suddenly arrived at the edge of the almost perpendicular hill

which overlooks the valley of Hambato. The view of the valley from this elevation, (about seven hundred feet,) is extremely beautiful, and the eye, fatigued and half blinded by the glare and heat thrown from the parched soil, rests with pleasure on the fresh and luxuriant green of this beautiful spot; the valley is narrow and shut in on all sides by dark, barren hills; it is not dependent on the clouds for the water that nourishes the eternal verdure in which it is clothed, for it scarcely ever rains here; a considerable stream runs through it, the water of which is carried in numberless channels to irrigate the fields; these fields are divided by rows of a very graceful kind of willow, whose feathery branches and light green foliage are strongly contrasted with the rich carpet of "*alfalfa*," or lucern, with which a large portion of the valley is covered. The climate of Hambato is said to be finer than any other in Ecuador, notwithstanding the almost endless variety to be found at different elevations from the sea; it is an eternal spring, no frost nips, and in the hottest season the air is tempered by cool breezes from the mountains. No very severe earthquakes are recorded to have happened; the same convulsions, which have laid in ruins the towns in the vicinity on every side, have been slightly felt at Hambato, and have passed without doing any serious injury; possibly this may arise from some peculiar formation of the valley. The variety of the productions of this extraordinary spot is such as might be expected from its climate and situation; elevated about six thousand feet above the level of the sea, enjoying almost continual sunshine, and supplied with abundance of water, tropical and temperate climes seem to have united in giving it the fruits peculiar to each; wheat, barley, pease, potatoes, maize, sugar cane, and coffee growing side by side, while apples, pears, plums, peaches, cherries, grapes, figs, olives, oranges and lemons are produced in the same garden. The climate is so healthy, that invalids from all parts of the country come to profit by its salubrity. I have mentioned that it scarcely ever rains at Hambato; at Mocha, where we slept the night before, about five leagues to the southward, it rains more or less almost every day in the year; and at La Tacunga, somewhat more than that distance to the northward, there is a stated rainy season, as in most parts of the Ecuador; such a total diversity of climate, in places so near each other, and not differing materially in elevation, is a very curious meteorological phenomenon; can it have any connection with the fact of the non-occurrence of severe earthquakes at Hambato? A very intelligent gentleman, a native of

Guayaquil, informed me that a heavy shower, incidentally occurring during the dry season, was almost invariably followed by an earthquake at that place.

We were detained in Hambato until noon of the next day, (July 13, 1832,) by the rise of the river of the same name which had carried away all the bridges; the river is a mountain torrent, subject to very rapid swelling from the melting of the snows of the Cordilleras; it as rapidly subsides when cold and dry weather diminishes its supplies. At noon we received information that the bridges had been repaired so that we might cross, and we hastily mounted our horses, anxious to arrive at La Tacunga before nightfall. On arriving at the river, we found the only bridge to consist of three or four trunks of trees not squared, elevated about forty feet above the river, on the abutments of the bridge which had been carried away; these were laid parallel to each other, but at sufficient distances, one from another, for a person easily to slip between them into the river which was roaring and foaming below. A number of people, with their horses and mules, were collected on each bank, disappointed, as I supposed, in the expectation of finding a bridge. Where is the new bridge? said I to our muleteer; there, sir, said he, pointing to the precarious footing afforded by the the trunks of trees; but how are our horses to cross? they cannot walk over on those round logs; no, sir, they cross by swimming; swimming! exclaimed I, in astonishment, they may swim but it will be down the stream to be dashed to pieces among the rocks; "*verémos*," we shall see, was the only reply. We now dismounted, and our muleteer, with the assistance of some Indians, unloaded our beasts, took the saddles and bridles from our horses and carried all across the bridge; we next followed and crossed safely, notwithstanding the narrowness of the path, and the slight nervousness occasioned by seeing the deep and rapid stream below. Our horses and mules were next to be got over, which was accomplished in the following manner; the river is about twenty yards wide very deep, and darts along with inconceivable rapidity; a long rope of twisted hide was tied round the neck of the beast to be conveyed across, and carried to the opposite side by the bridge, two men then pull at it and others drive the animal into the water and by the help of the rope, it is enabled to stem the current and reach the other bank. A number of people were waiting to get across their beasts by this singular ferry; the horses and mules generally went boldly into the water, and arrived, without much difficulty, at the other side, but the poor asses made all the resistance in their power, holding back, lying down, and roaring most piteously, and when at last forced into the water, they were seemingly incapacitated by fear from making any exertion, rolling over and over, and arriving at the bank half drowned; however, no accident happened and we recommenced our journey through a country formed of the materials thrown from Cotopaxi, toward which mountain we were now travelling; the quantity of lava thrown from the burning bosom of this terrific mountain is almost beyond belief; as far as the eye can reach, the whole country appears to be a mass of lava and volcanic sand, and although in some places there are patches of cultivation it has a sickly hue, and the whole bears the appearance of a spot on which a withering curse has fallen. A short time before sunset, we arrived at La Tacunga, after a fatiguing ride through fine sand which every wind raised in blinding clouds, and over bare hills of lava, heated almost to scorching by the rays of a nearly vertical sun. La Tacunga is the very picture of desolation and ruin, being a sad monument of the effects occasioned by the terrible convulsions of nature to which this country is subject; it has, perhaps, suffered more frequenly than any town in South America; in the year 1698, it was almost totally destroyed by an earthquake; in the year 1743 and 1744 it was much injured by eruptions of Cotopaxi; in 1756, another earthquake happened which destroyed the Jesuits' church, an enormous stone building, at the time, full of people; five thousand persons are said to have perished in it;* many other houses were ruined and many people lost their lives, beside those who were in the church. The last earthquake, which caused much injury, happened in 1800 and although it destroyed the church of San Francisco and many houses; comparatively few persons lost their lives. La Tacunga is built wholly of the dark colored spongy lava of Cotopaxi, which is easily worked and forms very handsome walls; whole streets are in ruins, but the most curious and appalling proof of the tremendous and irresistible force of the earth's throes, is presented by the ruined church of the Jesuits; its arched roof of solid stone has fallen in, burying thousands in its ruins; its walls, six feet in thickness, are cracked in every direction, and huge masses are torn off as if by the agency of some violent explosion; one mass, of

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* For the accuracy of this, perhaps, exaggerated statement, I cannot vouch: I had it from different persons in La Tacunga. T.

many tons weight, appears to have been twisted round after it was detached from the wall, and now rests on one corner, its upper end leaning against the wall; the strength of fifty men, unaided by machinery, would not serve to move it from its present position. On parts of the walls are fragments of fresco paintings, the colors of which are still quite fresh. We also visited the convent belonging to the same order, of which all except the lower story is destroyed; the "*patio*," or courtyard, is surrounded by a very handsome set of ornamented arches built of the same spongy lava of which the town is composed. The church of San Francisco, which was partially destroyed in 1800, has been rebuilt, or rather repaired; evident traces remain in it of the effects of the earthquake. Scarcely a month passes at La Tacunga without the shock of an earthquake. T.

2. *Details of a chemical analysis of Danaite, a new ore of iron and cobalt; by* Augustus A. Hayes.—The ore which was the subject of this analysis, was discovered some years since at Franconia, N. H.* and from its crystallographic and pyrognostic characters, it was considered as a new variety of arsenical cobalt; but as these would not enable us to determine whether the cobalt was present in an atomic or variable quantity, an analysis was attempted. It was, however, found difficult to effect so complete a separation of the constituents, as to give a true statement of its composition. The specimen examined was in the form of brilliant and perfect crystals, having a specific gravity of 6.214.

I. A portion which had been crushed in paper, was washed, dried, and reduced to a fine powder in a mortar of porcelain; the fine powder was exposed in warm air, and then cooled in a desiccated atmosphere.

II. 1000 parts of the powder were introduced into a flask, having a curved neck, with 6000 parts of strong muriatic acid. A few drops of nitric acid were added, and the flask connected with a large receiver, containing nitrous acid; as the action became less active, more nitric acid was added, and heat applied to the flask; the sulphurous acid being converted into sulphuric, and the hyposulphurous depositing sulphur in the receiver; by the cautious addition of nitric acid, the whole of the arsenic was taken up by the muriatic acid, leaving a portion of sulphur undissolved. The fluid was decanted

* Am. Jour. Vol. VIII, p. 302.

and boiled in another flask, the contents of the receiver were added to the sulphur and a portion of the acid distilled from it, till its solution and entire conversion into sulphuric acid was insured. There remains a white insoluble powder, which, after ignition, weighed 10.1 and was composed of silica and alumina, derived from the mortar.

III. The fluid and washings from the powder in II. were evaporated, with a slight excess of muriate of baryta; when much reduced, water was added, and the precipitated sulphate collected on a double prepared filter, was washed in muriatic acid, and then with water, until all traces of foreign matter were removed; dried and calcined with the upper filter, there were 1294.1 parts, containing .8 ashes, leaving 1293.3 sulphate of baryta, equal to 178.4 of sulphur. It was white, and contained no arsenic.

IV. When the washings were mixed with the fluid from the sulphate of baryta of III. an acid, pale yellow liquid resulted; this was divided into two equal parts by weight, one being used for the analysis, the other as a check on the results by different processes. The quantity of fluid equal to 500 parts of the mineral, being, in the usual way, decomposed by an excess of hydrosulphuric acid gas, the yellow sulphuret of arsenic, when dry, weighed 488.8; by nitric acid and muriate of baryta, it was decomposed into 281.6 sulphur and 207.2 arsenic, or 414.4 for 1000 parts.

V. After separating the sulphuret of arsenic, the liquor of IV. was of a pale pink color; it was evaporated at 120° in dry air; when much reduced, nitric acid was boiled with it to render the oxides peroxides; while warm, it was rendered brown and neutral, by pure ammonia, the last drop slightly impairing its transparency; the oxides were then precipitated by pure ammonia, and lastly by hydrosulphate of ammonia, collected as before, dried and ignited. It was found, from repeated trials, that the weight of the mixture suffered no alteration by exposure to heat, for a longer or shorter time; its true weight was 278.6. It was a soft, cinnamon brown powder.

VI. The dry oxides were dissolved in muriatic acid; by adding ammonia, the solution was neutralized, and succinate of ammonia separated the iron, without precipitating a trace of cobalt; after calcination, it weighed 237.6, equivalent to 164.7 of iron, or 329.4 in 1000 parts. The difference between 237.6 and 278.6 is 41. which is the weight of the protoxide of cobalt, representing 32.25 cobalt, or 64.5 in 1000: it was free from nickel.

Thus determined, the quantities of the constituents of this ore are,

Sulphur, - -	III. - - -	178.4
Arsenic, - -	IV. - - -	414.4
Iron, - -	VI. - - -	329.4
Cobalt, - -	VI. - - -	64.5
Derived from mortar,	II. - - -	10.1
		996.8
Loss, partly iron,	- - - -	3.2
		1000.

As arsenic, when sulphur is present, combines, in preference, with iron to form a binarseniuret, we therefore conclude that such a compound exists in this ore, and this opinion derives some support from the fact, that muriatic acid dissolves iron from the mineral, without a trace of arsenic being thrown out of combination.

By dividing the loss among all the constituents, its composition may be thus expressed, in accordance with definite proportions.

Binarseniuret of iron, - - - -	571.3
Sulphuret of iron, - - - -	290.6
Bisulphuret of cobalt, - - - -	136.5
	998.4

The employment of short trivial names in mineralogy having received the sanction of the most eminent naturalists, I propose the name of *Danaite* for this mineral, in honor of the late Professor James F. Dana, to whose skill in minute chemical research, we are indebted for our knowledge of the existence of cobalt in this mineral.

Roxbury Laboratory, May 27, 1833.

3. *Note to remarks on the Guaco.**—Since the remarks addressed to the Editor on this subject, the notice of the writer has been directed, by him, to a paper in the Journal of the Royal Institution, (for 1830,) touching the same plant; but it appears obvious that the writer, (Dr. Hancock,) does not, in that paper, understand by the name *guaco*, the same plant which has been sent from Mexico to Philadelphia and of which a specimen was forwarded to Professor Silliman.

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* This note came too late to be inserted in connexion with Prof. Johnson's communication on the Guaco.—Ed.

The following observation of Dr. H. is, perhaps, sufficient to establish the supposition above made.

"On the subject of Alexipharmics, I may observe, that those plants which are regarded as antidotes or counterpoisons, are chiefly those eminently bitter, aromatic, and piquant,—being the most powerful warm sudorifics."

"We know that the Corymbiferæ afford many examples of this sort; but the Guaco, although of this natural order, is almost entirely destitute of the forenamed sensible properties!!" If any one could take into his mouth a portion, however small, of the Mexican Guaco sent hither, and especially could swallow a teacupful of the infusion, he would be impelled to give a different account of its *sensible properties.* Dr. H., moreover, cites some cases in which the Guaco, or what he understood to be such, was tried ineffectually in the case of rattlesnake bite. This may be very possible, without derogating in the least degree from the credibility of Mutis, Chabert, his Mexican authorities and correspondents, or the statements from Venezuela, already presented in this number. W. R. J.

4. *Optics.*—A treatise on optics, by Sir David Brewster, has been published by Carey & Lea. It is from the "hand of a master," and has been adapted to the use of colleges in this country, by an appendix from Professor Bache, of Philadelphia.

The work presents the results of experiment and theory, applied to the investigation of different branches of optical science.

The phenomena of double refraction, and the polarization of light are treated of, and explained much at length. The author suggests new views on some points which had received the sanction of Sir Isaac Newton, particularly his theory of the colors of natural bodies, one of the most interesting branches of natural science. It is Sir D. Brewster's opinion, that although Sir Isaac incontrovertibly proved "*that the colors of material nature are not inherent in colored bodies;*" that yet, the rules by which he supposes the combinations of light produce transparency, opacity, and the varied tints which embellish the different forms of matter are insufficient and unfounded. He deems the "Newtonian theory of colors, applicable only to a small class of phenomena, such as the colors of the wings of insects, the plumage of birds, the oxidized films on metal and glass, and certain opalescencies; while it leaves unexplained, the colors of fluids and transparent solids, and all the beautiful hues of the vegetable kingdom, which cannot be produced by the mere vibrations of an etherial medium." He thinks, that certain rays are absorbed by material bodies, and that by entering into combination with their particles, *chemical* and *physical results are produced, establishing specific colors;* although the manner in which the combination takes effect is unknown. This theory is ably sustained, but the limits of this notice, do not permit any details of the reasoning.

A satisfactory explanation of the cause of erect vision, is among the most interesting solutions of the phenomena of "that master piece of divine mechanism, the human eye." "It has long been a problem with the learned," how objects could appear erect to the observer, when the images of those objects were inverted on the retina. It has been supposed by some that "infants, literally, see every thing upside down," and that, by subsequent experience, comparing the accurate information acquired by touch, with the erroneous impressions made upon the retina, they gradually learn to see objects in an erect position. In explanation, Sir D. Brewster says, that the lines of visible direction are always perpendicular to the retina; and all pass through one single point in the *centre* of its spherical surface; that they cross each other at this *centre*, so that those from the lower part of the image go to the upper part of the object, and those from the upper part of the image to the lower part of the object. Hence, the object is seen in an erect position "in virtue of the lines of visible direction being in all cases perpendicular to the impressed part of the retina."

This small volume is replete with exhibitions of the beautiful and surprising laws of light, which extends its influence from the smallest spire of grass, to the remotest orb in the heavens. It is a work in which theory rests, in almost every case, on the sure basis of mathematical demonstration.

The appendix of Professor Bache has added seriously to its value.

5. *Note on certain experiments on the inflammation of phosphorus in a rarefied medium;* communicated by Prof. A. D. Bache, of the University of Pennsylvania, in a letter to the Editor dated Philadelphia, March 25, 1833.—An error of the printer in the note of my experiments on the inflammation of phosphorus in a rarefied medium* having procured for me a rough remark from Professor

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* American Journal of Science, Vol. xviii, p. 372.

Moll, of Utrecht, I wish you would call his attention to the list of errata in No. 1 of the subsequent volume to that just referred to, in which the line beginning "Its inflammation occurs when phosphorus alone is placed," &c. is directed to be changed to "*No* inflammation occurs," &c. The word "Its" was substituted by the printer for "No," which was in my MS. I was so much struck with the influence that this typographical error would have in throwing the experiments into disrepute, should they be noticed and their repetition attempted, that on finding the note copied into Brewster's Edinburgh Journal of Science, I wrote to request a formal correction of the mistake. The letter, perhaps, did not reach him, or his known courtesy would have prevented the neglect of the request, and the subsequent insertion of a stricture upon the very passage, in which Prof. Moll supposes me to contradict the Holland experimenters.

I have not published the entire results of those experiments, from a wish to see how far they might have been anticipated, in a memoir contained in the transactions of the Zealand Society of Arts; the existence of which was made known to me by Prof. Moll's communication. These transactions I have in vain attempted to procure, and having no desire to *reproduce* any experiments already made abroad, I have thought it most prudent, for the present, to withhold my paper.

6. *On the growth of timber.—Extract of a letter from Mr. Alexander C. Twining, to the Editor, dated Albany, April* 9, 1833.

Dear Sir—I take this opportunity to mention a fact, which I once observed, and which may, perhaps, prove interesting to the readers of your Journal and lovers of natural science. In the year 1827, a large lot of hemlock timber was cut from the north eastern slope of East Rock, near New Haven, for the purpose of forming a foundation for the wharf which bounds the basin of the Farmington Canal on the East. While inspecting and measuring that timber, at the time of its delivery, I took particular notice of the successive layers, each of which constitutes a year's growth of the tree; and which, in that kind of wood, are very distinct. These layers were of various breadth, indicating a growth five or six times as full in some years as in others, preceding or following. Thus, every tree had preserved a record of the seasons, for the whole period of its growth, whether thirty years or two hundred,—and what is worthy of observation, *every tree told the same story.* Thus, if you began at the outer layer of two trees, one young and the other old, and counted back twenty years, if the young tree indicated, by a full layer, a growing season for that kind of timber, the older tree indicated the same.

My next observation was, that the growing seasons *clustered together*, and also the meagre seasons came in companies. Thus, it was rare to find a meagre season immediately preceding or following a season of full growth,—but, if you commenced in a cluster of thin and meagre layers, and proceeded on, it gradually enlarged and swelled to the maximum, after which a decrease began and went on, until it terminated in a minimum.

A third observation was, that there appeared nothing like *periodicity* in the return of the full years or the meagre, but the clusters alternated at irregular intervals; neither could there be observed, in comparing the clusters, any law by which the number of years was regulated.

I had then before me, therefore, two or three hundred *meteorological tables*, all of them as unerring as nature; and by selecting one tree from the oldest, and sawing out a thin section from its trunk, I might have preserved one of the number to be referred to afterwards. It might have been smoothed on one side by the plane, so as to exhibit its record, to the eye, with all the distinctness and neatness of a drawing. On the opposite side, might have been minuted in indelible writing, the locality of the tree, the kind of timber, the year and the month when cut, the soil where it grew, the side and point which faced the north, and every other circumstance which can possibly be supposed ever to have the most remote relation to the value of the table in hand. The lover of science will not be backward to incur such trouble, for he knows how often, in the progress of human knowledge, an observation or an experiment has lost its value by the disregard of some circumstance connected with it, which, at the time, was not thought worthy of notice. Lastly, there might be attached to the same section, a written meteorological table compiled from the observations of some scientific person, if such observations had been made in the vicinity. This being done, why, in the eye of science, might not this *natural*, *unerring*, *graphical* record of seasons past, deserve as careful preservation as a curious mineral or a new form of crystals?

If you should think fit to make such a suggestion, it might lead, in fact, to the preservation of sections from aged trees in different parts of the country, and a comparison of their lines of growth with the history of the weather as far back as our knowledge extends. If the observations just related, with respect to a particular lot of timber should be found to hold true of trees, in general, drawings of these sections, on a reduced scale, would soon find their way to the pages of scientific journals. It would be interesting, then, to make comparisons of one with another,—to compare the sections of one kind of tree with that of another kind from the same locality,—or to compare sections of the same kind of tree from different parts of the country. Such a comparison would elicit a mass of facts, both with respect to the progress of the seasons, and their relation to the growth of timber, and might prove, hereafter, the means of carrying back our knowledge of the seasons, through a period coeval with the age of the oldest forest trees, and in regions of country where scientific observation has never yet penetrated, nor a civilized population dwelt.

7. *Barometer.*—We have lately received from Mr. Hudson, Secretary and Librarian of the Royal Society, a series of "Experimental investigations on the Barometer," made by him, in order to determine, if possible, the laws which regulate its periodical changes, and to furnish data for explaining the anomalies of its daily and hourly oscillations. The observations, amounting to three thousand in number, were made during the months of April, May, June and July, 1831, and January and February, 1832. To insure the greatest accuracy, the experiments were conducted with the most perfect instruments, and with unexampled perseverance. For sixty days, the observations were consecutive, through day and night, fifteen times in each hour; and the remainder were made for sixteen or eighteen hours each day.

It is well known, that the periodical rise and fall of the barometer is marked with great regularity in tropical climates, but the law which prescribes and regulates those changes, has not been ascertained. As we recede from the equator, to our own extra-tropical regions, no constant law is apparent; and the movements of the mercurial column become irregular and violent. By examining, however, the variations for several days, and classing the observations made at the same hours on each successive day, and thus deriving from their union the hours of one mean day, Mr. Hudson found that these accidental variations neutralize each other—thus allowing the constant or equatorial oscillation to become appreciable.

The following are some of the results of Mr. Hudson's experiments and observations.

"That there is a striking connection between the barometrical changes, and the variations of temperature.

"That a relation appears to subsist between the variations before noon, and those before midnight; a great amount of variation before noon being followed, in the same mean day, by a corresponding small variation before midnight, and the contrary.

"That the season of the year, or the temperature of such season, appears to exercise an influence over the hours of maximum and minimum, and over the amount of mean variations. The minimum and maximum of the morning are earlier, and of the evening later, in summer than in winter. The variations in summer are small at noon, and great about midnight; those in winter, the reverse.

"The greatest mean variation occurs in the afternoon, minimum height of the barometer at four o'clock; and the next greatest, in the forenoon, maximum at ten o'clock.

"That the general relation between the barometrical changes and the variations of temperature, appears to be direct, during the morning hours, and inverse, during the day and evening."

These observations have been made with a thermometer attached, and the variations of temperature simultaneously registered with those of the barometrical changes. Mr. Hudson considers the variations of atmospheric pressure to be dependent on temperature, but has not stated any precise ratio by which the changes are regulated; nor has he explained any of those circumstances which accelerate or retard the uniform operation of the laws which cause its periodical oscillations.

The changes of temperature alone appear to be insufficient to account for the phenomena of the barometer.

There can be no doubt that, comprehending the whole atmosphere, there is a constant rise and fall, or a great semi-diurnal motion of the air, whereby it is subject to a regular elevation and depression twice in twenty four hours, analogous to the tides of the ocean; and it is well ascertained, that its movements are uniform at the equator, and nearly so through the tropics, while it is subject to great variations and irregularities within the temperate regions. These changes might be ascribed to the extremes of temperature in extra-tropical climates, were it not that barometers, which have been simultaneously observed in various and distant countries, rise and fall together; and it is seen, by Mr. Hudson's observations, that temperature cannot be the only disturbing influence, because the barometrical changes do not precisely coincide with the thermometer. If the effect of heat and cold were alone the cause of the greater or less density of the air, the effect should be strikingly obvious and uniform near the Pole, where the mercury of the barometer should be much higher than at any other place. But that is not the case. The maximum at 66° and 74° N. lat. has never been seen, many lines higher than thirty inches, which is the barometrical indication estimated by Kirwan as the natural state of the atmosphere at the level of the sea, over the whole globe.

Mr. Hudson intends to pursue his researches into collateral branches of the subject, and a much more full development may be expected from his additional investigations. He professes to be guided by the results alone, without reference to any previous theory or opinion. Among other points, he will endeavor to ascertain whether any connexion exists between the variations of the barometer and those of the magnetic needle, which will of course lead to an examination of electrical influences; and he will also make a further and complete estimate of the effect of temperature on the barometrical changes. In aid of his views, Mr. Henderson, Astronomer Royal at the Cape of Good Hope, Mr. Dunlop, Astronomer Royal at Paramatta, and Mr. Forbes, now on a scientific tour through Italy and Greece, have promised to undertake a series of observations, to be made simultaneously with those of Mr. Hudson in London.

8. *Propositions, stated by* Isaac Orr.

TO THE EDITOR.

Dear Sir—Will you do me the favor to publish, in your Journal, the three following propositions, addressed to the mathematicians of this country, and also, through your work, to the leading ones in Europe.

To the mathematicians of the United States and of Europe.

All mathematicians are respectfully invited to answer or demonstrate the following propositions.

1. Supposing the attractive power of the particles belonging to the material universe, to be, inversely as the square of the distance from their centres; and their repulsive power, or rather the *excess* of the ratio of the repulsive power, over the attractive, to be, as Newton has made it, inversely as the distance from their centres; and supposing both powers to be limited by and to the actual sur-

faces of the particles; then, a solid body, in free space, will arrange the particles of an elastic homogeneous atmosphere about it, so that they will be in regular columns, having their centres in right lines, drawn from the centre of the solid body; they will be all of the same form; the distances between their centres will be as their distances from the centre of the solid body; their magnitudes will be as the cubes of those distances; and their *acting* attractive forces, will be inversely as the squares of those distances. And if two such solid bodies, with similar elastic atmospheres, are made to approach each other, in free space, they will gravitate toward each other, by means of their elastic atmospheres alone, with forces inversely as the squares of the distances between their centres. What is the proof?

2. With the same elements, there is a condition, by which the particles may be easily movable among themselves, and around their centres, in any required degree, so that the resistance which they will present to a solid body moving among them, may be reduced to any required degree of smallness. How is this demonstrated?

3. Supposing the two powers of the particles to be limited by and to their own actual surfaces, and their repulsive power to be such as Newton has made it, then there is a condition, or rather a supposed property of the particles, entirely consistent with all their known properties, which will give to them all the attributes of ubiquity, which they really possess in nature, although their own powers are confined to and within their own actual surfaces. What is that property, and how is the proposition demonstrated?

To all these propositions, I already have answers or demonstrations, which appear to me decisive. Perhaps some other persons may furnish better.

Washington, March 15, 1833.

☞Editors friendly to science, are respectfully requested to republish the above.

9. *Prof. Hitchcock's Report on the Geology of Massachusetts.*—The first part of this report, with a geological map, was published in Vol. XXII of this Journal. We understand that the MS. of the remainder is now nearly prepared, and that it will be published in the autumn, by the government of Massachusetts, with a reprint of the first part.

It is understood that it will make a volume of from six to seven hundred pages, 8vo. illustrated by quarto maps and drawings, and numerous wood cuts. From the ability displayed in the first part, as well as from the well known character of Professor Hitchcock, it cannot be doubted that this volume will be one of great interest and importance, and will do credit, not only to the author, but to the enlightened government of Massachusetts.

Prof. Hitchcock has recently discovered chromate of iron, in considerable quantity, in serpentine, in Blanford; also finely crystallized sphene, in augitic gneiss, in Lee; and rotten stone, in connection with fetid limestone, in West Springfield. Native alum also occurs in the gneiss of Barre, as well as in that of Leominster.

10. *Manual of Mineralogy and Geology; by* Ebenezer Emmons, M. D., Lecturer on Chemistry and Natural History in Williams College. Second edition. Albany, Webster and Skinners: 1832. 12mo. pp. 299.—(Communicated.)—A manual, short, comprehensive, simple and accurate, and neither cumbrous nor expensive, has long been a desideratum. The work of Professor Cleaveland, although invaluable for reference or study in the *cabinet*, is much too large for a *pocket* companion in mineralogical rambles, and is moreover too costly for many who wish to engage in the study of mineralogy. Under these circumstances the work in question has been published; and it appears happily adapted to the object proposed. Dr. E. has adopted the *classification* of Mohs, but owing to the abstruseness of Mohs's system of *crystallography*, he has substituted, in its stead, that of Brooke. The introduction is clear, full and comprehensive, while the notes, in the form of an appendix, containing articles on the use of the blowpipe, &c. will in practice be found highly useful. The characters are copious and judiciously selected, and what is most interesting in the localities of minerals and their uses in the arts, is condensed into a small compass. Mohs's system of *nomenclature* is likewise adopted, but the *trivial* (or common) names are subjoined in a smaller type, thus obviating the necessity of committing a new system to memory, in the case of those already acquainted with the one generally in use. On the whole, we think this work creditable both to the author and the publishers, although the typographical execution is hardly what might have been desired; and we doubt not that he who examines it will coincide with us in the opinion, that it will prove a valuable acquisition to the mineralogical student.

11. *Manual of Botany for North America; by* Prof. Amos Eaton. Sixth edition, Albany, 1833. 12mo.—It is surely a happy token of the wide spread taste for the scientific study of plants, that six editions of Mr. Eaton's Register of American and common garden plants have been called for in this country; in addition to several other works of the same nature. The plan of his work is too well known to require any remark; it is only necessary to allude to the alterations made in the present edition. To quote from the preface, "Nothing new is presented either in the text, or in the catalogue, excepting what ought to have been discovered in this *progressive* science, since the fifth edition of this manual was printed; and not so much of *real improvement,* has been added, as between the fourth and fifth editions." A few terms of modern invention have been adopted, some genera have been modified, and the natural orders of Jussieu have been farther subdivided, in accordance with the best authorities for these innovations. The new generic names of DeCandolle are given as synonyms. The author professes to have engrafted upon this edition, all the improvements relative to American Botany to be derived from the recent writings of Lindley, Hooker, Loudon, and the four published volumes of DeCandolle. The etymologies of the genera are also given, apparently, with considerable attention, and will undoubtedly enhance the value of the work; but the copious glossary of terms published in the last edition, we are sorry to see, has been reduced within very unsatisfactory limits and confounded with the general index. This, surely, is to be regretted, as the student will still have to provide himself with a separate work for obtaining terminological information. "This edition presents a North American Flora, as full as the present state of the science will admit. It not only includes all the well defined plants of the United States; but those of the Canadas, Nova Scotia, &c. The number of genera descrided is 1228, the number of species is 5267."

12. *Botany of the Northern and Middle States; by* Lewis C. Beck. Albany, 1833. pp. 471, 12mo.—This is the first descriptive catalogue of our plants, arranged according to the natural system. The attempt certainly will not fail of being received with approbation by all botanical students; and the more especially as the treatise embraces a synopsis of the genera, after the analytical system of Linnæus, by means of which the advantages of both systems are placed together in the hands of the learner. The orders are arrang-

ed according to Jussieu, as modified by DeCandolle; and the author, has followed, with few exceptions, the arrangement and characters given in the article Botany, in the new edition of the Encyclopædia Brittannica. The work contains a sketch of the rudiments of Botany, a glossary of terms, and a table of the Linnæan classes and orders. It is confined to the description of indigenous plants growing north of Virginia; and describes 641 genera and 2105 species.

13. *Notices of text-books of the Rensselaer School,* [*or Institute,*] *in Troy, New York.*—We have received copies of four of the text-books of Rensselaer School. As they are composed upon the peculiarly practical plan of that school, a few short notices of them may be acceptable.

1. Art without Science; second edition.—This book is made up entirely of practical directions for the Surveyor and Engineer. As Prof. Eaton, the author, was, for a long time, a practical surveyor; and held a land agency of between two and three hundred thousand acres of land for ten years, the surveying part is necessarily a practical system. The engineering part furnishes elementary and practical views of minor value. Cost 75 cts.

2. Chemical Instructor; fourth edition. This is truly a simple and practical little treatise. It contains 324 pages, 12mo., and is made up almost wholly of directions for experiments, short rationale, and applications. The experiments are the result of Prof. Eaton's own trials, performed with the most cheap and simple apparatus. He has given minute directions, and the cost, for procuring every thing required for a course of experiments (which he brings under one hundred dollars) sufficient to illustrate the general outlines of the science experimentally. He refers to other books for the reading part, as he calls it. Cost $1.

3. Geological Text-Book; second edition. This work may be considered as more nearly original than any other work of the author, (Prof. Eaton.) It consists of a general summary of all his discoveries and observations, made at the expense of that distinguished patron of science, the Hon. Stephen Van Rensselaer, of Albany, with the synonyms, and most important theories of foreign geologists. It contains sixty eight lithographic figures of organic remains, examined in place by the author; and a geological map of the State of New York, and of the proximate parts of the adjoining States. Cost $1 25.

We understand that a small work is promised by a female pupil of Prof. Eaton, (which is to be under his supervision,) entitled Botanical Teacher; which may be of great use, especially in French Seminaries. It is almost ready for the press. It will contain short descriptions of every genus in North America, and descriptions of all the species by a set of figures; also the natural and artificial methods, physiology, and vegetable chemistry, combined in the same series of arrangement. Cost 75 cts.

Chester County Cabinet of Natural History.—We observe with pleasure, that this Institution, under the patronage of zealous and enlightened men, is proceeding with diligence and perseverance, in the promotion of its objects; the details of its progress are contained in the sixth report, published in the present year, 1833.

Hezekiah Howe & Co., *New Haven*, have in press, to be published in August next, Natural Philosphy for High Schools and Academies, designed to hold an intermediate place between the smaller elementary works, and the larger treatises used in Colleges; in one volume, 8vo., of about 300 pages. By Denison Olmsted, A. M., Professor of Mathematics and Natural Philosophy in Yale College.

H. H. & Co. have in preparation, and will shortly publish, under the revision of Prof. Silliman, An Introduction to Geology, intended to convey a practical knowledge of the science, and comprising the most important discoveries, with explanations of the Facts and Phenomena, which serve to confirm or invalidate various Geological Theories; by Robert Bakewell. The second American from the fourth London edition, greatly enlarged, with new plates, and numerous cuts.

New Haven, June, 1833.

☞ Various communications for this No. came too late for insertion, and others are under consideration, most, or all of which will appear in a future number.

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