DISTRICT OF NEW-JERSEY, ss.

BE IT REMEMBERED, That on the twenty-first day of November, in the fiftieth year of the Independence of the United States of America, Terhune & Letson, of the said district, hath deposited in this office the title of a book, the right whereof they claim as proprietors, in the words following, to wit:

"An Essay on the Art of Boring the Earth for the obtainment of a Spontaneous Flow of Water. With Hints towards forming a New Theory for the Rise of Waters."

In conformity to an act of the Congress of the United States, entitled "An act for the encouragement of learning, by securing the copies of maps, charts, and books to the authors and proprietors of such copies, during the times therein mentioned;" and also to the act, entitled "An act supplementary to the act, entitled an act for the encouragement of learning, by securing the copies of maps, charts, and books to the authors and proprietors of such copies, during the times therein mentioned; and extending the benefits thereof to the arts of designing, etching, and engraving historical and other prints."

WILLIAM PENNINGTON,
*Clerk of the District of New-Jersey.*

## TO WILLIAM COLEMAN, Esquire.

Sir,—I take the first opportunity that has ever been in my power to show you a publick mark of my esteem.

I dedicate this *Essay* to you for a reason that must entitle it to the attention of your friends; the consideration that you have, by the watchful guardianship of your pen, contributed more than any man now living to the honour and prosperity of New-York—my native city—You have gone hand in hand with the spirit of improvement, and have seen the rise, successively, of those great publick works—THE PENITENTIARY—THE HIGH SCHOOL—and, greatest of all, THE HOUSE OF REFUGE. When the city shall be abundantly supplied with streams of *pure and wholesome water*, you can scarcely have any thing further to desire.

Yours, Respectfully,

THE AUTHOR.

# ESSAY.



It is useless to the present exposition, to trace the origin of the art of *Boring*. It is only necessary to observe, that it has been known in Europe for the last fifty or sixty years. It was, however, but a partial operation, being no farther practised than to ascertain the presence of coal and other minerals, and to give a greater quantity of water to wells that did not at all times afford a sufficient supply.

When the western part of our country became populous, and men had leisure to attend to the riches that nature had so freely scattered around, it was discovered that salt, an article essential to their existence, and for which they paid in a triple ratio, was abundantly present in the whole range of country. Besides the "*Salt Licks*,"* there were other indications of the presence of salt; and one man, whose name is now unknown, acquainted with the practicability of obtaining an additional supply of water in wells by means of boring downwards with an auger or chisel, determined on making the experiment. Accordingly, after digging a deep well, he bored to a certain depth, and a quantity of salt water was obtained that was sufficient for the purpose of making salt for the neighbourhood. Intending to raise the water by means of a pump, he inserted a piece of tube in the bored hole, lest the muddy particles

* So called because of the practice of Deer and other animals resorting to these spots, to lick, or drink salt water.

that usually fall to the bottom of wells should choke up the bored aperture. The piece of tube that was inserted, happened to be longer than he intended, for it stood several feet higher than the level of the water; to every one's surprise, as soon as the tube was placed in the bored hole, the water arose and overflowed at the top. Another piece was added, and the water overflowed at the top of that one likewise. As the length of the tubes reached nearly to the surface, the idea immediately suggested itself of boring from the surface, without digging a well. The experiment succeeded; for, after boring to the depth of 70 or 80 feet, the water arose and overflowed at the surface.

This was, however, only in salt districts. In process of time, even in places where indications of salt were less apparent, experiments were made, and salt water was obtained, although the borer was often obliged to pierce the rock to a greater depth. Finding the project successful and profitable, the increased depth to which some borers had to go before the salt water flowed over the top seemed of no importance; and it was no discouragement to bore down to the depth of from five to seven, and even nine hundred feet. But as experiments receded from those districts where there was no doubt of obtaining salt water, it became necessary to shut out, by means of tubes, all the fresh water springs that intervened before the borers came to salt water, and thus, by degrees, it was as common to bring salt water above the surface, as it was formerly to dig wells. In this state the art rested in America, until the year 1823, when Mr. Levi Disbrow, after seeing the operation of boring in the Western states, formed the project

of bringing *fresh water* above the surface in New-Jersey.

In May 1824, Mr. Disbrow made the first attempt. It was at the distillery of Mr. Bostwick, who entered very readily into the scheme. Atthe trifling depth of 175 feet, a fine flow of water was obtained, which has continued for two years and a half to discharge one and a half gallons a minute, at the height of three feet from the ground.

This, and the other bored wells as they occur, shall be designated by numbers, as reference may be necessary.

*No.* 1. Which is the one above cited, is about 40 feet above the level of the Raritan, and the boring was principally through strata, denominated *red shell*, or *old red sand stone;* now and then some thin strata of gray wacke or slate, were discernable; and at long intervals there was an occurrence of blue clay. At the depth of 137 feet, the water arose to the surface; but as the stream was small, the boring was continued to the depth of 175 feet, when the quantity of one and a half gallons was obtained at the height of three feet above the ground. As the distillery, for which the water was wanted, was much lower than the points whence the water issued, and as it was known that the quantity of water increased in a double ratio at every foot below the surface, the tube was tapped several feet from the top, and of course a greater abundance of water was obtained. The temperature of this central spring is 52° Fahrenheit, and the whole cost of boring and tubing was about 425 dollars.

*No.* 2. Commenced August 7th, 1824, about one mile from well No. 1, 47 feet above the level of the Raritan. Went through 60 feet of soft red shell, and struck the first vein of water---three

feet of granite---blue shell---blue rock---at 110 feet came to a rock harder than granite: this rock was about four feet thick; in the centre of which, encountered loadstone; the poles of the borer were so strongly magnetized that a heavy jack-knife could be suspended from them. This stratum of loadstone seemed about 4 inches thick; came to water after passing this adamantine rock, through which the borer could only penetrate from two to six inches a day; went through various kinds of rock, some calcareous and others silicious. The red shell was always found at intervals; and water was almost always obtained either in the stratum, before encountering red shell, or else immediately after it. The strata of clay were never of any thickness, until towards the lowest part of the bore, when, after going through four or five feet of blue clay, at the depth of 394 feet, struck a vein of water, which immediately overflowed at the top, and is now, Nov. 14th, discharging two gallons a minute, at the height of 2 feet 8 inches from the ground. This well is tubed to the depth of 194 feet, with a copper tube of one and a half inches diameter. It is regretted that no particular note was taken of the thickness of each stratum of rock as it occurred in this well, as there seemed to be a greater variety in this spring than in any of the others. It was thought to be finished in the winter of 1824, as the water ran above the surface; but it was found necessary to bore deeper. There was an ebb and flow in this well until it was bored deeper. The present tube must have shut out the particular vein that caused the ebb and flow as it is no longer apparent. The temperature of this spring, at the depth of 250 feet, was 52° Fahrenheit; now, at 294, it is 54; thus adding another proof of the correctness of the opinion that the

temperature increases as we get more into the interior of the earth.

*No.* 3. Mr. Simpson's distillery, New-Brunswick. Began in Nov. 1824, and finished in Feb. 1825. Went through 7 feet of clay, and then 60 feet of red shell, when the first stream of water was struck. Atthe depth of 140 feet, a thin stratum of loadstone was encountered; the poles were strongly magnetized, but not equal to those of well No. 2. The rock succeeding the loadstone was gray granite for a foot or two, when the red shell reappeared. At 150 feet, there were indications of copper. This one is 176 feet deep, and cost 440 dollars; is tubed only 18 feet, and discharges two gallons a minute: 52° Fahrenheit.

*No.* 4. In Dunham's Alley, in New-Brunswick, ten feet above the level of the Raritan. Began it in Feb. 1825. Bored through made ground for 12 feet, and then met with continued strata of red shell to the depth of 208 feet. Water now rises above the surface; but the boring has been discontinued for the present, as *Mr. Disbrow*, to whom this well principally belongs, is too much engaged to finish it. The water is above the surface, but the stream is trifling.

*No.* 5. Jersey City. April, 1825. Level, 25 or 30 feet. Began to bore in a well 24 feet deep; water in it very brackish. Jersey City surrounded by salt water. Granite from the commencement to the present depth, which is 208 feet.—Struck several veins of water after going 146 feet. By inserting a small pump, three gallons a minute can be raised. The water runs over the tube 21 inches, unaided by machinery. They are still boring. Water excellent.

*No.* 6. Alexandria. Thirty-five feet above the level. Bored 23 feet in common soil, a stratum

of iron ore, of about a foot thickness, 11 feet of quicksand and water, 11 feet of sand, 10 feet of coarse gravel, 90 feet of black alluvial, intermixed with wood and fibrous particles, &c.; two feet of gray stone, 96 feet of blue, yellow, and gray clay. After getting through this clay, struck a vein of water, which arose to within 36 feet of the top. Bored to the dept of 450 feet, through different coloured clay, with now and then a stratum of coarse sand. Quitted in May, with the intention of resuming it again.

*No.* 7. Hudson, New-York. Seventy feet above the level of the Hudson. Began in May, 1825; 40 feet clay, 30 of brown sand, 4 hardpan clay and gravel. Struck a vein of water, which arose 17 feet; 70 feet of black slate rock, mixed with limestone. Still boring.

*No.* 8. North side of the Raritan, half a mile from New-Brunswick; 80 feet above the level of the Raritan. Began in 1825, in the bottom of a well that was 48 feet deep, and quite dry; 60 feet of red shell; struck a vein of water which gave eight feet water to the well; indications of coal; red shell, and now and then thin strata of gray wacke, to the depth of 250 feet, when water came above the surface, discharging one and a half gallons at the height of seven feet. Cost about 400 dollars, and is tubed 100 feet, with one and a half inch copper tube, connected at intervals of twelve feet, with brass screw joints. These copper tubes cost 50 cents a pound; and the screws are 75 cts. a piece.

*No.* 9. Albany. Began May, 1825. Boyd & M'Culloch, Brewers. Level 20 feet above the Hudson. Began in a 30 feet well; 11 feet of coarse gravel and hardpan; 41 feet black slate rock; very little water until after passing a depth of 200

feet of same rock; struck several small veins. At 250 feet encountered inflammable gas. Now 280 feet deep, and water within four feet of the surface.

*No.* 10. Albany. Waterworks Company. Began in August, 1825. Twenty feet of clay, sand, and gravel; 17 feet hardpan; struck a vein of water which instantly overflowed at the surface, at the rate of five gallons a minute. The diameter of the bored hole of this spring was eight inches, whereas all the previous ones were from two and a half to two and three-quarter inches in diameter.

*No.* 11. The same Company are now boring back of the Capital, in Albany, on very high ground, and are now at the depth of 120 feet in hardpan.

*No.* 12. New-York. Manhattan Company. Began Sept. 1825. Level 40 feet above the Hudson. Bored 40 feet in sand and gravel; 60 feet in hard granite; from that depth to 240 feet, occasional veins of water; increasing in quantity as the depth increases; water, when a tube is introduced, now within 30 feet of the surface; discharges 12 gallons a minute, by means of a pump. When down to the depth of 260 feet, the chisel passed a vacuum of an inch; the water immediately sunk one foot; but in the course of a few hours, when the cavity was filled, the water arose again. This has been the case in several wells; boring still continuing.

*No.* 13. Harper's Ferry. Began June, 1825. Level 12 feet. Very high mountains in the rear. Fifty feet of soft gray slate; 50 feet of granite, but not very hard; occasionally quartz and granite. At 110 feet, touched a fine vein of water: some quartz and granite at the depth of 264 feet. Discontinued for the present, but is to be resumed.

*No.* 14. Baltimore. Mr. Bosley, two miles west of the city. Seven feet common soil: 33 feet rotten gray rock; 140 feet of the same rock, only harder; struck a vein of water, which arose to within 22 feet of the surface. Some mischievous person having at this time thrown in a piece of steel, it cost a great deal of time, labour, and money to cut it up, it being of 30 inches in length.---The boring is going on, and much praise is due to Mr. Bosley for the liberal spirit he has shown in the prosecution of this work under so many discouragements.

*No.* 15. Horsimus. Eighty feet above the level of the Hudson. Mr. Haight's Carpet Manufactory. Began June, 1825, in a well 30 feet deep, which did not give sufficient quantity of water, as the machinery was idle one day in six. Bored 30 feet in sand, gravel, and hardpan. Got plenty of water.

*No.* 16. New-Hope. June, 1825. Sixty feet level. Eighty feet red shell, 110 limestone. Still going deeper.

*No.* 17. Philadelphia. Mathew Carey, Esq. Began in a well 48 feet deep, quite dry. Thirty-eight feet of hard granite, and brought 4 feet of water in the well. Object obtained. Granite, therefore, in this case, as well as in the spring No. 5, in Jersey City, is intersected by veins of water.

*No.* 18. Northern Liberties, Philadelphia. Level 40 feet. Forty-five feet sand and gravel; 145 feet gray granite rock, only varying from soft to hard. Struck several veins of water in this granite. Water at present within 25 feet of the surface.

*No.* 19. New-York. Corner of Rivington and Columbia streets. Commenced Aug. 1825. By degrees sunk a cast-iron tube, and began in a

well 20 feet deep. Ten feet quicksand; 20 feet marsh, mud, and clay; ten feet gray clay; stopped at granite. All the upper brackish water is excluded by the tube, and have now a fine flow of water from the junction of clay and granite. This water is excellent, and is pumped up by a small pump.

*No.* 20. New-York. Broad-street. Mr. Tunis Quick. Four feet common made ground, or street filling, of the consistence of mud; 6 feet of yellow clay; 19 feet gravel and quicksand; 10 feet of gray clay. Came to granite, fastened the cast-iron tube, and water arose to within 7 feet of the surface. Put in a pump; object obtained.

*No.* 21. New-York, corner of Avenue D, and Fifth-street. Bored through 6 feet of common street filling; 10 feet marsh mud; 65 feet of quicksand and gravel; 15 feet of gray clay. Came to granite, and obtained fine water. Tubed 96 feet. Bore 8 inches diameter. Water within 4 feet of the top.

*No.* 22. Dry Dock Company, corner of Avenue D, and Tenth-street. Six feet common filling; 10 feet marsh mud; 12 feet quicksand; 53 feet of common shore sand and gravel; 6 feet of hardpan; 3 feet of coarse gravel. Stopped at the granite, and got plenty of water within 4 feet of the surface.

*No.* 23. Newark Meadows. Grazing Company, at the junction of Belleville and Newark Turnpike, on the *salt marsh.* Ten feet of marsh, mud, and roots; 12 feet of fine quicksand; 36 feet blueish gray clay; 6 feet sand: 20 feet of ash coloured clay. Met with water: bored 20 feet farther in very stiff variegated clay, on the reddish cast. Touched the red free stone, and stopped. Water excellent and soft, and within three feet of

the surface. The reclaiming of salt meadows has been a great object obtained. The reclaiming of the fresh water springs is of still higher importance.

*No.* 24. Allen-street, near Hester-street, New-York. Began in a well 40 feet deep, that had about two feet of brackish water in it. Commenced in quicksand: bored 20 feet: now and then a stratum of gravel: 2 feet clay, 5 feet of coarse gravel and sand. Obtained water, as is always the case, before coming to the solid rock. All the waters of these last mentioned wells are like the water of the old *Tea Water Pump.*

Perhaps if the Manhattan Company, or the Corporation of New-York were to adopt the plans of wells No. 20, 21, 22, 23, 24, there would be no necessity of going farther below the surface, than to touch the granite rock.

"An overflowing well was commenced in the garden of the Horticultural Society at Chiswick, and after boring for five weeks without material interruption, tapped the spring on the 18th of Oct. and finally completed the task on the following day. The depth from which the water first arose was 317 feet: and the whole depth of the well, when completed, was 329 feet, the additional 12 feet of boring having been made in order to gain a perfect opening into the bed of the spring, which flowed, when first tapped, less copiously than after the final depth was obtained. The chalk, from which the water immediately comes, is soft, but the bottom of the well is in hard chalk. The water in all the neighbouring wells appears to have been obtained at about the same depth: and the strata, through which the perforations were made, are nearly similar to those met with in the

The tackle and the instruments used were very simple. A scaffolding was raised 20 feet above the proposed orifice of the well, on which a platform was fixed to support a windlass, by which the rods used in boring were lowered into, and raised from the well. These rods were of tough iron, about an inch and a half square, and ten feet long, the ends of each screwing on to, or unscrewing from, the top of the next, as they were lowered into, or raised from the hole. The instruments—fixed, as occasion required, to the lowest extremity of the series of rods, when in action—were augers of various dimensions, for boring: steel chisels, for punching: and a hollow iron cylinder—called a shell—fitted with a valve at its lower end, for bringing up soft mud. The rods, when an auger was attached to them, were turned round by means of moveable arms or dogs, which were made to lay hold of the part of the uppermost rod, at the top of the hole: the auger, being thus forced through the stratum of clay or sand, was drawn up, as soon as its cavity was filled with the substance it had loosened. The chisels were employed for punching through stones, hard chalk, or other hard substances; the rods, when these were attached, were moved by means of a powerful beam, acting as a lever, and worked by four men.

The water is discharged at the surface of the ground, at the rate of six gallons per minute, and is capable of being carried twenty feet above the ground-level, and even then supplies a copious stream. The well is lined, for the first 186 feet, with cast-iron pipes, with a three inch bore, jointed by means of wrought-iron collars which are riveted into the pipes. The succeeding 77 feet 6 inches are lined with copper pipes of two and a half inches bore, soldered into a single length, and resting in

the chalk, through which the remainder of the hole is bored, and in which no pipes were used. The whole series of pipes was introduced at once, the hole having been prepared for them as soon as it was ascertained that the augers had reached the chalk stratum. The land-springs in the gravel, above the blue clay, were kept out, in the first instance, by extra iron pipes. The spring, which was found in the sand, below the blue clay, and above the chalk, arose to within a few feet of the surface, but did not overflow. The whole of the water of this spring is, however, excluded from the well, by the pipes with which it is lined.

The cost of the well, including that of the pipes, boring, and every other expense whatever, did not exceed 130*l.*; and the manner in which it was executed was in every respect satisfactory. Indeed, it is impossible to speak too highly of the care, attention, and dexterity of Mr. Worsencroft, and the workmen whom he employed. The various strata bored through were as follow:—

| | |
|---|---|
| Gravel, | 19 feet. |
| Blue Clay, | 162 |
| Coloured clay, varying from brick-red, mixed with blue and yellow, to many shades of dull purple, | 30 |
| Clay, with nearly a uniform colour of yellow ochre, occasionally mixed irregularly with gray. This was more sandy than the previous stratum; among this water arose in some quantity, | 22 |
| Soft soil, apparently composed of clay and sand; it varied much in colour; being sometimes bright green, otherwise yellow, intermixed with green, or sometimes beautifully veined with dark red and yellow, | 28.6 |
| Chalk, among which many flints were scattered; of these, one was one foot in thickness; and so unusually hard as to occupy the workmen three days in punching, before they could force a way through it, | 67.6 |

The water was found, as before mentioned, at the depth of 317 feet, in a bed of soft chalk, mixed with small flints: the hole was bored 12 feet among the water, so that the total depth of the

well is 329 feet: and it is supposed by the workmen, that the last piece of chalk that was brought up, sticking to their punch, was from the upper surface of a new layer of chalk, in which there is no water.

The principal impurity discovered in this water by the action of re-agents, is common salt, of which it contains about four grains and a half in the pint. When evaporated to dryness, the residue contains a sufficient quantity of carbonate of soda, to render it manifestly alkaline; this is also the case with the waters of the other deep wells in and about London."

Besides these enumerated wells, there are a number of others in different states of progression; they are not mentioned, because there have been no returns.

Thus, in the space of two years, several wells have been finished, and many begun. Nothing extensive, however, will be effected until a reduction of the expenses of boring shall take place, which cannot occur until there be a simplification of the machinery, and an introduction of steam power in lieu of the present one, which is manual labour.

But for the shrewdness of Mr. Disbrow, who is an Eastern man, the practicability of getting pure and wholesome water in this simple, natural way, might not have been tested in a century, if ever. Certainly the merit is his of *bringing fresh water, by design, above the surface*, in a way hitherto unpractised.

When we consider how necessary to health, nay, to life itself, a pure and wholesome stream of water is, we cannot be sufficiently attentive to the creation of such streams as are now under discussion and experiment. England, always on

the alert, has availed herself of the new art, and is now daily opening these central springs.

It will be observed that the Chiswick Horticultural Society have completed one of these wells, and it has been flowing for upwards of eighteen months. A number of others have been finished in its neighbourhood.

Mr. Skinner, Editor of the AMERICAN FARMER, is the first one in America that published the account of these bored wells; and it is much owing to his earnestness on the subject, that the thing has been brought forward. The obtainment of a spontaneous flow of water is one of the greatest blessings that has ever been conferred on mankind.

To those who live in districts where pure and wholesome water has always existed, the above assertion may be deemed extravagant; but there is not a resident of New-York, of the Southern states, of Cuba, of Curacao, or of more southern latitudes, but will agree to the truth of these remarks; and it is to those in particular that this part of the Essay is directed. It is unknown to many that in Cuba, on the Coffee plantations, they are obliged to dig wells from two to four hundred feet deep; and a Planter thinks himself well rewarded in an expenditure of from 10 to 1500 dollars, if he get four or eight feet water in this deep well. When we think of the vast labour of drawing up this water for daily use, and then find how small a quantity can be appropriated to each individual, when the family consists of from 1 to 300 persons, and from 50 to 200 head of cattle, we may readily imagine how salutary and advantageous a stream of water would be that flowed constantly and in abundance.

In Curacao, the distress that was occasioned by the drought of several years, was beyond

calculation. If there had been wells of good water, the drought would not have been so severely felt.

If in Havanna, where yellow fever is generated, all the old modes of supplying that city with water were abandoned, and the new one of bored wells was adopted, the malignant effluvia of these impure streams, always stagnant, would cease, and tropical fevers would be within the reach of medicine. Water thrown in reservoirs for daily use, loses its vitality; as soon as the vivifying gases have escaped, it becomes putrid, and engenders miasmata and animalculæ. Water, to be pure, should have certain gases always present; in what way, therefore, can this be obtained but by a running stream? Fortunate are those who live in the vicinity of those streams. Reprehensible are those who, having the means of procuring them, neglect them.

Hitherto, with all the disadvantages of imperfect machinery, ignorance of peculiar geology, and inadequate funds for improvement; and above all, the disadvantage of deep-rooted prejudices, the project of boring for fresh water has been quietly gaining ground. It has, under all these impediments, been done at an expense not exceeding two dollars and a half a foot, except when encountering granite. Until the expenses attending boring shall decrease, none but corporate bodies will be able to undertake the work. Boring through granite and other equally hard rocks, is a tedious operation; sometimes the chisel cannot penetrate more than three or four inches a day.—But this is under the present infant state of the art. Should a bored well cost the Manhattan Company of New-York 6000 dollars, the expense compared with the benefit is too insignificant to be

worth a thought. They have been thus far liberal towards effecting their object, and as they seem sincere in their desire to comply with their part of their engagement to the city, it would be well for the citizens of New-York to give them a little further time to finish their experiments.

According to the theory of modern geologists, there are no fissures in primitive rock that would be deemed channels for water. They, therefore, decry the project, and think it unworthy of scientific experiment or even reasoning.

All men of science, who have ever deigned to answer the repeated inquiries on this interesting subject, have unanimously denied the probability of obtaining water by any other modes than those of Hydrostatic pressure, and Hydraulics. "It is their opinion that water can only be obtained in those places where there are indications of the presence of water—such as high hills in the vicinity. Success in well digging," &c.

It is intended in this Essay to prove that water can be procured, in the *First* place, by means of the art of boring, in any spot that the borer chooses. And, *Secondly*, that water may rise above the surface independently of gravitating pressure.

A spontaneous flow of water, by means of boring, occurs at this moment, in districts where red shell predominates, as in the cases of wells No. 1, 2, 3, 4. Where clay, sand, gravel, and hardpan prevail, as in well No. 9. And where water is daily rising in those wells, No. 5 and 10; and where granite and mica alone are present.—If, as geologists contend, granite has no seams nor fissures through which water traverses, whence come the waters that are in wells No. 5, 10, and 18? the water in No. 5 being inexhaustible by

pumps. There are undoubtedly seams in granite rock, although they do not occur as frequently as in those rocks that are considered as secondary.—Granite lies in blocks mostly at right angles; but notwithstanding that, these blocks are of great thickness, being from four to twenty feet, they are undoubtedly broken or separated at certain intervals; and through these broken or separated parts, waters and gases find their way as readily as through the fissures of red shell, or the porosities and interstices of soil, sand, and gravel.

That the borer will have to pierce this primitive rock from two to six, or even 800 feet, to obtain a spontaneous flow of water *above* the surface, does not militate against the position that water *will* rise in this case. As well might it be urged that a man could not get water from a deep well, because the rope of the windlass was not long enough to allow the bucket to reach the bottom.

The Manhattan Company ought not to be discouraged were the borer to go to the depth of 600 feet. It is a wealthy Company, and it will be both dignified and praiseworthy to prosecute this scheme to the utmost verge of prudence; not only as it respects the advancement of science, but as it concerns the interests of so distinguished and populous a city as New-York; the health of which city being in so great a measure dependant on the good faith of this Company.

Having said thus much respecting the art of boring; and having given an account of those bored wells that are finished, as well as of some of those that are still progressing, a few hints shall be further added towards forming a new theory for the rise of waters, accompanied with sufficient facts, derived from unquestionable authority, to prove

the probability of waters rising above the surface by a power independent of gravitation.

When men have been early initiated in certain rules of science—when the whole arrangement of a particular science has arisen from a well constructed hypothesis—when a century has given the world undisturbed possession of it—it is extremely difficult to question the soundness of the theory, or to dispossess men of their opinions; and it is still more hazardous to present another, which professes to have the effect of altering the course of reasoning, and in fact of disturbing the whole fabrick of the rise of waters.

With this opinion ever present—and with a knowledge, too, that the subject cannot be properly discussed in a small pamphlet—it is with extreme diffidence that the following facts and hints are presented to the publick. They are the result of much investigation, both of reading and observation; and were it not from a thorough conviction that the benefit resulting from an adoption of this new theory would be of immense importance to the world, this Essay had never met the publick eye.

It is curious and useful to trace the progress of the mind in the formation of a theory. It is difficult, however, to go through all the changes from surmise to conviction. Sometimes it is the result of patient investigation; sometimes chance presents it suddenly. In the present case, the rise of waters on elevated points, by means of boring, where there were no hills within several miles, that indicated, or indeed that could be called the reservoirs of water that supplied these bored wells, carried the thoughts to the tops of hills, where lakes and springs were known to exist.—Thesedrewthe thoughts stillhigher, to thosepoints

that were to supply these lakes and springs; and finally the Andes appeared to be the resting-place. Thought could go no higher: as, with the exception of a few of the Asiatick mountains, there were no higher points known. The Andes seemed, therefore, to be the great reservoirs that were to supply all the lesser heights in the world. An examination of the capacity of the Andes to accomplish this great work was the result, and it ended in a thorough conviction that they did not furnish more water from their *external source than was sufficient to supply their own immediate wants.*

For it must be inferred, that the warmer the latitude, the more rapid the circulation of fluids. The more that is carried off by evaporation, the more is there wanted to repair the waste. This is noticed, because it may be urged, that such great quantities of vapours fall on the twelve great mountains of Quito as would be sufficient to account for all the phenomena of issuing waters.

If water were found, uniformly, to partake of the peculiar mineral quality of the rock whence it issues, or even of those adjacent, some doubts might be entertained of the correctness of the present opinions. But so rarely do waters, when analyzed, show the presence of the rock from which they are seen to flow, or even to present the character of simple *rain water*, that it is most surprising that this *inquisitive* age should have suffered the investigation to remain so long quiet.

Congelation, in a range of mountains of the same altitude and latitude, commences at the same point; thus, throughout the whole range of the Andes, *the snow never melts above the height of* 14,600 *feet from the level of the South Sea.*—

These mountains, therefore, as reservoirs, actually present no higher elevation than 14,600 feet; for, although they are in fact much higher, yet, as the cold prevents vapours from becoming fluid, no water can be said to come from their highest points.

If therefore, the snow-water that is dissolved at the congelating point were to fill the reservoirs of these mountains, there still would not be enough to supply all the mountains of lower elevations, even if the twelve great mountains of Quito were to be considered as reservoirs.

But we cannot always presume that the reservoirs are situated at the congelating point. *There is every reason to suppose that the large reservoirs of mountains are near, or in the centre of their base.* Nay, some have been discovered more than two hundred feet below the surface of the base; and some miners, in excavating for coal, having opened upon one of these reservoirs, were suddenly precipitated into the abyss. Many of these large caverns, by causes now unknown, are opened to the gaze of the curious eye, showing themselves in all their frightful profundity.

The explanation of the Halleyen theory is this: That vapours are attracted to the heights of mountains—that cold condenses them, and they fall as rain—that the fluid enters the fissures and crevices of the mountain, and descends under ground until it finds its way to another mountain; which, being likewise filled with crevices and fissures, conveys the water to the top, whence, with the addition of water formed by vapour upon this new mountain, it again presses down, and wanders under ground to get to another mountain, and so on. It never occurred to the philosophers, that there is scarcely a mountain in the world that has

not numerous springs and streams issuing from many points of its surface; and which would force out all the waters that were received from higher levels. The water that is discharged perpetually from one cataract alone, would be more than could be condensed on the tops of the highest mountains of the Andes. Before the streams that came from the first mountain could arrive at the third or fourth, they would be dispersed, by waste, and by falling in deep cavities, spreading through certain soils, forming boggy and marshy lands. *Lakes are sometimes thus formed;* but although lakes are often formed by cataracts and springs, yet they are also found on the tops of the highest mountains. "Near to *Loch-ness*, in Scotland, is the great mountain called *Meal-four-vouny*, of a round shape, on the summit of which is a lake of *fresh water*, about thirty fathoms in length, and six in breadth, without any course or stream running into or from it. *Although of so inconsiderable a circumference, it is unfathomable.*" This is only one instance in a thousand that might be brought to prove the existence of lakes on the tops of hills and mountains. Besides the fresh water lakes, there are others of a different character, and evidently coming from some deep internal source.—Of this nature are those bituminous lakes of Trinidad, and the Dead Lake, or Dead Sea, and the Mud Lake of Java.

*All vapours that fall on mountains from* 40 *to* 44° *latitude, are necessary to sustain the animal and vegetable life of those latitudes.* In the three summers of drought, 1821, 1822, and 1823, the forest trees on our highest mountains were perishing for the want of their accustomed moisture; and yet the lakes and springs that were on their very tops, were no ways diminished. This proved that the

issuing waters received no addition from the condensation of vapours, for there were none.—But there is a very strong argument against the *supposition* that water comes from reservoirs that are on the tops of mountains.

*Cotopaxi*, one of the loftiest of the Andes, is a volcano; and there is reason to believe that in ages gone by, many, if not the whole of those equatorial mountains were volcanoes, either at the time of their "upheavement," or soon after. The higher the mountain, the greater force it must have taken to eject it; and, consequently, the more direct would be the communication with the central power that expelled it. Vast caverns, as has been observed, are discovered in these volcanick mountains, when by some great eruption the interiour is laid bare. The craters on the tops of mountains, are funnels that continue to the whole depth, and perhaps are miles in extent below the surface.—Volcanick mountains, therefore, cannot be reservoirs of water; for, should the wandering waters of *high levels* enter one of these cavities, they would be engulphed at once.

*Cotopaxi*, even so late as 1803, exploded; and in a single night, so active and extensive were the *subterranean fires*, that the external walls of the cone were heated to so great a temperature as to melt the snows that had accumulated from the time of its last eruption, which was in 1768, a period of thirty-five years! On the morning after the explosion, the cone appeared naked, and of the dark colour peculiar to scoriæ. Although no fire were seen issuing from the top, we must from this imagine how intense had been the fire that could heat such a thick mass of rock.

*Pichincha*, another of these high mountains, has been a volcano; but its crater is filled with

calcined matter. These two great mountains, therefore, cannot be considered as reservoirs of water, for the direct communication they have with subterranean fires, precludes the idea. Yet, although they may not have a water communication with other mountains, they still may have the chasms and fissures of their *sides* filled with the melted snow water of their tops, from which fissures and chasms the streams issue that are to supply the vegetation at the base, as well as the small rivulets and brooks.

When mountains have ceased for several centuries from being volcanoes, all combustible matter having been destroyed, *the waters of the interiour* may be propelled through the wide chasms that the eruptions have made; and, accordingly, tremendous cataracts are seen issuing from their sides, and large lakes, of great circumference and depth, are seen on their very tops. These cataracts and lakes, flowing too as they have for ages undiminished, could not have been supplied by the melted snow of the frozen area of each mountain.—This would be to suppose that all this melted snow would make a ravine for itself around the mountain, and flow to the point whence the water issues. This cannot be admitted.

In our latitudes, hills of no more than five or six hundred feet elevation, have tremendous cataracts falling from their sides; and some have lakes of large dimensions on their tops. It is much more philosophick to attribute the flow to some central effort, than to suppose that waters have been chasing each other from mountain to mountain, until they were compelled to disperse near the foot of an insignificant hill.

On analyzation, or even on a casual inspection, the majority of these issuing waters do not always

appear as simple rain water, which would be the case were they to proceed immediately from melted snow, or from condensed vapours. Waters that are seeking a level, have such a strong impetus given them to effect this object, that they have neither to wander *far nor deep;* consequently, they are soon forced up to the surface, and either appear as simple rain water, or else are but slightly impregnated with mineral salts or gases, as with but few exceptions, such as salt, minerals lie very deep; and even if a stream of water were running from a mountain, and had found its way under ground through a bed of mineral, after it had worn a channel for itself, the water would be but little impregnated. They strongly confess their *subterranean* origin, some being chalybeate, others salt—others bituminous—sulphurous—calcareous.

The mere running down the sides of a mountain could not so strongly impregnate the waters with the mineral qualities of even its own rock; nor could a sulphurous spring be said to have its source in the highest mountain near it, when the presence of sulphur had not been detected within many leagues of the spring.

The *Gerez* mountains consist entirely of *granite;* and no where are there any stratifications to be seen; and yet from one of the high platforms of one of the highest parts of the range, *four warm springs issue*, and this, too, from a rock unquestionably primitive.

The *Guimaracus*, too, have *warm springs* under similar circumstances, they also being primitive rocks.

A range of mountains, nearly of the height of *Marao*, consisting of slaty sandstone, passing into clay slate, contain chalybeate springs. At *Rio Mayor*, on the eastern declivity of a range of cal-

careous hills, salt springs are found. On the steep sides of a mountain called *Serra de Monchique*, of the same height as the Gerez and Marao, are warm springs; these mountains are also granitick.

On the top of *St. Helena* is a *fresh water* spring that flows perpetually. There are a number of others scattered over the island.

Many more might be named; and many of them within our own immediate knowledge, are of similar character.

New-Jersey, Virginia, and the Western States, have a great number of mineral springs issuing from places where there are no indications of the minerals that impregnate the waters.

It is plain, therefore, that these mineral springs do not proceed from melted snow, nor from the condensed vapours of the atmosphere, nor yet from adjacent mountains, as there have not been any minerals discovered near them.

The *Peak of Teneriffe* is 12,126 feet above the level of the sea. Humboldt observes, that the heat of the bottom of the crater was only perceptible in a few crevices which gave vent to *aqueous vapours.*

Mr. Bennet says, that as they ascended the Peak, he examined several channels that had been worn by rains, and there was no appearance of any other rock than lava; and yet, on proceeding higher, they halted to water their mules at a spot whence a small spring of bad and brackish water issued out of a lava rock. Now, this spring could not, small as it might have been, come from rain water; for, let the interiour of the mountain contain what mineral it may, the waters that are the result of condensed vapours, are not impregnated by it.

The *Souffriere* mountains, in the Island of St.

Vincent, is likewise a volcano. Previous to its last eruption, which was in 1812, there were two springs of water, or, as the author of the fact states, two pieces of water issuing from the sides of the base of the cone, *one perfectly pure and tasteless, and the other strongly impregnated with sulphur and alum.*

Two things occur to the mind on reading the foregoing facts. One is, that no stratifications are found in these primitive rocks; and the other is, that from these unstratified granite rocks, waters of different temperatures and different characters issue at all heights, either as cataracts, lakes, or springs.

Many great rivers have their sources in mountains, either issuing from their tops or sides, with incredible volume and force.

Thus, the *Jemma*, near Gungotree, has its source in the mountain called *Roodroo Himala;* but so powerfully is it ejected, that late travellers have abandoned the opinion of its originating from melted snow or condensed vapours alone; for, as has been observed, the point of congelation, in all cases, does not embrace a belt of more than a few feet, and of the belt, not the one thousandth part of the waters reach the point whence the great bodies of waters are seen to issue.

The *Ganges*, too, the *Nile*, the *Indos*, the *Hoang-ho*, the *Kiam-ku*, the *Senegal*, the *Rhine*, the *Rhone*, the *Vistula*, the *Elbe*, the *Loire*, the *Garonne*, the *Dauro*, the *Tagus*, the *Guadiana*, the *Guadalquivir*, the *Po*, the *Adigo*, the *Arno*, the *Severn*, the *Don*, the *Ain*, the *Wherse*, the *Swale*, the *Forth*, the *Tay*, and the *Monongahela*, all have their sources in mountains, many of them receiving no increase from any other streams, but issuing in such astonishing abundance from the rocks as

to form immense rivers; particularly the Nile, which overflows and fertilizes all Egypt, without having any tributary streams.

For, although the fact be capable of demonstration, that condensed vapours is quite sufficient to account for all the quantities of water that are returned to rivers; yet, when a specification is made of one particular river, we are very much perplexed, as not all the vapours that could collect on twenty mountains, even if they could be brought to bear on one point, would be sufficient to produce some of the tremendous cataracts that fall from a single mountain.

If all the vapours that are carried off from the Nile, and from that portion of Egypt which it overflows, were to condense on one point of the mountain that supplies the lake from which the Nile flows, they would not be sufficient to keep up the quantity of water that flows in the Nile; for much more of the waters of the Nile disappears than what is carried off by vapour, some falling into cavities, and others expanding laterally into marshes and bogs, from which evaporation is less abundant.

Buffon thinks, that as lakes and inland seas receive large supplies of water from many large rivers, without any augmentation of their bounds, they probably discharge part of their supplies by *subterraneous passages*. Many fresh springs, and even rivers, rise out of the sea, which, displacing the salt water, render the lower part of the sea, wherever they abound, quite fresh.

Surely, a knowledge of this fact alone, must make the most incredulous reconsider the opinion he has received of the *cause of waters issuing from mountains*. Such an immense body of water as supplies the Nile could not proceed from melted

snow; nor could this melted snow, wich is, in fact, only condensed vapour, always increase in quantity exactly at the same period; nay, on the same day of each year; the 18th or 19th of June, which Dr. Pocoke affirms to be the fact, he having kept an accurate account of the rise of the Nile for three years.

But, on the presumption that the rivers flowing in such abundance, and so constantly, come from a higher level, we must inferthat the highest elevation of all, from which all lower levels are supplied, must generate fluids at a rate past the powers of man to compute.

If *Chimborazo*, and the highest Asiatick mountains were entire reservoirs, and these reservoirs discharged thousands of tons every minute, they would not be sufficient to supply all the mountains and hills of lower elevation, with the great streams that issue from them; nor, if each lower elevation were to add its own waters of condensation to what it receives from higher levels, would it be enough to produce the quantity that constantly issues.

*Waters that are formed on mountains, either from melted snows, or from vapours falling below the congelating point, are principally in requisition for the external uses of nature.* Some certainly do enter the deep crevices, and find their way below to a deep abyss; but the most of them do not get into the interiour; they run down the cavities that are formed within the crust of the mountain, and burst out as springs at the base; or, they follow the external channels that are worn in the sides, and form rivulets and brooks, whilst those that imperceptibly glide down at every point, go to assist in giving and continuing life to surrounding vegetation. Each mountain, therefore, has enough to

do with all the fluids that are generated on itself. It is to another source that we must look for the origin of these mighty cataracts and waterfalls, which have astonished and perplexed philosophers from the most remote periods to the present time.

Mountains bear evident proofs of having been forced up, at some unknown period, from their original level; and, accordingly, they are found running mostly along the sea coast, thus showing their relative position to the immense cavities of the sea; and, what may be here remarked, too, is, that those places are most subject to earthquakes that are in the same latitudes with volcanick mountains. In the 5th conclusion of M. La Place, he says, that the irregularities of the earth, and the causes that disturb its surface, have very little depth. If this be true, then the subterraneous passages, through which volcanick matter issues, cannot be very deep, perhaps not more than three or four miles from the surface; certain it is, that these passages communicate, for the same earthquake has been felt over a surface of "*four million of square miles, and seemed to have originated under the Atlantic Ocean.*"

There are, no doubt, large cavities at the bottom of the sea, into which the sea would undoubtedly fall, were it not upheld by the vast columns of gases that are present.

During the above mentioned earthquake—the greatest in extent that has ever been recorded—some mountains were swallowed; and others were thrown up, and remain to this day in the middle of the ocean. During the convulsion, the sea was thrown up, by some central effort, thirty or forty feet above its usual level, sometimes ebbing and flowing four times in an hour; the water, in deep

wells, arose and overflowed at the top, for several hours; on the disappearance of mountains, lakes were found in the places where the mountains were engulphed; two hundred and fifteen of them being formed in *Oppido:* and springs that had for centuries ejected hot water, now showed unusual signs of agitation, rising and falling, disappearing altogether for several minutes, and finally, when the earthquake had subsided, returning to their natural composure, only with the increase of *quantity and temperature.* Many mountains were rent asunder, and now lie with their interiour exposed to view. Many of the cones of volcanick mountains fell into the great *reservoirs of their centre,* and although of thousands of tons weight, their fragments could not be seen in the abyss into which they had fallen.

In consequence of the violence with which mountains were upheaved, their strata are displaced, broken, and often reversed. Large internal cavities, fissures, and crevices are to be expected, and through these openings, when the convulsion first took place, issued the terrible agents that effected the great disruption. Inflammable gases, lava, and other subterraneous matter, were ejected as long as they obstructed the circulation of the interiour, some thrown up entire, in their natural state, others undergoing some chymical disintegration or change. In process of time, all unnecessary matter was thrown off, and these fissures and cavities still remained, and *through them,* to this day, the gases and waters that are formed by chymical combinations are ejected.

It is not meant by this, that all the ejected waters are *generated* in the interiour; for, it is a well known fact, that large rivers, after flowing for many miles, are suddenly engulphed, and appear no

more. Such immense bodies of water, falling into one of the excavations with which the interiour of the earth abounds, get more and more out of the sphere of the laws of gravitation, and come more immediately under the influence of the centrifugal force, which is propelling gravitating matter from it. The denser the body, and the greater its descending velocity, the greater and denser will be the agent that is necessary to force it up again.

A body of water that has a precipitous descent, falls with great velocity. By the suddenness of the fall, supposing itto fall into an abyss, the gases, which are always issuing upwards through these caverns, unless of such a tremendous force as to overcome the two-fold force of velocity and density, are *bent* out of their course, and are carried along with the water, until they encounter some of those immense bodies of gases that are struggling through the fissures and cavities of mountains; the waters are thus forced up by the united gases, and issue out of the sides and tops, impregnated with the mineral gases that are extracted by the internal combustion.

When we consider, that even in our day, these powerful gases are finding vent at intervals through every section of the globe, thereby producing those tremendous earthquakes which have swallowed up whole cities, we cannot deny similar or lesser effects to the same causes, only more constant in their operation.

Gases are forcing themselves up, not only through crevices and large fissures, but through the pores of the earth in every direction.

We see this forever occurring before our eyes, and hear of it through every traveller; and yet the fact has never been converted to scientifick

exposition. Inflammable and other gases, have been known to issue from an area of two or three miles, throwing up the small particles of sand that impeded them, until little mounds were formed, from the very point of which mounds the gases issue.

There are instances of burning springs that have existed for many centuries, some having been set on fire in times unknown, are burning to this day; and in well No. 9 there is a constant escape of inflammable gas.

If this fact be taken into consideration, surely, without any great stretch of credulity, we may infer that gases coming in a more direct line from the centre, will possess an infinitely greater and more constant power than those that proceed from some local chymical arrangement. And, as it was owing to the central effort that mountains were ejected, we must look to the *track* left by the central agents, and we will there see that they are still at their post, throwing back to the surface gravitating matter.

Accordingly, waters, whether they be engulphed in large quantities, or are those that are gravitating through the pores, are immediately arrested in their downward course, and hurried back again, some in very different directions from what their original course indicated.

Vast subterranean passages are constantly kept open, through which the great bodies of gaseous and aqueous matter find their way, the waters being forced up, and made to flow as cataracts, waterfalls, springs, or lakes; or, empty themselves into the immense basins of the sea; whilst some of the gases, if unaccompanied by water, issue up through the volcanoes and rents that they themselves have made, carrying with them inflammable

matter; and the remainder, being less concentrated, or rather more dispersed, become more equable and constant as they approach the surface, and assist in the ascent of waters that are, under similar circumstances, expanding upwards.

To recapitulate.—Water must be always ascending from the central point, either forming seas and oceans in a direct manner through large rents or passages; or else be sent to the surface, equally dispersed, as perspirable matter from the pores. This latter assumption is predicated from aknowledge of the fact, that moisture is always perceptible in the interiour of the earth, being present in proportion to the capacity of the body to conduct it. Rocks and stones, minerals, clays and sands, are always damp, let the distance be whatit may from the surface; and this presence or ascent of waters is called by men of science—for the fact is not unknown to them—*capillary attraction.*

Of all earthy bodies, sand possesses this attractive power the strongest, an instance of which is seen at this present moment on the shores of the Gulf of Mexico. On the beach, directly in front of Alvarado, forty years ago, was a small ridge of sand running along the shore, about half a mile, being evidently thrown up by the winds. It was not then more than two feet high, having the appearance of a wave. A fresh water spring was known to exist at the northern extremity of this ridge; *and there it still continues to be seen, although the sand ridge is now a hill of upwards of one hundred feet in height.* Vessels that lie in the harbour send daily to the top of this huge sand hill for the water, which is very good. The inhabitants of the town, likewise, resort to the spot daily, and the water is obtained, by merely scoop-

ing it up from a hollow in the sand. The main body of water has ascended in a straight line from the point of its commencement; and, accordingly, the greatest quantity is confined to one spot, but the moisture has spread laterally to a considerable distance, the sand adjacent being damper than that farther off. A stick can be thrust down its whole length from any part of the surface of the hill, as the particles of sand are but lightly held together. The rise of the water through so porous a body as sand, must proceed from this same capillary attraction; and when we can clearly define what capillary attraction means, we shall cease to wonder at the rise of waters in bored wells. Let us examine the attributes of capillary attraction.

The denser a body is, the more incapable it is of transmitting gases and water. But where the attraction of cohesion is but slight, these volatile bodies pass through without difficulty.

Sand is one of the most porous of all earthy matter; and from the peculiarity of the structure of each particle, the interstices are capable of suspending, or rather of transmitting all gravitating or *expanding* matter. May not water, therefore, ascend in sand, not because "the particles of water have a stronger affinity for the particles of sand than for themselves," but, *because the interstices between the particles of sand are vacuums*, and that water has a tendency to rise in a vacuum.

Almost all things in nature might be called capillary ducts. Every thing capable of transmitting rarified particles, is a capillary duct. Linen, sugar, paper, &c. are eminently so. The atmosphere, too, is invisibly transmitting volatile bodies.

Water gravitates to the point whence gravitation ceases, and is forced back again to the sur-

face, rapidly at first, and more slowly as it gets within the range of atmospherick pressure. The expansive power given to it by the centrifugal impetus is a permanent one, and water always retains it in proportion to the presence of calorick in the atmosphere.

The more the air is rarified, the more quickly the particles of water ascend; the whole atmosphere is then a capillary duct, and is more suited to the minute particles of water. We are not yet acquainted with all the phenomena of water; but it must possess a greater variety of powers than those usually attributed to it.

The tendency of gas to ascend is perceptible to the most common observer. Water has a similar tendency; but, owing to the particles being of equal density throughout, they move simultaneously and imperceptibly, each particle possessing its own peculiar individuality.

Water not only obeys the laws of attraction and repulsion, both as it respects its own particles and those of other bodies that pass through it, but it likewise gravitates to and from the common centre. Although it be allowed that water obeys these laws, yet the degree in which it is impelled by the central law, has never yet been accurately investigated.

The ability that the central power has to throw all gravitating matter from it, is known and acknowledged; and were it not for the constant exercise of this power, the whole globe would be compressed into an infinitely small space. The effect, therefore, of the centrifugal system is to press off from itself all matter that is no longer necessary to promote the internal circulation; and for this purpose all dense, as well as fluid matter is kept in a state of expansion. The dense matter of the earth

being more or less porous, is capable of sustaining and transmitting all volatile bodies to the surface. *Fluids and gases forever, retain their disposition to expand;* but it is only particularly observable when the pressure of the atmosphere is taken off.

If the air were to continue rarified for a certain period during the night, as well as the day, and no rains were to intervene, rivers and seas would all fly off to the upper regions, leaving the earth devoid of moisture; even the sap of plants would disappear. The blood would no longer circulate in animals; and life would become extinct. By a wise disposition of forces, it is so arranged that we are kept from this terrifick evil.

Water is restrained from exercising its disposition to expand by the presence of another power, called atmospherick pressure. This power, however, does not exert itself in the same ratio beneath, as above the surface, excepting in cases where there is an accumulation of dense matter that is gravitating, such as a heavy body of water, or of the electrick fluid. Even in this case, the central power is prepared to protect itself. The heaviest precipitations of electricity are expelled in the form of *aurora borealis.* The common combustion of the atmosphere—or, the electrick matter that is always present in the atmosphere—is forced back as it gravitates, in the form of magnetick effluvia.

Voluminous bodies of water that fall precipitously, and descend into the central reservoirs, are expelled in the form of seas, lakes, cataracts and springs, returning to the surface, deprived of some of their atmospherick gases, and impregnated with others that escape from minerals that lie deep, whilst the more equable fall of waters, such as rains, &c. are sent up again in the form of dews.

The whole earth is saturated with water and gases, and the effort to expel them is constant.

Water, therefore, has but little to impede its disposition to evaporate in a vacuum. Independently of this, there are many intervening bodies which, in some degree, take off the pressure of the atmosphere. Thus, oil prevents the gaseous particles of water from escaping too suddenly.—Oil, therefore, thrown on water, enables the particles to elevate themselves more readily. But as gaseous particles of water will, by their expansive power, extricate themselves; they will fly to those parts where there is the least resistance; accordingly, if a piece of tallow be placed in a bowl of water, the water will be elevated immediately under the grease, but will have a correspondent furrow all around it, with an elevation of the water again at the sides of the bowl.

The sides of a bowl or vessel filled with water are better conductors of calorick than the space above the water. The air, therefore, at the sides being more rarified, enables the water to rise there with greater ease than in the middle.

The more nearly the sides of a vessel are brought together, the more perceptible, at the sides, will the elevation of the water be, until, as they approach more closely, so as to assume the form of a capillary tube, the vacuum becomes more perfect, and the water will ascend above the level of the mass into which the tube is inserted.

*Water ascends in capillary tubes, by its expansive power, unrestrained by atmospherick pressure; which, owing to the minuteness of the bore of the tube, and to its being a vacuum, has less power than on a wider extent of surface.*

Nothing perplexed philosophers more than this rise of waters in capillary tubes; and they finally accounted for it on the principle that the attraction between the particles of glass, and those of water, was greater than between the particles of water themselves. And they added, as a reason in support of their hypothesis, "that if a glass tube be placed in a position perpendicular to the horizon, and a drop of water is applied to the under side of the tube, it will adhere to it, nor will it fall from the glass until its bulk and gravity are so far increased as to overcome the attraction of the glass."

If this fact were applicable to glass alone, the reasoning might be admitted; but it will apply to almost all dense bodies, whether elastick, like flesh, dense, like iron, or porous, as wood. A drop of water will hang suspended from the finger, or from any other dense body, quite as long as from the under surface of glass.

Philosophers have stated a fact that is to bear them out in their hypothesis, which is equally applicable to the opinion of waters rising in capillary tubes, by means of a vacuum.

Their solution of the phenomenon is only true in part. *Nothing offers greater resistance to atmospherick pressure than animal bodies.* When we consider that each inch has a pressure onit of fourteen pounds, we must suppose that the expansive power of the fluids and gases that the bodies contain, is of sufficient force to counteract the effects of atmospherick pressure; nay, of superiour force; for these elastick gases are not only able to repel the pressure, but, in addition, they send off, by the pores, all matter that is unnecessary to the circulation, or that has been rejected by it.

This may appear irrelative to the subject, but it is brought forward to show the uniformity in all created matter, that the same laws pervade the animal as well as the mineral economy; and it may, too, be made to bear on the particular point in discussion, which is, that water may rise to the surface independent of atmospherick pressure, and that capillary attraction, or, as it may be said, *that the constant presence of vacuums in the porous bodies of the earth, will enable all elastick fluids to rise to and above the surface.*

When we see that atmospherick pressure forces the blood to the lungs, and that the elastick gases of the body have sufficient power to throw it off again, we can readily give our faith to a similar operation in the earth, which is less liable to fluctuations or irregularities.

The circulation of the blood is now well understood; and, with the few hints thrown out in this Essay, a regular theory can be devised for the circulation of the fluids within the body of the earth.

Water, therefore, is present in every spot of the globe, though more abundant where the rock or earth is porous, but even present in granite, as has been satisfactorily proved by the appearance of springs of different character and temperature on granitick rocks.

Water, besides its obedience to the laws of attraction and repulsion, must be subject to another power, entirely different from, and independent of them. The matter of which space is composed, seems to have the power of giving to all bodies, of a round form, a rotary motion, when they are impelled through the air. After a bubble attains a certain height, if there be no air percepti-

nothing more is intended than that a subject should be investigated which is of such vital importance, not only to a great and commercial city, but to those portions of the globe where there is a deficiency of pure and wholesome water.

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## ERRATUM.

Page 19, thirteenth line from the top, for *miasmata* read *miasma*.

Page 25, sixteenth line from the top, for *Meal-sour-vouny*, read *Meal-sour-vouny*.

Page 32, top line, for *wich*, read *which*.