

VIII.—*On the Supply of Water from Artesian Wells in the London Basin, with an Account of the Sinking of the Well at the Reservoir of the New River Company, in the Hampstead Road.*

By ROBERT W. MYLNE.

THE sinking of Artesian Wells is a subject in which the inhabitants of London have taken considerable interest during the last few years, and public Companies have been projected for the purpose of supplying a portion of the Metropolis with pure and soft water by that means.

The construction of Artesian Wells is now generally understood, many having been sunk in England, as well as on the Continent, where they obtained their name, from having been originally adopted in the French province of Artois, called by the Romans *Artesium*. These wells are made by boring vertically through a deep stratum of clay into one of sand, where water is generally found, and from whence it will rise to a considerable height, in many instances to the ground surface, and sometimes higher. This greatly depends upon the elevation from whence the sand stratum is supplied at the verge of the basin, within which the stratum of clay is situated.

The strata under, and around this Metropolis (designated as the London Basin) are peculiarly adapted for these wells, the whole being comprised in an immense bowl of chalk, many miles in extent, on the interior surface of which there is a thick lining of sand supporting a deep bed of clay, commonly known as the London Blue Clay; and upon this the Metropolis, and adjacent country, stands.

The sand which lies below this clay has always been found considerably charged with water, derived, no doubt, from the surface of the more distant country, and entering where the sand makes its appearance on the surface, which may be termed entering at the verge of the basin. This outcrop, or margin of sand, in some instances, is at a great height above the level of the Metropolis. It therefore necessarily follows, that, on boring into the basin, the water will rise in the bore-holes to various distances from the surface, according to the elevation of their respective situations.

Under these circumstances, most of the wells already sunk in and about London obtain their supply of water; and from this source it has been asserted that a very large quantity of water might be procured for the various uses of the inhabitants, while others consider it so very precarious, and the water so difficult to obtain, that they prefer boring down into the chalk, where they suppose an inexhaustible supply can be found.

With a view to obtain as much information as possible on this point, a well has been sunk by the New River Company: a brief account of which will be found in this paper, setting forth all the material circumstances which occurred during the execution of the work. But before entering on the detailed account of this particular well, it seems desirable to mention a few circumstances connected with other wells, which have come under the knowledge of the writer, and which, perhaps, may be considered to throw some light on the subject.

First, as regards those wells which are supplied from the deep *sand springs* below the bed of clay. There is one at St. Alban's House, Piccadilly, where the water rises to within about 50 feet from the surface of the ground; also another at the banking-house of Messrs. Coutts and Co., in the Strand, which formerly rose above the surface of the ground, and discharged itself into the Thames; but, from other wells having since been sunk in the neighbourhood, the water surface has lowered several feet, and at present is below the low-water level of the river. At Norland House, Kensington, there was one which ran over for many years; and when the spring was first struck, it was so strong that it washed the well-sinkers out at its mouth; this great overflow continued some time, but has now ceased from the effect of other wells sunk in the vicinity.

Instances have occurred around London of the water rising to great heights: at Tottenham there were several wells that ran over; and also at Tooting, Mitcham, and Hanwell; but all of these have more or less diminished in their discharge, and but few rise to within many feet of the surface of the ground which they formerly overflowed.

In the town of Cambridge, which stands upon clay, a considerable number of wells have been sunk, most of which rose above the surface; but they are now much reduced, both in height and quantity.

At Gloucester the depth of the wells vary more than in other places, although the town is situated on ground gently falling towards the river;

instances exist here where persons have obtained a good supply of water at a reasonable depth, while attempts to obtain a supply at a considerable depth, by their immediate neighbours, have utterly failed, after incurring great expenses.

Of those sunk or bored into the chalk, in the vicinity of London, the most remarkable as regards the strength of the springs, and the quality of the water, are those around Wandsworth. One in particular, at some Copper Works: where, from a large bore-hole, the water is forced out to the height of about 20 feet above the ground. For convenience it has been confined by a bent tube, so as to deliver the water horizontally into the mill-head. Several others occur along the banks of the River Wandle, all delivering above the ground surface, and so plentifully that they give considerable power to the mills on that river.

The proprietors of the larger wells, have generally found that there is an intimate connection between all that derive their supply of water from the sand stratum.

A striking instance of this is afforded by the well in Messrs. Calverts' brewery, in Thames Street, which is materially affected when Messrs. Barclay and Perkins work theirs in Southwark, although situated on the opposite side of the River Thames. Also the supply at Messrs. Whitbread's brewery, in Chiswell Street, which is one of the earliest wells of any magnitude, was so much inconvenienced from this cause, that they were compelled to bore to a very great depth, and thus obtain a more permanent supply through vertical pipes.

Messrs. Combe and Delafield's supply, in Castle Street, Long Acre, was also affected in this manner, and on deepening the well it completely destroyed another that had been sunk for the establishment of a saw-mill in St. Martin's Lane.

At one period, in sinking the well at the Hampstead Road reservoir (before alluded to), the water was likewise found to be sensibly affected to the extent of from 10 to 14 feet in height, by the working of an engine at the well at the Zoological Gardens, in the Regent's Park, which terminates in the sand.

It is needless to enumerate the many further instances that might be adduced to establish this fact; I shall, therefore, now advert to the difficulties that present themselves in obtaining water from the sand springs, when subjected to a considerable draught.

The sand is of so fine a nature that it will pass through the smallest apertures,

and is easily put in motion, from its specific gravity being little more than that of water, and, from its extreme sharpness, it is found to cut the pump barrels exceedingly; large quantities of sand will in this way be drawn up with the water from beneath the clay, thus forming large cavities below, and causing the clay to sink, by which the foundations of all buildings situated near the well are endangered.

A very remarkable instance of the subsidence of the ground occurred at the Hampstead Road well, where the quantity of sand raised by the engine through the 8-inch pump was such as to cause a very serious settlement in the large raised reservoir adjoining, by separating the high banks into two distinct portions; damaging a culvert, and snapping a line of iron pipes asunder. This no doubt would have affected the adjoining houses, had not the pumping been discontinued. A similar case happened at Messrs. Reid and Co.'s brewery, in Liquorpond Street, where the well, after the engine was set to work, during the time of sinking it, was found to have created such a cavity below, that the proprietors were obliged to close it almost entirely, to save their buildings from ruin. At the Vinegar works in the City Road, the well, from the same cause, was altogether abandoned for manufacturing purposes; as also a large well at the brewery of Messrs. Ramsbottom and Co., in Broad Street. At Whitechapel there was another well, belonging to Major Rhode, where it was found, on inspection, that the withdrawal of the sand, by pumping, had formed an immense cavity underneath the plastic clay; this caused a material subsidence of the ground, and 20 feet of the lower part of the brick shaft disengaged itself, and falling to the bottom, the fragments were completely buried in the quicksand.

Many other instances might be mentioned of wells having been abandoned, from the quantity of sand raised, and occasioning great loss of property, through the sinking of the surface-ground; but it will be needless to pursue the subject any further.

It therefore appears, that little dependence can be placed upon the quantity to be derived from the *sand spring*, and also that a great risk attends the obtaining it in large quantities. To obviate these difficulties, it has lately been considered advisable to sink through the sand into the *chalk*, which has been done generally by the means of boring, and the introduction of a small pipe; but as yet there is little experimental knowledge on the subject; and, from the few instances that have occurred in the Metropolis, a sufficient number

of facts have not been collected to enable a correct opinion to be formed, as to the quantity of water that can be obtained from such a source.

Among the larger wells that have been sunk into the chalk, there has been one lately executed at Brighton, for the supply of that town with water, which produces an abundance of fresh water from below the level of the sea. The water here issues from the fissures in the chalk, which are intersected by horizontal headings driven from the bottom of the well, from whence the water is pumped up for the supply of the town.

A singular circumstance happened in cutting through the chalk hills, for the formation of a tunnel for the Thames and Medway canal: that operation had the effect of draining the whole of the fresh water from the wells within the range of a mile, and substituting salt water in those wells.

A large bore was also made in the chalk valley through which the River Lea passes in Hertfordshire, where the layers of flints in the upper part of the chalk yielded a small quantity of water; but no increase took place beyond the depth of 100 feet, although the well was continued to the depth of 300 feet, at which point the chalk marl began to make its appearance; but the tool having broken in the bore, the work was abandoned.

In Paris, where a basin of clay exists similar to that of London, a bore-hole has been in operation for a long period, and is at present being carried on at the depth of 1360 feet in the chalk, and 1490 feet below the surface of the ground; as yet no quantity of water has been obtained.

It will therefore appear, from the few instances which have been mentioned, that different situations will be affected by varying causes; and from the little information that can be collected, with regard to sinking wells in the chalk, no rule can at present be laid down upon which an opinion can be formed as to the possible results of an experiment at any particular place.

Having offered these preliminary observations on the subject of wells, I take leave to subjoin a section of the well lately sunk at the New River Company's reservoir, in the Hampstead Road; together with some sketches of the tools used during the works, and a statement of the mode in which the work proceeded. The execution of this work was placed under the immediate care and superintendence of Messrs. Hunter and English, experienced millwrights, whose attention was unremitting during the operation.

PARTICULARS OF THE SINKING THE WELL AT THE HAMPSTEAD ROAD
RESERVOIR, THE PROPERTY OF THE NEW RIVER COMPANY.

WM. C. MYLNE, ENGINEER.

On the 21st March 1835, the well-sinkers commenced excavating in made ground, to the depth of 6 feet, and continued through 17 feet of red (Hampstead) gravel, at a diameter of 20 feet; the sides of the shaft were supported by strong wooden curbs of a less diameter than the excavation, and clay puddle was filled in behind them in order to shut out the land springs. These curbs were sunk down through the bed of gravel, and made to enter a few feet in the London blue clay lying immediately below it. At this depth a cast-iron footing was fixed within the wooden curbs, upon which a 14-inch brick shaft was carried up to the ground surface, of a clear diameter of 12 feet 6 inches, worked in Roman cement, and the cavity of 6 inches; that remained between the back of the brickwork and wooden curbs, was carefully filled up with concrete.

The excavation was continued through the stratum of blue clay at a reduced diameter of 12 feet 6 inches, and steined with 9-inch brickwork in cement; thus leaving a clear shaft of 11 feet diameter.

The brickwork was built by continual underpinnings, as the work proceeded; and cast-iron rings were inserted at about every 8 feet in depth, projecting beyond the back of the brickwork a few inches into the clay, for the purpose of supporting the shaft as it progressed.

On attaining the depth of 57 feet in the clay, the boring auger, that was always kept about 6 feet in advance in the centre of the well, gave indications of having passed through the blue clay into a stratum of soft mottled clay; it was therefore thought advisable to discontinue the brickwork, in order to ensure a foundation for its support.

On proceeding with the excavation, the diameter was again reduced to 10 feet 9 inches, for the purpose of introducing, as a substitute for brickwork, cast-iron cylinders, formed of 6 segments, 6 feet in length, united by bolts through flanches projecting on the inside, leaving 9 feet 9 inches clear diameter; these were joined together, and being forced down by hand-screws, were made to follow the work as the sinking continued in the remainder of the blue clay,

and then through a 10-foot bed of soft mottled clay: on approaching the bottom of this stratum, water first made its appearance.

An engine and two 8-inch pumps, in two lifts, were erected and set to work, by which the well was kept dry. The sinking was thus continued with the same sized cylinders, following the work to the further depth of 8 feet, in a bed of fine brown sand: during the progress through this sand the quantity of water considerably increased, occasionally accompanied by large quantities of sand blowing up above the lower edge of the cylinder; this was observed chiefly to come from the north-east; and on boring a hole in the cylinder at that quarter, in the mottled clay stratum, it was found that the clay had fallen down, leaving a cavity extending 3 feet beyond the cylinders. From the very unequal pressure, occasioned by this cavity, the cylinders were forced out of the perpendicular, and became completely jambed when their lower edge was within a foot of the bottom of the sand stratum.

From this circumstance it was found necessary to commence with cylinders of a sufficiently reduced diameter, so as to be placed within the others, to allow them to sink perpendicularly.

During the period that elapsed in preparing these smaller cylinders the water rose to within 85 feet of the surface of the ground, and the fine brown sand within the cylinder to nearly the level of its original surface.

On this second set of cylinders being ready, the water was pumped out of the well, and the sinking proceeded with through the accumulated sand and the remainder of the sand stratum, and entered another bed of mottled clay, similar to the former. There was then found a gut of sand on the north-east side, upon the surface of the clay, to the depth of 2 feet; extending 4 feet on the circumference of the well, and diminishing towards the centre.

During the sinking of the cylinders through this bed of mottled clay, the water and sand entered in large quantities from the same side as the gut, to the great inconvenience of the workmen; and on reaching the bottom of the stratum, which was 19 feet 6 inches in depth, they came upon a thin layer of pebbles, so closely embedded in black sand as to form a complete mass of stone, which was broken through with difficulty by hammers and chisels: the layer being from 9 to 12 inches in thickness, and the pebbles averaging about the size of an egg: on leaving this, a bed of dark brown sand presented itself, and was sunk into, to the depth of 4 feet 6 inches, from which there was little

increase of water beyond that still continuing to run from the north-east side. This run of water was found, on inspection, to have occasioned a similar cavity behind the cylinders in the last bed of clay, as that before described in the upper bed, with the same attending consequences, the cylinders being forced out of the perpendicular, and again jambed in the sand; when, after several ineffectual attempts to force them down by powerful hand-screws, it was found necessary to commence with a third set of cylinders, of a further reduced diameter of 7 feet 4 inches.

The sinking then proceeded through the remaining 7 feet of dark brown sand, and into a bed of quicksand, of a darker colour, to the depth of 5 feet; where, on the 19th January 1836, the cylinders became so jambed that it was again found impossible to sink them lower.

During the latter portion of this work great difficulty was experienced from the frequent blowing-up of the sand, often to the height of 6 feet at a time: and also from the immense quantity of sand that was pumped up with the water, continually choking the pumps. This had caused not only the large cavities already mentioned behind the cylinders, but the lower part of the brick shaft was observed to have inclined bodily towards the north-east; thus causing numerous serious cracks, and in some places so affecting the shaft that it became of an oval figure. Several segments of the cast-iron cylinders were also broken asunder at their vertical flanches. This led to an examination behind the brickwork. An opening was made in the brick shaft, about 60 feet from the surface, where a cavity was found, extending many feet at the back of it; this was immediately filled up with stones and brickbats, concreted with lime and gravel. Several lengths of cast-iron cylinders were then placed on the top of the second set, for the purpose of lining the brick shaft; and all the irregular spaces between them and the brickwork were filled up with good concrete.

This settlement of the ground not only extended itself to the works in immediate connection with the well, but also to the reservoir banks contiguous, which were found to have sunk so much, that a large portion of the embankment and inside lining of brickwork, on the side nearest the well, was separated from the remainder, and the cast-iron main beneath the bank was broken in several places.

From the circumstance of these extensive settlements, it was considered advisable to discontinue the pumping, and thus suspend the works for a short

time, in order to consider of some other mode of getting through the remainder of the sand stratum; of the many plans suggested one was adopted, by the recommendation of Mr. Simpson (engineer to the Chelsea water-works), whose Report is annexed. It is there proposed, that the sinking should be continued with the water remaining in the well.

In accordance with this recommendation, on the 22nd August 1836, the 8-inch pumps were taken out, and a wrought-iron cylinder, or tube, formed of boiler-plates, rivetted together to the length of 62 feet, with a clear diameter of 5 feet 10 inches, was lowered to the surface of the sand, which had risen 7 feet in the well since the discontinuance of the works; the level of the water, which varied considerably at times, generally stood about 102 feet from the ground, thus leaving a column of water of 29 feet in the well.

Across the top of the tube, which stood 33 feet above the water, a platform was placed for the workmen to carry on their operations.

The sand now having the pressure of water upon it, was found to have become hard, requiring to be loosened by chisels. After that, the sand was excavated by an instrument called a miser: the different misers employed varied in size and figure, but were all constructed on the same principle, and each capable of holding about 2 bushels of sand, although they seldom came up more than half full.

In this manner the sinking was continued, while the wrought-iron cylinder was forced down by hand-screws that were placed on its upper edge. After thus forcing through the remainder of the quicksand stratum, a bed of sand, intermixed with small flints and pebbles, was sunk into, to the depth of 7 feet; on passing through which a bed of chalk was entered, containing numerous small flints, very closely embedded, to the depth of 4 feet 6 inches. This stratum was excessively hard and difficult to penetrate, thus rendering the progress of the works exceedingly slow: at the bottom of this stratum the chalk became much more solid, and the cylinder was sunk into it, to the depth of 12 inches; at which period the works were discontinued for a short time, leaving the well at a depth of 151 feet from the surface of the ground.

During the sinking through these different strata the wrought-iron cylinder had been lowered on an average from 4 to 5 inches per day, and the works kept constantly in operation.

It was now considered that the water and sand would be entirely shut out, and that the sinking might be continued in the usual manner. The platform

was then cleared away, and two 8-inch pumps, in two lifts, were put up within the wrought-iron cylinder, and on its being set to work by the engine the well was freed from water.

Towards the end of March 1837, the workmen commenced excavating in the hard chalk, at a diameter of 6 feet. The chalk was now found so solid as to require no lining; and, as the works proceeded, layers of flints were cut through, running about 2 feet 6 inches apart, and from 9 to 12 inches in thickness: each of these layers yielded water from their under-side, and they continued at such intervals to the depth of 33 feet, or 183 feet from the surface of the ground.

At this depth, one of the layers being partly broken into, produced more water than heretofore; and from this extra quantity (added to that yielded from those above) the 8-inch pump was found incapable of keeping the water lower than within 7 feet of the bottom.

The sinking was therefore discontinued, and attention was directed to the better securing and finishing the works above. The chalk was excavated to an enlarged diameter below the bottom of the wrought-iron cylinder, for the purpose of forming a brick footing, of a diameter of 4 feet 7 inches in the clear, increasing at the bottom to 7 feet 9 inches, being 10 feet 6 inches in length; on the top of this brickwork a broad cast-iron ring, in segments, was fixed, projecting a few inches beyond the back of the brickwork into the chalk, upon which rested the cast-iron cylinders that were introduced within the wrought-iron tube for the purpose of strengthening it, and to guard against the admission of sand, in case of its failure from corrosion.

These cylinders are of a clear diameter of 4 feet 7 inches, and were erected one over another to the height of 35 feet; and the 31 feet of wrought-iron tube that remained standing above them was cut off, leaving 31 feet of it in the well.

It was now considered advisable, in order to obtain as much water as possible, to admit such quantity from the sand-spring as was practicable without the admission of sand; to effect this, three $1\frac{1}{2}$ -inch cocks were inserted in the cylinders nearly at the top of the dark brown sand stratum, and the water flowed through them mixed with a small quantity of sand.

The whole of the works having now been properly secured and made complete, about the end of February 1838 the 8-inch pumps were taken out and two of 12 inches diameter introduced, in two lifts. During a considerable

time that elapsed in preparing for the erection of these pumps, the water surface in the well had remained at a level of 108 feet from the surface of the ground. In the month of August 1838, being the period at which the springs are short, and having also been preceded by a dry winter and summer, the engine was set to work, and the result of two weeks' experiment, as to the quantity of water raised, is shown below. Another experiment was also made in March 1839, being the period at which the springs usually produce their utmost, and following a rainy winter season, the result of which is also annexed.

Engine set to work 1st August 1838.—Surface of water in the well 109 feet from the ground.—Depth of water in the well 74 feet.—One 12-inch column of water, in 2 lifts.

	Cubic Feet.
Quantity of water raised during the first week . .	103,950
Ditto ditto second week .	104,625
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	2)208,575
	<hr/>
Average cubic feet raised per week	104,287
Or 14,898 cubic feet per day of 24 hours.	

Engine set to work 20th March 1839.—Surface of water in the well 105 feet from the ground.—Depth of water in the well 78 feet.—One 12-inch column of water, in 2 lifts.

	Cubic Feet.
Quantity of water raised during the first day . . .	30,584
Ditto ditto second day . .	30,415
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	2)60,999
	<hr/>
Average cubic feet raised per day of 24 hours . .	30,499

SUMMARY of the Expenses incurred in sinking the well, erecting an engine and pumps, and making good all damages occasioned during the execution of the work :—

	£.	s.	d.
Excavations, cartage, labour, &c.	3,006	2	0
Steam-engine and machinery	1,912	17	10
Millwrights'-work, well-sinkers, castings, &c.	5,762	8	6
Bricklayers' and masons' work	1,740	5	9
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	£12,421	14	1

The following table shows the depth of the different strata of earth, through which the well was sunk :—

	Feet.	In.
Made ground	6	0
Red gravel	17	0
London blue clay	59	0
Soft mottled clay	10	0
Fine brown sand	9	0
Soft mottled clay	19	6
Black sand and pebbles	1	0
Dark brown sand	11	6
Dark quicksand	6	0
Sand, with flints and pebbles	7	0
Chalk, with small flints	4	0
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	150	0
Chalk, with flints, as far as has been excavated	33	0
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Total depth	183	0

Trinity high-water mark, 77 feet 8 inches below the surface of the ground.

REPORT OF J. SIMPSON, Esq., ENGINEER.

SIR,

Thames Bank, Pimlico, March 30th, 1836.

Having, in pursuance of your request, surveyed the well and works at the New River Company's Hampstead Road reservoir, and obtained the necessary information, I have now the pleasure to submit the following Report.

With respect to the stability of the well and works, I have to observe, there is a settlement in the second brick curb, about 29 feet from the surface; towards the bottom of this curb it is very much distorted, and there is every indication of its having been forced over towards the reservoir by the pressure of the earth.

The well-diggers have had to contend with much more than the ordinary obstacles generally encountered in such undertakings; the subsidence of the soil immediately contiguous to the curb and cylinders has been great, and notwithstanding the precautions adopted of sustaining them and the pumps by long iron bolts, serious injury has accrued to the curb and cylinders, and the well should not, in my opinion, be proceeded with until they are effectually secured.

It has been stated to me, that, during the sinking of the lower cylinder, the sand was continually forced under it into the well, whenever the spring got vent, more especially on the side next the reservoir; and there are sufficient indications on the surface to show that the subsidence of the earth has been very extensive—there is no doubt but that the settlements in the reservoir have been caused by it; and from the appearance of the walls of the cottage, the subsidence has also proceeded in that direction; and, although difficult to ascertain its precise limits, it seems to me we may conclude that it ranges from one to two hundred feet round the well; the quantity of sand dug out from the bottom appears greatly to have exceeded the cube of the well at the depth of the lower sand stratum: from the state of the water I saw pumped out on the 17th inst., it contained from $\frac{1}{8}$ to $\frac{1}{12}$ sand and clay, the colour of the latter being frequently discernible; and from the occasional gushes of clay, sand, and water, through holes which had been bored in the lower cylinder, to prevent its flowing over the top, on to the well-sinkers, it is manifest there is a great subsidence of the soil round the curb now going on, and that it proceeds most rapidly when the water is pumped out of the well.

K K 2

From examples of wells bored and sunk in and near the Metropolis, particularly on the western side, viz., Hammersmith, Fulham, &c. &c., the springs in the chalk formation are evidently more abundant, and in most instances rise much higher than the springs from the sand stratum above it; nearly all the overflowing wells near London derive their supply from the chalk formation; the water in most cases is found at about 70 feet depth in it, sometimes in strata of loose flints, sometimes from fissures, and occasionally from soft veins in the chalk. Sufficient proof of this has been obtained by borings in and near the Metropolis, and by connecting the observations with the cases of wells actually sunk into the chalk immediately outside the London basin; the fact of the water rising to higher levels may be attributable to the more open structure of the formation compared with the sand strata, but it is more probably attributable to the sources from whence the supplies are derived being in more elevated situations; and there seems already sufficient evidence to connect a considerable portion, if not the whole, of the sources of supply with the rivers and streams traversing the basements of the strata, where they crop out and intermingle with the chalk on the uplands near the Metropolis.

The chalk formation is evidently the stratum from which large supplies of water can reasonably be anticipated to effect the object; however, so far as my practice has directed me, a shaft must be sunk, and adits driven, to open and unite the fissures in what may be really termed the cavernous structure of the chalk, to admit of the water flowing to the well as freely as possible. The difficulty and expense of sinking a shaft through the sand strata in or near London has hitherto been a serious obstacle: boring has been the expedient resorted to; and although, by this process, large supplies of water have been obtained, I am of opinion the real capabilities of the chalk formation, as a water-bearing stratum in this part of the country, have not yet been fully developed.

To return to the object more immediately in view, viz., the sinking of the well in the Hampstead Road safely into the chalk, I have to state, that the work has occupied my most serious attention, previously to the adoption of any plan. I am of opinion, it will be *advisable to secure the present brick curbs and upper cylinders* with strong timber segments and struts; and wherever derangements of the curbs and cylinders are discernable, to fit in and substantially fix strong scantling vertically between them and the segments, to counteract the lateral thrusts now acting against the curbs and cylinders

from the pressure of earth on the opposite sides to the great vacuities in the soil contiguous to the well.

The surrounding soil will, no doubt, be saturated with water to the utmost extent until July; and I recommend further proceedings to be delayed until the commencement of that month, when it may be reasonably anticipated that the soil will become more consolidated, and be in a state more suitable for the prosecution of the undertaking.

With regard to the recommencement of the work, only two of the plans which have occurred to me are deserving attention.

1st. The driving of an iron pile curb.

2nd. The sinking of iron cylinders cast in entire circles.

The model of the iron pile curb you shewed me appeared very well designed for the purpose in view; the driving it, however, would be a work most difficult to execute.

According to the section of the strata before mentioned, which, in the absence of better information, I must quote, the bottom of the third cylinder may be taken to be from 13 to 14 feet above the chalk; and, as it is not practicable to keep the sand lower in the cylinder than 6 feet above the bottom of it, the drift of the curb, with 3 feet in the chalk, will be from 22 to 23 feet. I do not see how such an extent of drift can be effected with less than three tier of pile curbs, especially as the water must be kept pumped out of the well for the performance of the work, which will throw considerable pressure against the piles; and the quantity of sand which will inevitably be forced under the cylinders with the water, will prove a serious interruption, independent of causing the further subsidence of soil round the well, added to which the concussions arising from the blows of the ram of a pile-engine at such a depth will affect the mass to a serious, if not to a dangerous extent. I cannot, therefore, recommend this mode of proceeding.

The sinking of iron cylinders through sand and gravel, without pumping out any of the water within the shaft, is now a very common practice among the well-diggers; it is performed with the common boring rods and tools, the shells, or buckets, are fitted with valves at the bottom to open upwards; they are much larger than those used in borings, and the men turn and force them into the strata and draw the material up in them with the greatest ease; when the cylinders become set, they make use of a small sling ram, or occasionally of a very heavy sledge-hammer, to jar them, and they resort to this expedient

whenever they find the cylinders do not sink according to the proportions of sand or gravel they remove. The keeping of the water in equilibrium inside and outside the cylinders is very important; I have practised this method, and from my observation of its efficacy in several instances, I recommend its adoption at the well in the Hampstead Road; it may involve the necessity of two sets of cylinders, but I think, if the first be made strong enough a second will not be required. The top of the cylinder is always kept above water, which will be an advantage in the case in question; it will enable the men to work in a part of the well where there is much more room, and afford them greater facilities for their operations.

In case my observations have not extended to any point, or to every particular, you directed my attention to, I request the favour of you to inform me, that I may supply the deficiency.

I remain, Sir,

Your most obedient servant,

(Signed)

JAMES SIMPSON.

Wm. C. Mylne, Esq., Civil Engineer,
New River Head.

SKETCH OF THE SUSPENSION BRIDGE OF MONTROSE IN ELEVATION.

AS IT APPEARED AFTER THE STORM OF THE 11TH OCTOBER 1833.

C.W.PASLEY, C.B. COLONEL, R.E.

THE ORIGINAL LENGTH OF ROADWAY BETWEEN THE PIERS 412 FEET

FIG. 1.

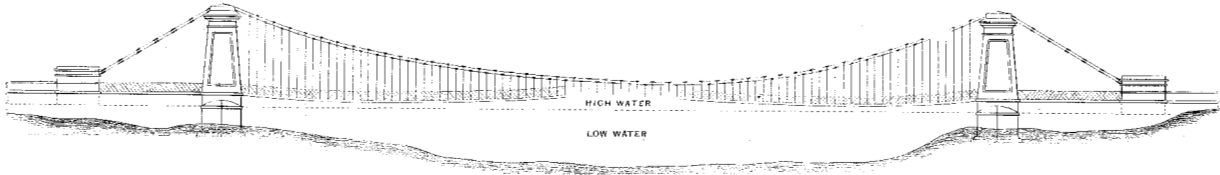
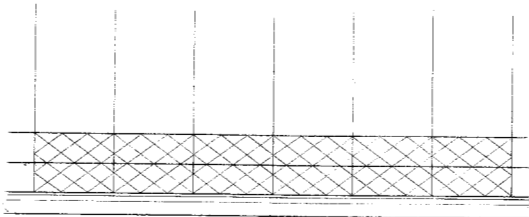
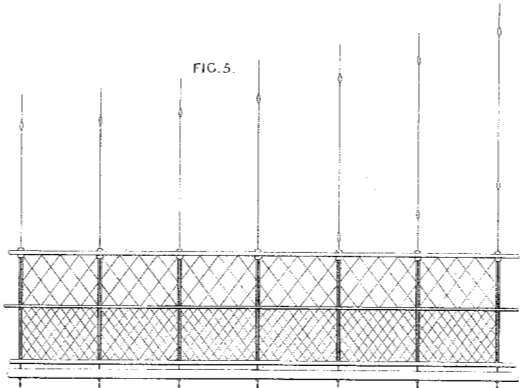


FIG. 2.



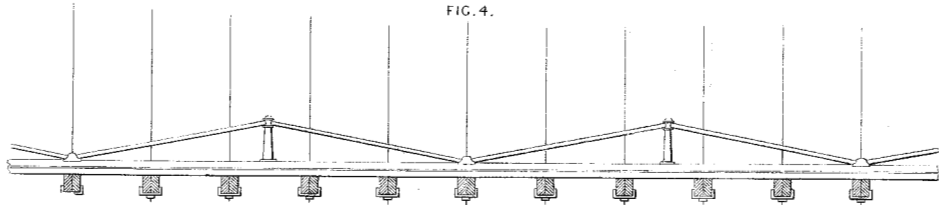
SKETCH OF THE SIDE RAILING OF THE BRIDGE AT MONTROSE

FIG. 5.



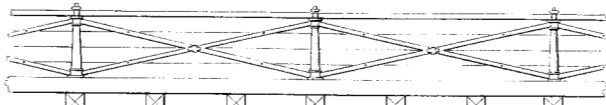
SIDE RAILING OF THE MENAI BRIDGE

FIG. 4.



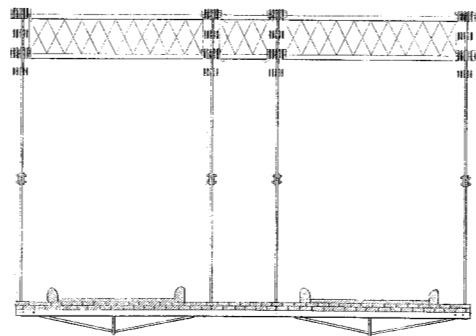
CENTRAL TRUSSING OF THE BRIDGE AT HAMMERSMITH

FIG. 3.



SIDE RAILING OF THE BRIDGE AT HAMMERSMITH

FIG. 6.



TRANSVERSE SECTION OF THE MENAI BRIDGE

SCALE FOR FIGS. 2, 3, 4, 5, AND 6.
10 5 0 10 20 FEET

Reduced from the original Drawings by Messrs Jones & Lomax.

SECTION OF AN ARTESIAN WELL

SUNK BY THE

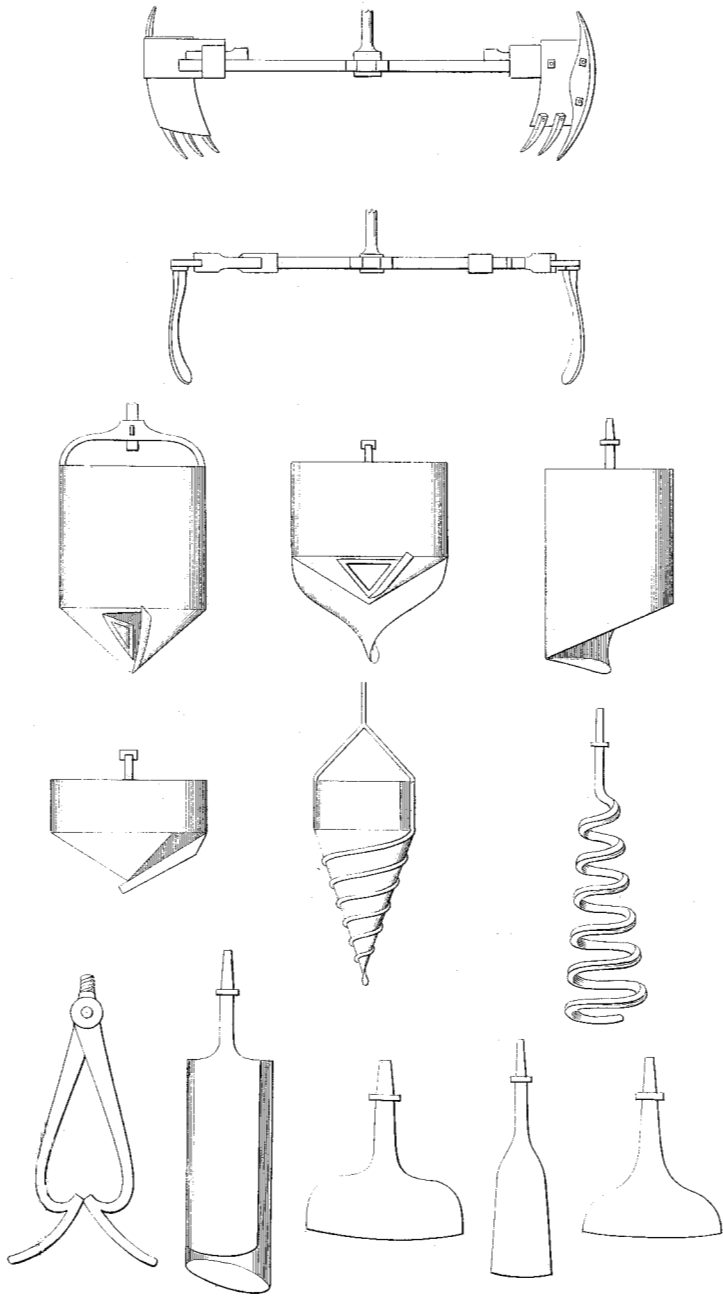
NEW RIVER COMPANY

AT THE HAMSTEAD ROAD RESERVOIR, LONDON.

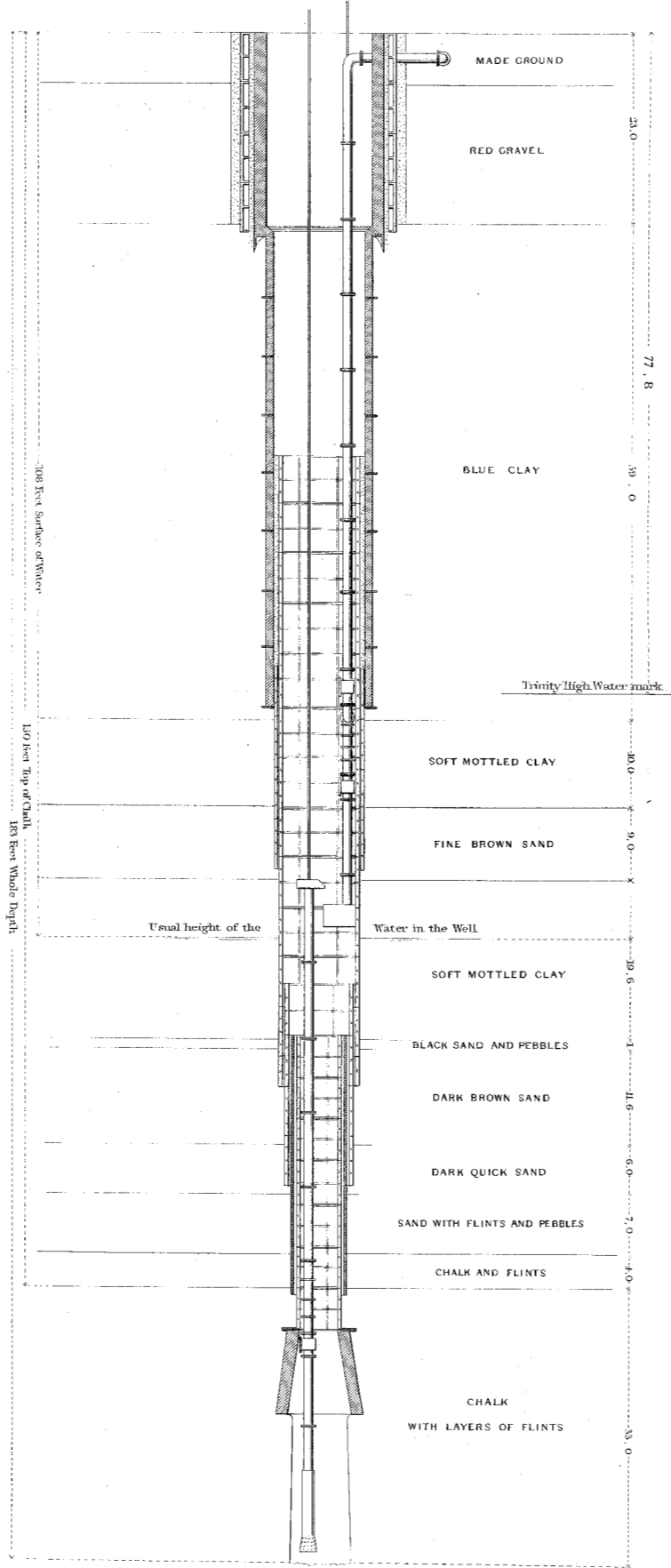
WITH

DRAWINGS OF THE TOOLS USED IN ITS EXECUTION.

WM C. MYLNE.



SECTION



10 5 0 10 20 30 FEET