Thames and metropolis improvement plan / by John Martin.

THAMES AND METROPOLIS

IMPROVEMENT PLAN:

BY

JOHN MARTIN, K. L.

THE SECOND DIVISION,

SUPPLY OF PURE WATER TO THE METROPOLIS.

THIS PLAN EMBRACES THE FOLLOWING ADVANTAGES:

1. AN INEXHAUSTIBLE AND UNINTERMITTENT SUPPLY OF PURE WATER TO LONDON.
2. A SUPPLY OF SEWAGE MANURE TO THE COUNTRY.
3. THE IMPROVED NAVIGATION AND INCREASED BEAUTY OF THE THAMES.
4. AN IMPROVED SYSTEM OF INLAND DRAINAGE.
5. THE MELIORATION OF THE HEALTH OF THE INHABITANTS OF THE METROPOLIS, AND OF THE COUNTRY DISTRICTS, BY THE REMOVAL OF EXISTING SOURCES OF DISEASE.

THE THIRD DIVISION CONTAINS

A PLAN FOR IMPROVING THAMES STREET.

A PLAN FOR REMODELLING WESTMINSTER BRIDGE,

THE MODE OF CONSTRUCTION BEING EQUALLY APPLICABLE TO EITHER THE NEW CHELSEA, BATTERSEA, OR PUTNEY BRIDGES.

MEANS OF CONNECTING THE PORT OF LONDON WITH THE INLAND RAILWAYS.

TOGETHER WITH

DESCRIPTION OF MARTIN'S PATENT WATER AND SEWER PIPES, PATENT DRAIN TRAPS AND SEWER OUTLETS, AND MEANS OF CONSUMING SMOKE.

LONDON:—LINDSEY HOUSE, CHELSEA,

1849.

PLANS DEVISED AND PUBLISHED BY MR. MARTIN.

PLAN FOR SUPPLYING THE CITIES OF LONDON AND WESTMINSTER WITH PURE WATER FROM THE RIVER COLNE;—containing, likewise, the details of a Proposition for securing the Thames from the admission of the Sewage, and rendering it available as Manure.

With numerous Plates.——*London*, 1828.

OUTLINES OF SEVERAL NEW INVENTIONS—namely:

1. Elastic Iron Ship.
2. New principle of Steam Navigation.
3. Elastic Chain Cable.
4. Coast Lights on a new construction.
5. Plan for Purifying the Air, and preventing explosions in Coal Mines.
6. Second Plan for supplying London with a purer Water, by a Weir across the Thames near Chelsea.
7. Plan for more effectually Draining certain Marshy Lands contiguous to the Thames.

With numerous Plates.——*London*, 1829.

PLAN FOR IMPROVING THE AIR AND WATER OF THE METROPOLIS, by preventing the Sewage being conveyed into the Thames (by means of parallel Sewers) and for using the Manure for Agricultural purposes.

With numerous large Plates.——*London*, 1832.

PLAN FOR SUPPLYING LONDON WITH WATER FROM THE COLNE, combining a Railway, and new construction of Rail.

With large Plate.——*London*, 1834.

PLAN FOR AN IMPROVED SYSTEM OF INLAND DRAINAGE.

With Plate.——*London*, 1834.

PLAN FOR WORKING AND VENTILATING COAL MINES.

Two Plates.——*London*, 1835.

THAMES AND METROPOLIS IMPROVEMENT PLAN.—The objects being, To supply the Metropolis with Pure Water.—To embank the River Thames, and preserve the Sewage.—To improve the Navigation below London Bridge.—And to connect the Port of London with the Inland Railways.

Numerous Plates.——*London*, 1842.

PLAN OF LONDON CONNECTING RAILWAY.

With Maps.——*London*, 1845 & 1846.

THAMES AND METROPOLIS IMPROVEMENT PLAN (Sewage portion distinct.)

London, 1846.

OBJECTIONS TO THE TUNNEL SEWER, proposed by The Metropolitan Sewage Manure Company by their New Bill: suggesting instead an Alternative Line.

Numerous large Plates.——*London*, 1847.

THAMES AND METROPOLIS

IMPROVEMENT PLAN;

THE OBJECTS BEING

TO IMPROVE THE DRAINAGE AND AIR OF THE METROPOLIS, AND TO PRESERVE THE SEWAGE FOR AGRICULTURAL PURPOSES.

TO AFFORD TO THE METROPOLIS AN UNFAILING SUPPLY OF PURE WATER.

TO EMBANK THE RIVER AND IMPROVE THE NAVIGATION.

TO DRAIN THE COUNTRY DISTRICTS, AND PRESERVE THE PURITY OF NATURAL SPRINGS AND STREAMS.

AND TO CONNECT THE PORT OF LONDON WITH THE INLAND RAILWAYS.

SECOND DIVISION.

Plan for supplying LONDON with the pure Water of the Thames, unmixed with the foul drainage; and for improving the salubrity, the beauty, and the navigation of the River above the point of supply.

THE subjects of drainage, ventilation, and supply of water are now so inseparably associated in the public mind, that I have no hesitation in selecting the present time for urging that division of my Thames and Metropolis Improvement Plan which comprehends the supply of water, and its immediate and necessary connection with the diversion of the Sewage from the River; the mode of effecting which, and applying the manure to agricultural purposes, is described in the first division of the general plan already published.

The objects of this second division are—to give an abundant supply of water to each house from the lowest to

the highest levels, without employing steam engines;—to derive the supply at the distance of only one mile and a quarter from Hyde Park Corner;—to separate from the stream the tidal water and filthy drainage of London, and the adjacent towns and villages, so that even in time of flood, the water shall enter the pipes in a perfectly bright and pure state;—to form public Baths, and afford running Fountains to the ornamental lakes in the public parks, leaving no stagnant waters or reservoirs in the Metropolis;—to remove the nuisance of smoking engines;—and finally, to permanently improve the salubrity, beauty, and navigation of the River, and increase the value of the property upon its banks.

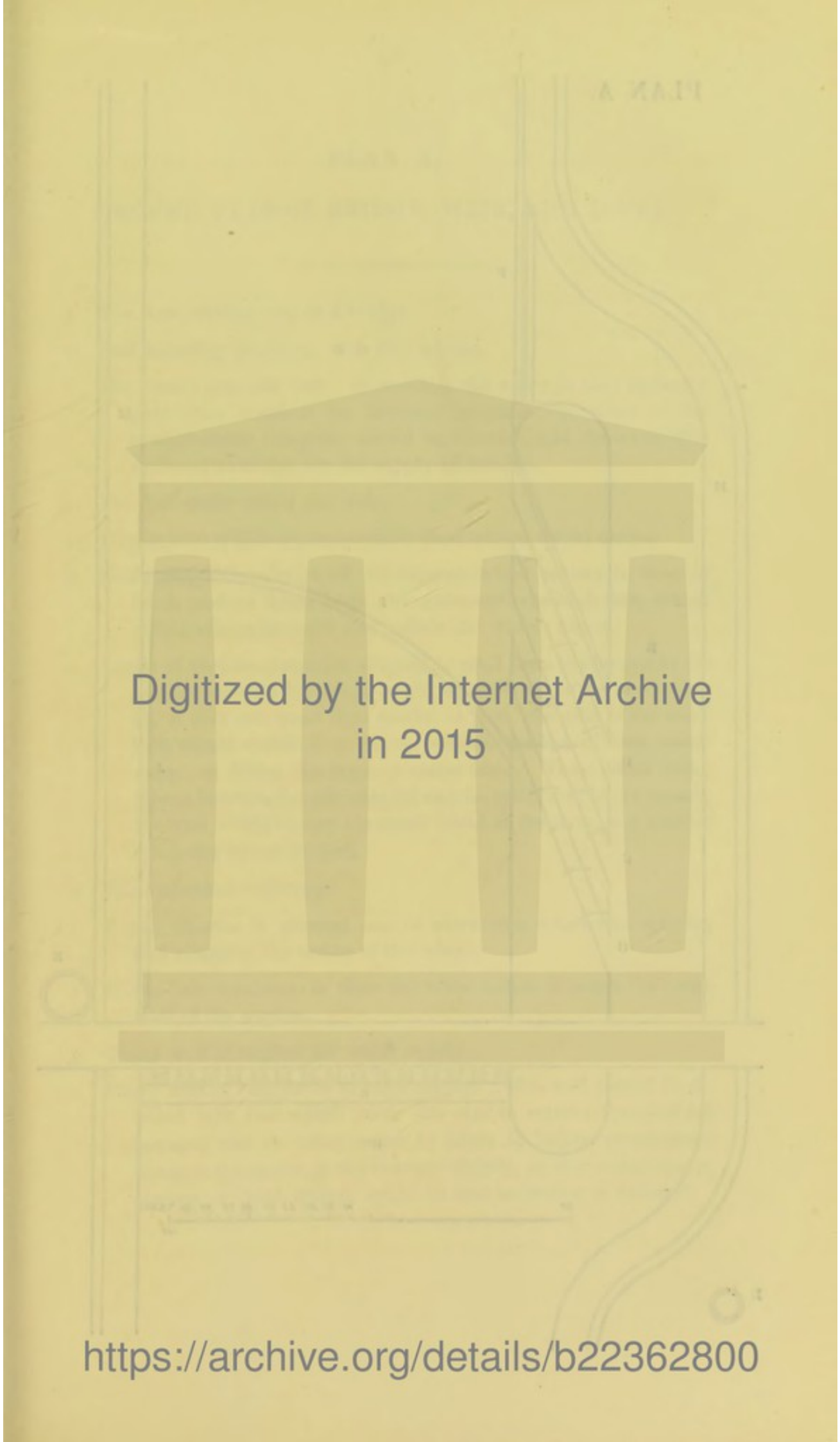
Much as the question of a copious supply of pure soft water to the Metropolis has been agitated, and considerable as have been the improvements within the last 20 years, yet the great object of an unlimited supply of perfectly pure water has never hitherto been definitively attained. The existing companies declare that they cannot afford an unintermittent supply without an outlay that is tantamount to rendering the works impossible:—to derive the supply from distant sources, even if adequate in quantity, is not only enormously expensive, but is depriving such distant districts of the waters which properly belong to them:—and the alternative of sinking Artesian Wells is obviously impracticable for so extended a purpose, if we may judge from the experiments of many individuals—the facts that the wells at Watford are ascertained to be higher on Monday mornings than they are on those other days of the week when the breweries work their wells—and from the signal failure of the attempt made by the Chelsea Company in 1826. Notwithstanding the favorable situation of the works (the lowest level on the banks of the Thames) the result of this experiment was, that after boring 200 feet into

the chalk, which was 240 feet from the surface, only 200,000 gallons of water in 24 hours were obtained from three bore holes of 6 inches in diameter, the quantity stated in the House of Commons Report of 1834 to be daily consumed in the Metropolis, being upwards of 33,000,000 of gallons! The engineer, in consequence of this trial, and of extensive enquiries from others who had introduced boring on a large scale, reported the case hopeless for any thing like the purpose required, as "generally speaking, for one bore hole which had succeeded round London, another had not succeeded; the supply as far as his observation had gone, having been continually decreasing." In addition to this, is an objection raised by the late Mr. Buddle, the eminent coal viewer, that even supposing the quantity attainable, the abstraction of so much water would endanger London, there being no means of leaving pillars and props, as in coal mines, to support the superincumbent strata. After a careful and mature consideration of all these facts, and of the merits of every proposal which has been advanced by myself and others, I have, at length, arrived at the unequivocal conclusions that—the Thames is the only source whence a sufficient quantity of water to meet the increasing requirements of the Metropolis can be permanently obtained;—and that for this end the point of supply must be from the united body of the stream, and near to London, in order to obviate that interruption of the navigation, which would infallibly occur by abstracting the water higher up, or from the rivers and springs contributing to its flow. The objection, however, to deriving a supply from any low point, is the difficulty of preserving the purity of the main stream, from the tidal and sewage waters which at present pollute it; and this difficulty I propose to meet by the following plan, which combines many objects of the highest importance to the sanitary condition, not only of the Me-

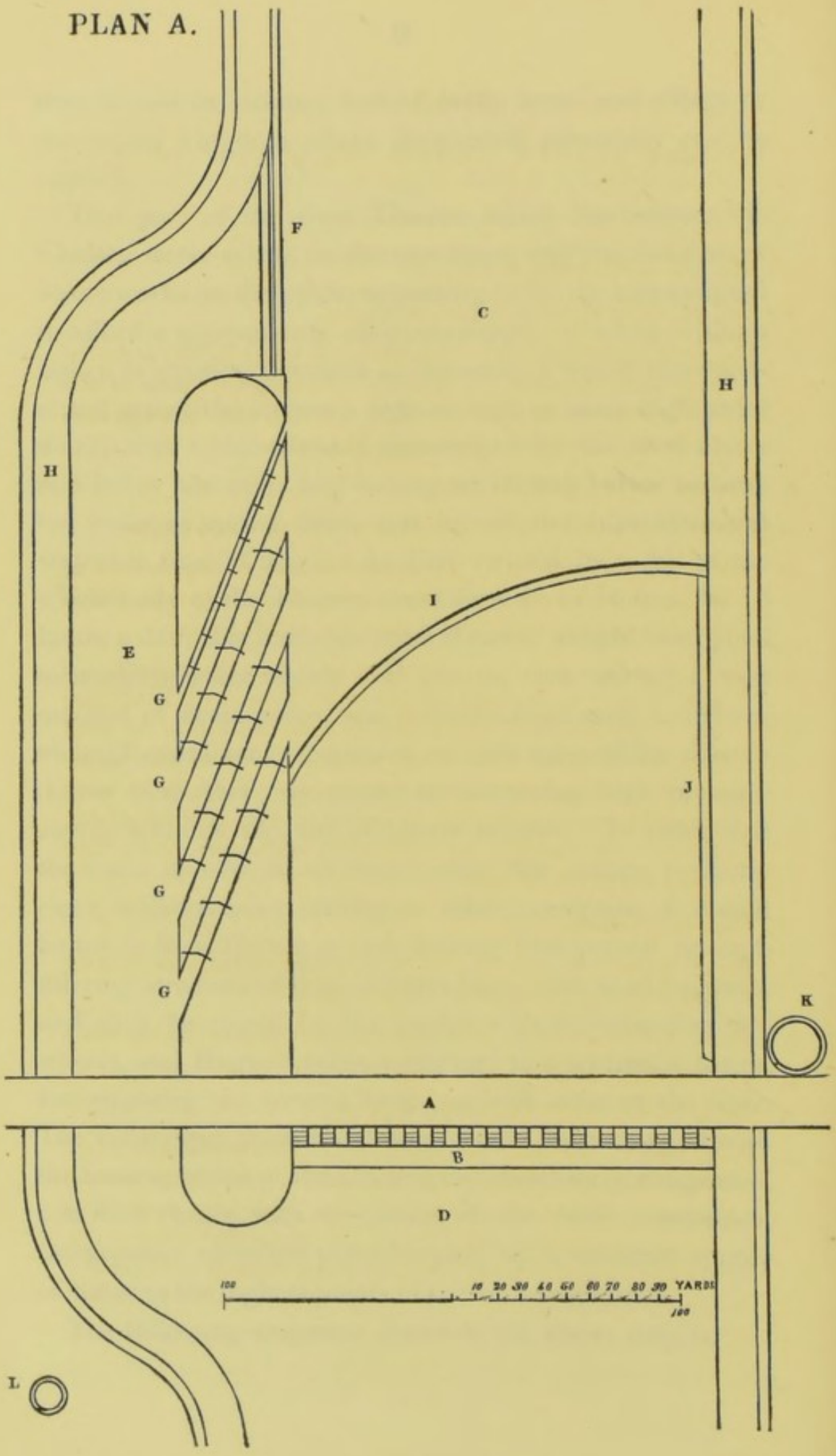
tropolis and its vicinity, but of every town and village in the united kingdom where its general principles can be applied.

That part of the river Thames which lies between the Chelsea water-works on the one shore, and the Southwark water-works on the other, appearing to be the best adapted to afford a permanently adequate supply of water without injury to existing demands or interests, I would there construct across the stream a weir as high as mean high water mark, with a side channel connected with the river above and below the weir, and having self-acting valves to back the water in spring tides, and let off the superabundant waters in time of flood. As there would be a fall of the whole body of the Thames over this weir, of 16 feet, for 16 hours a day, this immense natural power should be applied to working water wheels and pumps, thus saving a vast amount of steam power and nuisance from smoke, and enabling the different companies on both sides of the river to derive from this one point, an unvarying high pressure supply without the aid of steam engines. In order that the water should at all times enter the pumps perfectly clear, without using settling or other reservoirs, it should be taken from the upper bed, having first passed through filtering strainers of double horse hair, with sand between, and then be raised by the pumps with self-adjusting tide wheels, and Hague's vacuum engine, to a hydraulic tower, for supplying the various levels on both sides of the river. The main pipes from the tower should be connected with the feeding mains of the Chelsea and Southwark companies, and from thence with the mains of the other companies, the pressure upon the pipes keeping up a constant supply of water to the highest points of the various districts.

The following diagrams elucidate the above details.



PLAN A.



PLAN A.

GROUND PLAN OF BRIDGE, WEIR, AND LOCKS.

A The weir serving also as a bridge.

B Self adjusting platform, with tide wheels.

C The river above the weir; to maintain the water in that perfectly pure state requisite for domestic purposes, the whole of the sewage above this point should be diverted, and the water thus rendered available for the supply of London.

D The foul water below the weir.

E Channel by which superabundant flood waters would escape.

F Self-acting valves to let off the superabundant waters in time of flood, and to keep back any extraordinary high tide, which would otherwise enter and pollute the waters above.

G Locks of various capacities adapted to craft from the largest to the smallest size, as the whole might be working at the same time; or, if only one small boat needed to pass, one gate of the small lock would enable it to do so, without the loss of time consequent on filling the large or entire basin. These locks being placed between the side channel and the main body of the stream, the weir would occupy the entire width of the river, and neither space nor power be lost.

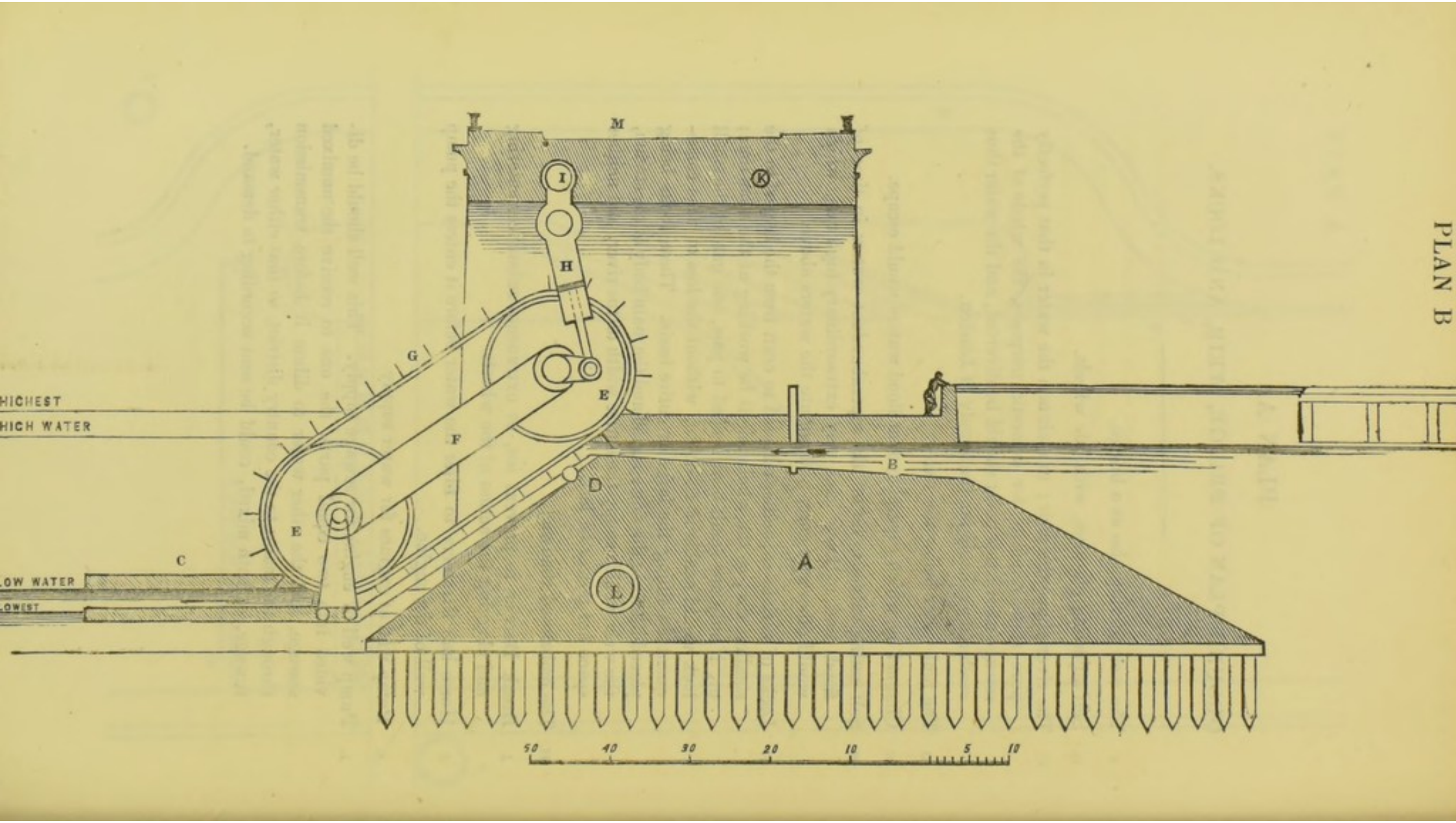
H The embanked roadway.

I Break Barrier to prevent ice, or extraneous substances entering and clogging the action of the wheels.

J Horse-hair Strainers to filter the water before it enters the pump well of the engine.

K Pump well of engines for water supply.

L Pump well of engine for sewage supply. This well should be divided into two equal parts, the one to receive the unmixed sewage, and the other water to dilute it before transmission through the mains to the country district, so that either water, sewage, or both mixed, could be sent according to demand.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PLAN B

PLAN B.

Self-adjusting Tide Wheel, which possesses the advantage of continuous power without the loss from tail water, caused by the immersion of the Float Boards. It consists of two wheels connected at a given distance by a strong unyielding beam: an endless Metal Band with float boards at regular intervals, extends round and joins the two wheels, the upper of which is maintained in a fixed position, whilst the lower rises and falls as the tide raises or lowers the floating platform upon which it rests, thus preventing the immersion of the float boards, which will invariably retain the same position relatively to the water. The downward pressure of the stream will act severally and conjointly on the whole range of floats as they are brought within the force of the current, until they rise out of the stream, passing through the trough of the platform. By this disposition of the Floats, if one be supposed to move with a force equal to 10, a range of ten Floats will give a force of 100, securing the hitherto unattained advantage of power equal to a large wheel, with the increased velocity of a small one.

A Section of Weir.

B Channel for the Water.

C Self-adjusting Platform and Trough for each wheel.

D Hinge of Platform.

E The double Wheel.

F The Connecting Beam.

G The Metal Band and Float Boards.

H The Pump.

I Vacuum Pipe.

K Water Pipe.

L Sewage Pipe.

M Roadway of Bridge.

There being a cessation of power for about two hours of each tide, it will be desirable to meet this by placing hydraulic towers on certain heights, such as Camden Hill, Barrow Hill, Pentonville, and on the Surrey side, Knight's Hill; as these hills being already high, little additional altitude would be required; but wherever there are stand pipes at present, they should be enclosed in brickwork of sufficient strength to support a capacious cistern on the top for the purpose of receiving the water which would be pumped during the night when there is little consumption: in this way the head of water requisite for pressure would always be maintained without any waste of power. To complete the works, the banks of the upper part of the river should be raised where they may require it, and wherever soft and earthy, faced with slate planking—a sufficient towing path made on the right, and foot-path on the left bank to unite with the embankment at London, forming a continuous walk from Twickenham to the Tower; and as the weir itself would furnish the foundation for the new Chelsea Bridge, the separate objects would all combine together in one general system. As the point indicated for the weir is below the entrance of the Grosvenor canal, I propose to remove the locks, to enlarge the canal itself, and to form a new entrance channel into which the water from above the weir should enter freely. There being a difference of 16 feet between the upper and lower levels at the weir, it would be easy to secure a constant change of water, and scour of the canal, by laying a pipe from the basin towards the lake in Buckingham Palace garden, whence the waters should finally discharge through the lake in St. James's park, maintaining a continuous natural run, and affording the power of flushing the King's Scholars Pond and other sewers with fresh water at any time. Thus the health of the entire district would be improved, and by

forming gardens of the whole of the waste and unoccupied ground between the canal and Chelsea Hospital, and giving a semicircular turn to the road connecting Sloane Street with the Bridge, a noble crescent facing the south west might be formed to the profit of the proprietors. and advantage of the public. The tide and foul drainage below the weir being separated from the water above, and the refuse of the numerous factories, mineral and gas works, and all the sewage of the western suburban districts likewise diverted, the River would be permanently secured as an inexhaustible reservoir of wholesome running water, and the whole of the fertilizing manure would be rescued from worse than waste; whilst the navigation would be vastly improved, as the stream would be rendered sufficiently deep to be at all times navigable by those larger vessels now detained for hours every tide, the Richmond steamers even being constantly grounded in the summer season. In support of this last recommendation, I have the favorable testimony of different practical men, who concur in the advantage of thus backing the water, and amongst others of the late Mr. Leech, the river surveyor, who was opposed to my early plan, suggesting a weir between Battersea and Vauxhall, upon the ground of obstructing the traffic, but who subsequently expressed to me his change of opinion, and conviction, that instead of impeding, it would greatly improve the navigation; and unquestionably all must see that the uniform embankments and invariable high water would augment the value of the property, and the beauty of the residences and walks upon the shores of the river. The proposal is also entirely free from the objections which attach to plans deriving the supply at a higher level; or from the Colne or other tributaries, such as compensation for mills,—the cost of conduits from the source of supply to the Metropolis,—and the already mentioned

incalculable injury to the river Thames, consequent upon abstracting so much water as would be required for the consumption of the Metropolis, from a high point, or from any of the intervening tributary streams. As regards the compensation for mills.—Mr. Telford's estimate in 1834, for his Verulam Plan was £224,314, and for the Wandle £150,095; but according to Mr. Anderson, the Colne alone would require £450,000 compensation for mill property. Then the cost of conduits would at a moderate computation be £20,000 a mile, exclusive of the expense of the requisite tunnelling, embanking, and compensation for land upon the line: but the most important consideration of all, is the injury to the Thames itself between Henley and London, both as to its beauty, and its utility as a navigable river. According to the evidence of Mr. Payne, clerk to the Conservancy Commissioners, whose jurisdiction extends from Staines to the source of the Thames,—so deficient is the quantity of water above Maidenhead in dry seasons, that the Commissioners have a discretionary power to limit the depths at which barges may pass, namely to 3 feet, when they ordinarily travel 4 feet:—that there never is any surplus water excepting in floods:—and that there is no period when even "400 cubic feet in a month" could be abstracted from the navigation!—How much then would all such places as Windsor, Richmond, and other lovely scenes and populous places, constantly suffering from this cause, be farther injured by abstracting from their already deficient streams; and on the other hand, how greatly would their beauty be enhanced, and how many advantages would they derive by adopting the foregoing suggestions.

Although the advantages above enumerated might in themselves be esteemed a sufficient recommendation of this plan, its financial superiority in other points is so clear as to establish the correctness of my calculation, that so large

will be the amount in recovered property and machinery; and in the annual expense of maintaining the steam power, as to be fully commensurate with any reasonable estimate for works that may be formed. In the first place, the substitution of water power for steam engines, is alone a most important item, as we are informed that in the great water works at Philadelphia, wheels have superseded steam engines, yielding twice the quantity of water at a cost of exactly one tenth; and that here in London the Grand Junction Water Works Company had alone expended down to September 1833, no less a sum than £127,260 upon engines, engine houses, reservoirs, and the value of land for their formation. Other companies, it is known, have proportionate expenditure; and exclusive of the money so sunk, Mr. James Simpson, the Engineer of the Chelsea Company, has stated in the before mentioned Report upon Water Supply, 1834, that the annual expense of maintaining an engine power equal to raising 100 cubic feet a second 60 feet high, or at an average altitude of 120 feet, would be at least £25,000 a year: but to raise such a body of water to higher levels, or to a uniform elevation of 120 feet, the expense would be enormously greater, as the following extract from Mr. Mills evidence in the same Report will show. "The actual expense of pumping 3½ feet per second, or 288,048 feet per day, is stated in the Parliamentary Report of 1821, by the West Middlesex Company, to be £3,150 per year, about £1000 per cubic foot for water pumped 136 feet high. The actual expense of pumping 3½ cubic per second, or 310,000 feet per day, is stated in the same Report by the Grand Junction Company to be £3,500 per year, equal to £1000 per cubic foot per second for water pumped 115 feet high. The expense in the same Report by the New River Engineer, for pumping 18½ cubic feet per second, 84 feet high, is stated to be £16,000 per year,

which would amount to £1400 per cubic foot per second for an elevation of 120 feet." "The quantities supplied by the companies was stated by them to be 69 $\frac{6}{10}$ cubic feet, proposed to be raised to 103 feet per second. Now it is manifest, that if the above calculations are correct, that to pump the present supply on the north side of London will cost £18,500 per year, and to pump the supply at the south £9,100 a year, making the present cost £27,600 per year, and that to increase the present supply by pumping to 43 feet, would require an endless expense of £43,000, equal to 4 per cent. on a capital of £1,075,000. It is also clearly proved that the present New River, even if the water could be conveyed in a pure state, cannot yield more than half the present supply for their district and the East London; and that to pump 42 feet per second would cost £42,000 a year, equal at 4 per cent. to a capital of £1,050,000; and that to increase their present supply, by pumping to 60 feet, would cost £60,000 for pumping alone, 4 per cent. on £1,500,000," making £103,000 a year for pumping.

The whole of this enormous annual expense would be saved by the substitution of the water power, which should be used to the fullest extent; nevertheless it would not be advisable to remove all the existing steam engines, as many of them are in situations peculiarly advantageous for diverting the sewage, and engines worked by fire being necessary to consume the foul air in the drains, these might at once be applied to raising and forcing the manure into the country. This constitutes the second great advantage of the plan, for not only would one set of engines be rendered unnecessary, but in turning them out of use for one purpose, they are immediately ready for application to another, without incurring any expense whatsoever, whilst the sale of the surplus engines would raise capital to invest in the new works. Then again, the source of supply being close to London,

the great mains from the present suction points of the Grand Junction and West Middlesex Water Companies to their London Reservoirs, would no longer be needed for conveying the water, and could consequently be appropriated to the transmission of the sewage, effecting the saving of many miles of large main from the respective feeding points at Brentford and Barnes to the town reservoirs, and the accompanying cost and nuisance of opening the ground and laying fresh pipes; the sewer water could be carried off without delay, the entire apparatus, including the small reservoirs applicable to the covered manure depôts, being already provided in the most desirable situations, and all convertible to their new use with very little expenditure: next, the river above the weir being an inexhaustible reservoir of pure running water, the settling, filtering, and other reservoirs would be unnecessary, by which many acres of ground, in situations of great value for building purposes, would be recovered: there would be an unlimited supply of pure soft water from one single, instead of from six separate points; no fresh pipes would need to be laid down, as the water could at once be projected from this single feeding point into the mains and services of the existing companies: the companies would require no additional capital, as the proceeds from their present plant would cover the additional expenditure; the bridge so much required must be at this spot, and as the weir combines with it the construction of a bridge, the two objects may obviously work together: and finally, the point indicated appears to be the very best for advantageously diverting the sewage of the Westminster district.

The foregoing plan has reference only to the six companies that derive their supply from the Thames; the New River, and the East London Companies, having entirely independent sources; but inasmuch as it is stated in the

Report of the Health of Towns Commission, 1845, that the New River only supplies two-thirds of its complement of population, it is proposed to discharge into its mains the required additional quantity to enable it to afford an uninterrmittent supply. Nevertheless these two companies might be rendered independent of such aid, by applying the foregoing plan to the river Lea, constructing the weir as low down as practicable: the river Ravensbourne might be similarly backed; and, indeed, I would strongly recommend that this means of gaining water power should be applied to all rivers acted upon by the tide; as the action of the tide alone is used with advantage in some places by means of side cuts; but in running streams, in addition to the occasional tidal power, there is the constant power of the descending current. This power in the Thames, even above the tidal action, is most important, for there are six locks between Teddington and Staines, at each of which water power could economically be gained by my new wheel, and transferred by the vacuum engine to any point.

It is not necessary here to do more than revert to my early proposal for diverting the sewage from the Serpentine, and for supplying pure water to that and the other ornamental lakes in the Parks, by conduits from the Gutchwell Spring, or Garrett's Mill, or by Artesian Wells. Suffice it that the recommendation, in my plan of 1828, led to the diversion of the Bayswater Sewer, but by means so injudicious and inadequate to the extension of building then and now going on, that the flood water and sewage have again overflowed, and rendered the Serpentine, as much as ever, a stagnant receptacle for foul sewer water. This has recently been partially remedied by giving a more easy turn to the sewer, but ere long it will be found requisite to provide further accommodation for the drainage; and I, therefore, again urge my first suggestion to carry off the sewage of the Bayswater

district by a small sewer or pipe, running in or parallel with the bank of the Serpentine, and discharging into the Ranelagh Sewer near Knightsbridge. The sewage having been diverted, the next measure should be to drain off the foul waters, by opening the centre sluice at the lower end of the Serpentine; and then to level the bed, and lessen the general depth of the river, so that the deepest part may not exceed five feet. To effect this, the depth at the shore, and where the bed is too shallow, should be increased to four feet, and the material thence removed employed to fill up the numerous deep holes and inequalities in the centre; the whole then be covered with clean gravel, which abounds in the neighbourhood, through which the springs in the bed would rise freely, and contribute to the main stream; and finally, the banks should be lined with slate planking, to preserve them from washing up. It would farther be advisable for the surface of the water of the lake fronting Kensington palace to be three feet lower than it is at present, in order to improve the drainage, and render the banks more dry and agreeable, the bed and sides being treated in the way already described for improving the Serpentine. As regards the water to be supplied instead of the notoriously foul water which now enters, it must be evident that the Thames in a pure state as shown above, would answer every purpose required; but in accordance with my opinion that ornamental waters should be from independent sources, entering freely without the aid of engines, I prefer recommending obtaining the supply by boring, for the soil indicates that at no great depth springs would be found like those at Garratt's Mill, &c. near Wimbledon Park, which rush up with immense force, after boring 130 feet, yielding 30 cubic feet of water per minute. It is only reasonable to infer that where the water forces itself up naturally in such abundance, as it does in and near the Serpentine, the ground

will be favourable for the Artesian supply, especially when we know that the conduits at Paddington, which anciently supplied London with water, were close to the head of the Serpentine, and are still to be found under the gardens of Westbourne Terrace, or Conduit Street West, two springs on Craven Hill having only within the last few weeks been covered in:—these springs it should be remembered are public property, and no private parties should, therefore, be allowed to appropriate them. That they may be turned to useful account in the way suggested there can be little doubt, for whatever may be the opinion regarding the practicability of attempting to supply the entire Metropolis with water by means of boring, there can be no question as to the sufficiency of supply for the Parks only, and surely it would be advisable to obtain this supply of the purest water, when the depth at which the spring is to be found could be ascertained at very small expense. The experiment should be made in the centre of the lake opposite the palace, and the water entering as a fountain, would thence be conducted to the head of the Serpentine, where the fountain suggested in my former plan should be, though of a form somewhat more picturesque than that at present existing, and finally flow off at the lower end, to supply the other ornamental waters in the Parks. To render the bathing place on the banks of the Serpentine, as complete and useful as possible, it would be convenient to have on each side of the river, for about 200 feet in length, a single row of forms, with backs and small partitions under the seat, for the bather to deposit his clothes; this arrangement would neither be unsightly, nor intercept the view; but would, on the contrary, furnish comfortable sheltered, and agreeable seats during the day for loungers.

Having thus explained how an abundant quantity of water may be procured without injuring the navigation, or the picturesque beauty of the river or its tributaries, it is

nece ssary to show how the waters above the weir and point of supply, may be preserved from pollution; which I can best do by referring to the first division of this plan, describing the removal and distribution of the sewage for agricultural purposes; merely adding in this place some details which recent circumstances have suggested to me as advisable for its more advantageous practical working; and for its special application to the banks of the higher part of the river. Following out the mode of working by distinct portions formerly recommended, it only remains now to suggest the most desirable sewage stations above the weir, and for the western division of the Westminster district of Sewers.

The deviations of the Metropolitan Sewage Manure Company from their original plan, and from the provisions under which their first act was granted; having raised an apparently insurmountable barrier to farther effective proceedings, their present engine power being totally inadequate to the distribution of a large body of sewage, I am induced to recommend for consideration the following mode of dividing the sewage portion of the extreme western district of London, as possessing many advantages in point of economical arrangement over those which have hitherto been advanced. Instead of conveying the King's Scholars Pond, Ranelagh, Millman's Row, and intervening Sewers to an engine station near the mouth of the Kensington Canal, the sewage between and belonging to these sewers should concentre and unite at the weir, and thence be carried across the river by means of a main pipe laid in the bridge (see plan B) and road, until it meets the Southampton Railway, in the embankment of which it could be conveyed towards the Surrey Hills or Bagshot, with services and taps at convenient points for distributing the sewer water over the soil, and to the covered tanks, there being many elevations

upon the line, suitable for such manure reserves. By this route, the breaking up of many streets would be avoided, and the sewage would reach the country by a shorter and less populous line than any other in the same direction, whilst the Railways in the vicinity afford the required facilities for conveying the produce of the land to the Metropolis.

That part of Fulham which comprises the Common Fields, Parsons Green, Walham Green, North End, &c. being at present inadequately drained, might have a small sewer or drain pipe laid in the public roads, for the supply of the surrounding market gardens, and as the sewage must not be discharged into the river, and the ground is a dead level, this drain should be inclined towards the Stanley Bridge Station, or to the head of the Kensington Canal, an excellent central point for the engine to take up the sewage of this district and Kensington, and of the rapidly extending suburbs Notting Hill, Norlands, Shepherd's Bush, East and West Acton, and Hammersmith, all at present discharging into the Counters Creek sewer, which under the name of the Kensington Canal poisons the atmosphere of the West of London. By adopting the weir the canal would always be full of pure water, presenting the advantage of affording the supply for diluting the sewage.

The Grand Junction Engine will take up the sewage of Brentford, and the surrounding population, and force it on to the most suitable distant localities, as the manure is valuable in proportion to the distance from the source of supply, being of no value near the town. The engines for pumping the sewage must always be kept as near to the river as possible, to afford facility for sending water into the country in the dry season, when it would be as essential as the manure itself. In all those populous parts situated above the water supply, it might be desirable to adopt the suggestion

contained in the plan submitted in 1843 to the Health of Towns Commissioners, for separating the house from the surface drainage, and highly approved by some practical men; it was to make the foundations of all buildings as elevated as possible, and for each house to have two drains, one for the surface or flood drainage, flowing into and sweeping the main sewer; the other small, and discharging into a drain leading direct to a closely covered district receptacle, which should be of sufficient capacity to receive from 12 to 24 hours house drainage, in reserve, at such period when the pumps will be required to convey water only to the land. This will not involve any great size for the receptacles, as the quantity of house drainage when relieved of the surface drainage, is very small, and always uniform. The surface, or flood drainage, on the other hand, being only occasional, the large sewers or conduits of the present system of drainage, are necessary to carry it off: it must, therefore, be evident that by separating the two, nothing but pure water would enter the river, whilst all the fertilizing material would be saved, and the means secured for diluting it to any desired extent. In new districts the system could be easily effected, but even in many old localities it might be adopted without difficulty, by making the house drain on the top, or a little on one side of the great drain, keeping near to the surface, to avoid intercepting each other, or expense in construction. The plan of pipes and district receptacles could be adopted wherever the main sewer is too small at the lower end, to admit of any augmentation of sewage: it is also peculiarly applicable to poor, crowded, and as yet undrained neighbourhoods, like Spitalfields and Bethnal Green, and to those suburbs so distant from the river or main intercepting sewer, as to require a great length of drain, as the pipes and receptacle would cost less, whilst the lower drains being so relieved of an immense body of

drainage might be made much smaller, and no smell could possibly arise from the gullies, as only rain water would flow down the sewers.

The house drainage of all isolated buildings or cottages, however humble, should in like manner be conveyed by small pipes into covered cesspools, there being either one for each house, or where the houses are sufficiently near, a cesspool common to all; where the villages are wide and straggling, an earthenware pipe should be carried through to its whole length, the expense of the pipe and small receptacle being defrayed by the landholder, who would receive an ample return by employing the manure upon his land; where the manure is not sufficient in quantity to warrant using engine power, covered watering carts might be used; but in all cases where there is a sufficiency of fluid, engine power is found to be the cheapest and readiest mode of distributing it over the soil.

After these few additional recommendations as to the diversion of the sewage above the weir, and the application of the principle of separating the drainage under certain circumstances; it only remains for me to explain the local improvements on the banks of the river before introducing that division of the plan which relates to "Inland Drainage."

In order to secure the health of the population within the city, the state of the surrounding neighbourhoods should be carefully attended to—no bogs or marshy grounds, osier beds, stagnant waters, sluggish streams, canals, ditches, or open sewers; foul nuisances, or smoking factory chimnies being permitted to exist there any more than in the town, for whichever way the wind blows it carries along with it the poisonous miasmata generated in the suburbs. Now the south-west wind is a prevailing wind in London, but this wind can never blow without impregnating the air of the best and most fashionable

quarter, with all the impurities of the damp, imperfect and ill-managed banks of the river from the Houses of Parliament to Brentford,—all the foul air from the mouths of the sewers,—and all the foul smoke from the gas works, lead works, potteries, and other factory chimnies that should be compelled to consume their smoke. The river ought to be the most healthy part of the Metropolis, as running water is by nature a purifier, carrying along with it a constant current of air, whereas wet and marshy soils have more evaporating surface exposed, the exhalations being also of the worst and most dangerous description. At present the ground on the banks of the river is in places so low as to be under water several times at each new and full moon, most prejudicially affecting the air of the surrounding neighbourhood; the Fulham Town Meadows just above Battersea Bridge for instance are so situated, and no remedy even attempted, though the spot is capable of being rendered both healthy and lovely at small cost, there being no obstacles in the way. The soil might be drained by digging a graceful channel for a piece of water, the material excavated being employed to raise the ground above the water level, the front next the river being faced with slate planking, which can be procured of the proper form, dimensions, and thickness, at the rate of 6d. a square foot: the water in the excavated channel should enter at one end, and flow off at the other, like an arm of the main stream, and the form being properly varied and planted on the sloping banks, it would constitute a beautiful and picturesque addition to the landscape. Again, around the Bishop's Palace at Fulham, is a stagnant moat and great foul ditch, with swampy ground next the river; this should be treated in the same way, both for the benefit of the inhabitants of the Palace and of the public, as the spot is at present highly dangerous, when it might be rendered

most beautiful and healthful at small expense. The public walk should here and there diverge from the banks of the river to vary the scene, for utility should not be the sole object considered;—the eye and imagination should likewise be gratified, if for no other purpose than to induce the innocent and healthful recreation in the open air, of walking, fishing, or boating. Wherever the banks of the river are so low as to be liable to be overflowed, whether by tide or flood, they should be slate planked, or built up so that the waters shall never rise beyond their proper limits, and thus the navigation will be permanently maintained, whilst the waters being preserved from pollution, will always be sufficiently pure for domestic purposes.

The next division of the subject that naturally presents itself is Inland Drainage, without which, indeed, no matter what precautions may be taken, in other respects, no system even of town drainage can be complete, as the two must necessarily work together.

Tabular View of the Expenditure, and of the quantity of Water supplied by the Water Companies of London,

According to the returns made to Parliament in 1834.

Name of Company.	Gross expenditure to 1833.	Annual current expenses.	Expended on Engines and Engine Houses.	Expended on Reservoirs & Land.	Expended on Pipes.	Height of Supply above the Thames.		Average daily supply for Houses, Buildings, and Street waterings.		Number of Engines.
						Mean height.	Highest	Gallons each House.	Aggregate quantity.	
East London.	£. s. d. £594,988 — 9 for engines, reservoirs and pipes.	£. s. d 15,889 — —	No special return.	No special return but 19 acres of depositing reservoir.	No special return, but 200 miles of iron pipe in 1828, some 7 Gs. a yard.	Feet. 60	Feet. 107	120	5,593,896	Two of 80 H. P. each One of 70 „ Two of 30 „ and 76 H. water power
New River.	1,116,964 — —	38,000 — — likely to be increased.	No special return.	No special return. 5 acres at Clerkenwell 1 do. at Pentonville 38 do. on 50 acres of land at Newington.	No special return.	84½	145	241	16,904,945	Two of 60 H. P. each One of 100 „
West Middlesex	404,263 2 6 for engines, reservoirs and pipes.	18,000 — — exclusive of reserve fund.	Expended on these kinds of Works between 1828 & 1834 £78,239. No special return.	No special return.	3½ miles of mains to Kensington. 7 to Barrow Hill.	155 that at Kensington. 122	188 Barrow Hill.	185	3,060,000	Two of 70 H. P. each One of 105 „
Grand Junction	331,174 1 7	11,000 — —	£46,531 14 9	£80,728 7 8	£175,008 11 1	100	151¾	150	1,200,576	Two of 100 H. P. each One of 70 „
Chelsea.	271,311 3 9 exclusive of labour and repairs.	17,981 — — exclusive of reserve fund.	No special return. Expense of pumping to filter bed £800 a year.	No special return.	No special return.	85	135	168	2,337,000	One of 70 H. P. One of 60 „ One of 25 „
South London.	245,306 13 10	5,000 — —	No special return.	No special return.	No special return.		80	100	1,200,000	One of 45 H. P. One of 20 „
Lambeth.	182,553 — —	6,500 — — exclusive of reserve fund & filtration.	No special return.	No special return.	No special return.	55	185	124	2,075,000	One of 110 H. P. One of 80 „ One of 36 „
Southwark.	Since 1823 £25,000 have been expended on works.	No return.	No special return.	No special return.	No special return.	38	60	156	1,107,600	One of 42 H. P. One of 20 „

The Statement of Annual Expenses contains no provision for repairs, improvements, casualties, &c. which would amount to a large sum.

The supply is supposed to be nearly doubled since 1834, so that the annual expense of purifying has proportionately increased.

TABLE shewing the quantity of Water in the River Thames flowing over Teddington Weir, together with that which flows into the river from the Colne at Isleworth, about 4¼ miles below Teddington Lock, and the distance below the Weir which would be filled up by such river water if emptied five times in every twenty-four hours.

See House of Commons Report on Water Supply, 1834.

Quantity of water in cubic feet flowing over Teddington Weir, with that flowing into the Thames at Isleworth from the Colne per minute.	Quantity of water in cubic feet flowing over Teddington Weir, and also from the River Colne at Isleworth, in 24 hours.	Distance below Teddington Lock that the above River Waters would fill up to low water mark five times in every 24 hours, and to high water mark 2½ times.
Cubic feet 56,412	Cubic feet 81,233,280	Five miles below Teddington Lock, viz. at the ninth mile post above Battersea Bridge, and above the confluence of the Brent.

On Tuesday, the 15th July, (the Tides being at neap,) the tide only flowed one hour at Richmond, the ebb lasting 11 hours; the summer is of course the period when the flood ascends the greatest distance, from there being less water from the sources of the stream; there are several months in the year during which the tide at Richmond never turns.

By order of the Court of Directors of the Grand Junction Water Works Company.

Brook Street, Grosvenor Square,
16th July, 1834.

W. M. COE, Secretary.

Mr. W. Anderson states that the above is the average of three sections taken; but if taken at the height of one foot six inches, flowing over the paddles at Teddington weir, which he understood from the men at the lock would be the flow, the water at that time would make 58,149 feet, and according to the regular summer height, it is full two feet over the paddles, it would be 75,600 cubic feet a minute. Mr. A. farther says, that the calculation of the distance that the waters would fill up, is at a mean width of 200 feet, and depth of 3 feet 6 inches, the ordinary tide rising about 6 feet at Kew, and about 1 foot at Teddington lock, the mean of which is 3 feet 6 inches.

The quantity of water flowing in the Wandle is stated by Mr. Telford in the same report to be 1,020 cubic feet a minute, or 1,468,800 cubic feet in 24 hours.

THIRD DIVISION.

INLAND DRAINAGE.

The unwholesome fogs that prevail around London, principally originate in the lamentably defective drainage of the neighbouring lands—in the numerous stagnant pools, open ditches, and undrained marshes in the east; and cold clay lands along the banks of the Thames, Colne, Lea, Wandle, &c. &c. When these spots are thoroughly drained, the fogs will cease, and London become the most healthy city in the world; it behoves all, therefore, to consider the best means of obtaining such truly important results.

It appears to me, that hitherto, sufficient distinction has not been drawn between land drainage and town drainage, the principles of which are diametrically opposed—the operation of the first being to leave every impurity behind in the soil, the drain itself running only pure water; whereas, in the last, all moderately fluid refuse should be discharged into the drain, which would continue to increase in impurity as it progresses; thus, land drainage in reality terminates where town drainage begins, the perfection of the one being, that it must be entirely free from pollution, whilst the other cannot be too gross and impure at the outlet.

The land drainage, however, can never be complete or

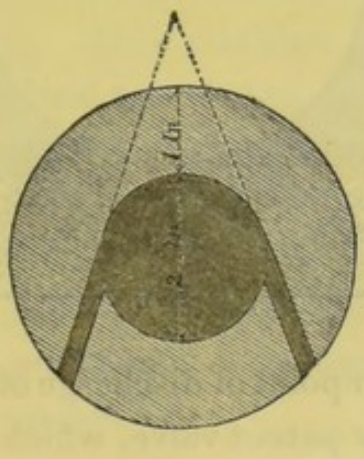
unmixed with earthy matters under the present system of slight and imperfect open ditches, for the following reasons—first, as soon as made they either fall in, or are grown up with weeds, becoming bogs from these and various other stoppages: secondly, through the stoppages, the water which should go to the tank for the cattle, or be reserved for irrigation, is entirely wasted: thirdly, this water becomes stagnant, and even when clear of house drainage, so poisonous in itself, as to infect the surrounding country, not only injuring the health of those who live near it, and of the cattle, but causing rank and mischievous vegetation: and fourthly, is the consideration of the great waste of ground under these united circumstances. To remedy these evils, and secure the pure run of rivulets, the banks should be lined with pebbles or slates, wherever so soft and earthy as to be likely to wash up; the clay and loose earth should be cleared away from all bogs, until the spring which causes them is reached, when a well properly lined with stone or slate should be made in proportion to the size of the spring: the surface should then be cleared, and a properly inclined course for the water made to run to the rivulet or reservoir, with as many slate troughs on the line as might be required and the waters being thus enabled to flow uninjured and unimpeded to the main stream, would always be fit for every purpose whether domestic or otherwise. As the open trenches in and at the sides of the fields are recommended to be superseded by under drains, the following is the mode of filter drainage which I propose to adopt. Deep parallel trenches or drains filled with sand, and having perforated drain tubes laid in the bottom, should be formed at considerable distances apart; and transversely, of these small and less deep sand drains should be made to facilitate the passage of the water to the tube

drains, by which the water would be conducted away to the unperforated pipes, which will finally discharge it in a perfectly pure state into the stream, irrigation reservoirs, and cattle troughs.

The following diagrams show the forms of my patent pipe.

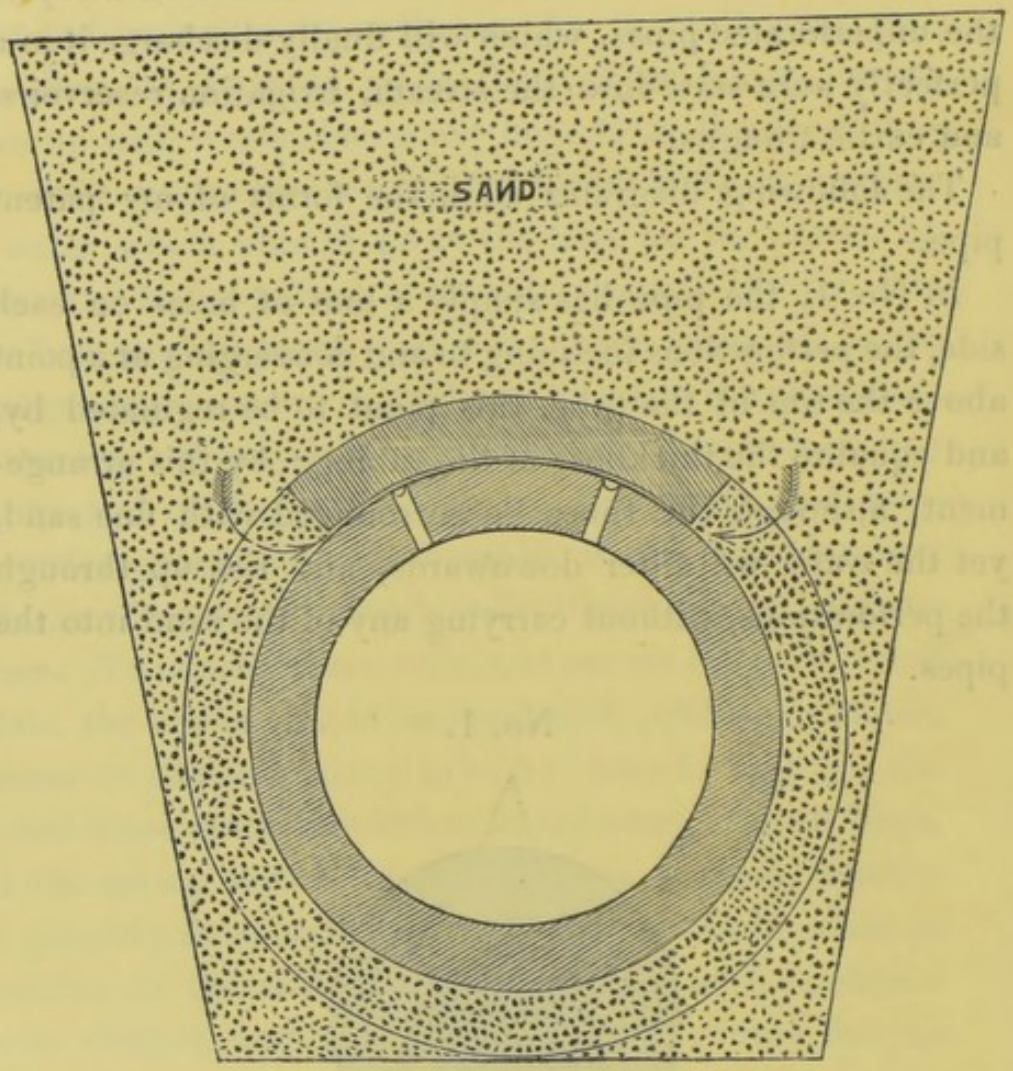
In No. 1, the pipe has simply a line of holes on each side, the perforations inclining to and converging at a point above the top of the tube, this point to be regulated by, and equal to the thickness of the tubing: by this arrangement, although the tubes be surrounded with fine sand, yet the water will filter downwards, and rise up through the perforations, without carrying any of the sand into the pipes.

No. 1.



In No. 2, the lines of holes are in the upper part of the pipe, and slant downwards, the semicircular cap which covers them allowing the water to filter upwards and enter the holes, producing the same result as No. 1, though the construction presents some superior advantages.

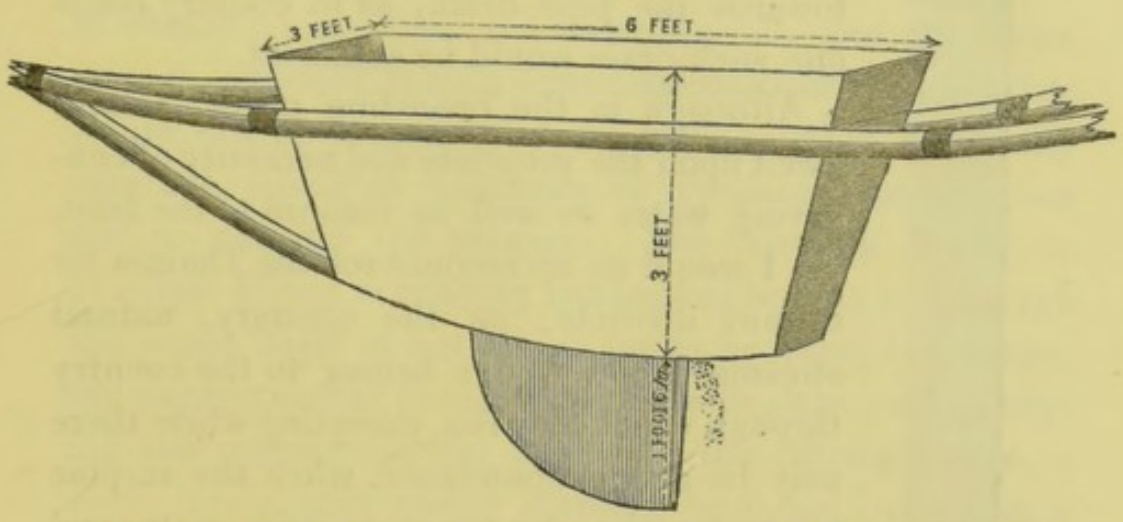
No. 2.



The extremity, or point of discharge of every pipe, should be protected by my patent valve, which will remain closed when at rest, though a slight pressure from within will press it open, whilst any pressure coming in the opposite direction, will keep it closed.

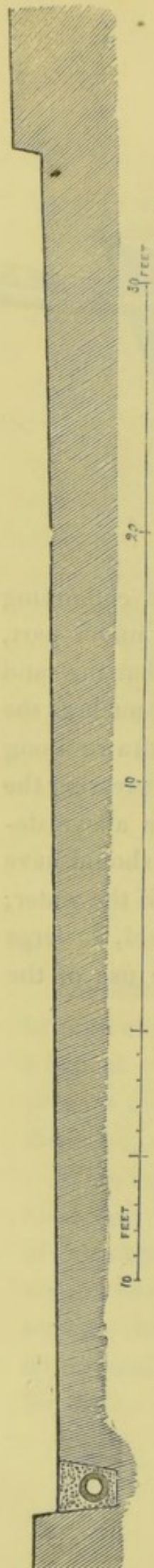
As an economical means of cutting the drains is a very important consideration, not only in this but in every system of drainage, some mechanical apparatus will be necessary for the purpose; I have therefore patented a machine for cutting drains in clay, or other soft, wet land, and depositing sand in the drain, as shown in the following diagram, No. 3.

No. 3.



It consists of an upper compartment for containing dry sand, there being a cutter fixed at the under part, immediately behind which is an opening, so that the sand may flow down, and be deposited in the cutting made as the machine advances. This machine is to be drawn along the surface of the land as a sledge, the weight pressing the cutter into the soil, and forming the trenches above described. Every ditch and country road side should have a small pipe like No. 2, laid down to carry off the water; and there should likewise be a tank in each field, so large as to contain a sufficiency of water for the use of the cattle in the dry season.

No. 4.



No. 4 shows the section of a road inclined towards the pipe drain, as in country roads one such drain would be sufficient.

Although in the preceding pages, I have dwelt upon the propriety and necessity of conveying water as well as manure to the land, yet I would on no account rob the Thames for distant districts; on the contrary, natural streams should always belong to the country through which they run, excepting where there may be a superabundance, when the surplus might be taken for the more arid spots, and no water being allowed to run to waste, there would be sufficient for every purpose. To attain this at that season of the year when water is much required to mix with the manure, and to distribute over the sandy lands; all the waste flood waters of the rainy season should be dammed back in such places as might most conveniently facilitate agricultural operations: thus the river Brent, which owes its waters solely to land floods, and in flood time is of no inconsiderable size, might be permanently maintained as a reservoir for these objects; and again, near Chertsey and Weybridge, the river Wey, which is very turbid in time of flood, might be similarly reserved for irrigating the sandy lands in the neighbourhood. There are other streams in the same vicinity, such as Bourne Brook, admirably adapted to the purpose; and the numerous ponds and backed waters already existing on many heaths, are evidence how desirable and useful a more general and uniform system would be.

All marshy or boggy lands should be excavated so as to obtain a lower level and increased fall, and the reservoirs thus formed having proper embankments and outlets would not be stagnant, as the fresh supplies constantly entering, would as constantly be discharged in irrigation and in diluting the manure. The Virginia Water in Windsor Forest is nothing but backed water; and though the water itself is not clear, yet by adopting the foregoing suggestions of lining the sides with slate, and rectifying the present marshy banks by the filter drainage, a more lovely spot would scarcely be found, affording a happy example that such backed waters would add greatly to the beauty of the country landscape. This, however, is not all, for the improved drainage would render the land more productive and the air more healthy; whilst the power and capabilities of the natural streams being preserved, and all the drainage and sewer water, which at present pollute them, diverted and rendered available for the readiest and most beneficial application to the soil, the whole would form a uniform system, so intimately connected together, that no individual part could be separated without detriment to the remainder.

When I first published the outlines of the foregoing plans more than 20 years ago, my impression was, that works of the above nature were far too extensive and important to be intrusted to private speculation; but that as the government has charge of all relating to the physical and moral condition of the people, to which ends nothing can be more essential than cleanliness and good air, the government alone should direct the supplies of water, and systems of drainage, and of ventilation, and not leave these vital subjects to the caprices of corporations or of individuals. Although general opinion at the time was against public interference, my early impression has since been

fully confirmed by actual experience; for in consequence of the government in 1836 declining any participation in such works, I exerted myself to accomplish my objects by other means, and eventually succeeded in establishing a Company for carrying out one portion of my project—the "Diversion of the Sewage from the River, and its application to agricultural purposes." Thus I would appear to have attained a desired point of success, but on the contrary, every object has been retarded by an unavoidable defect in the constitution of all companies—namely, that individuals gradually enter the direction, who, however favorable to the ends in view, are quite unacquainted with the details of the operations. Unfortunately the Metropolitan Sewage Manure Company is in this position, for the directors are totally ignorant of the means of effecting the great national work they have undertaken to conduct, and instead of being guided by the plan they profess to carry out, and of profiting by the knowledge and experience of myself and other original promoters, who, like Mr. Hawksley, are practically conversant with the subject, evince their incapacity by petty experiments with inefficient machinery to prove facts that have been long established by others. From the first I have protested both at the board and publicly against their measures, and urged the necessity of preserving the integrity of the promises made to the public. I was overruled by the majority, though my representations have all since been confirmed. An engine station has been erected remote from the sewer water the directors engaged to supply—the Commissioners of Sewers have repudiated their deep Tunnel Sewer, but accord them permission to distribute the *water of the Kensington Canal*, which, however impure, is very deficient in those fertilizing agents which abound in the large town sewers: whilst the appropriation

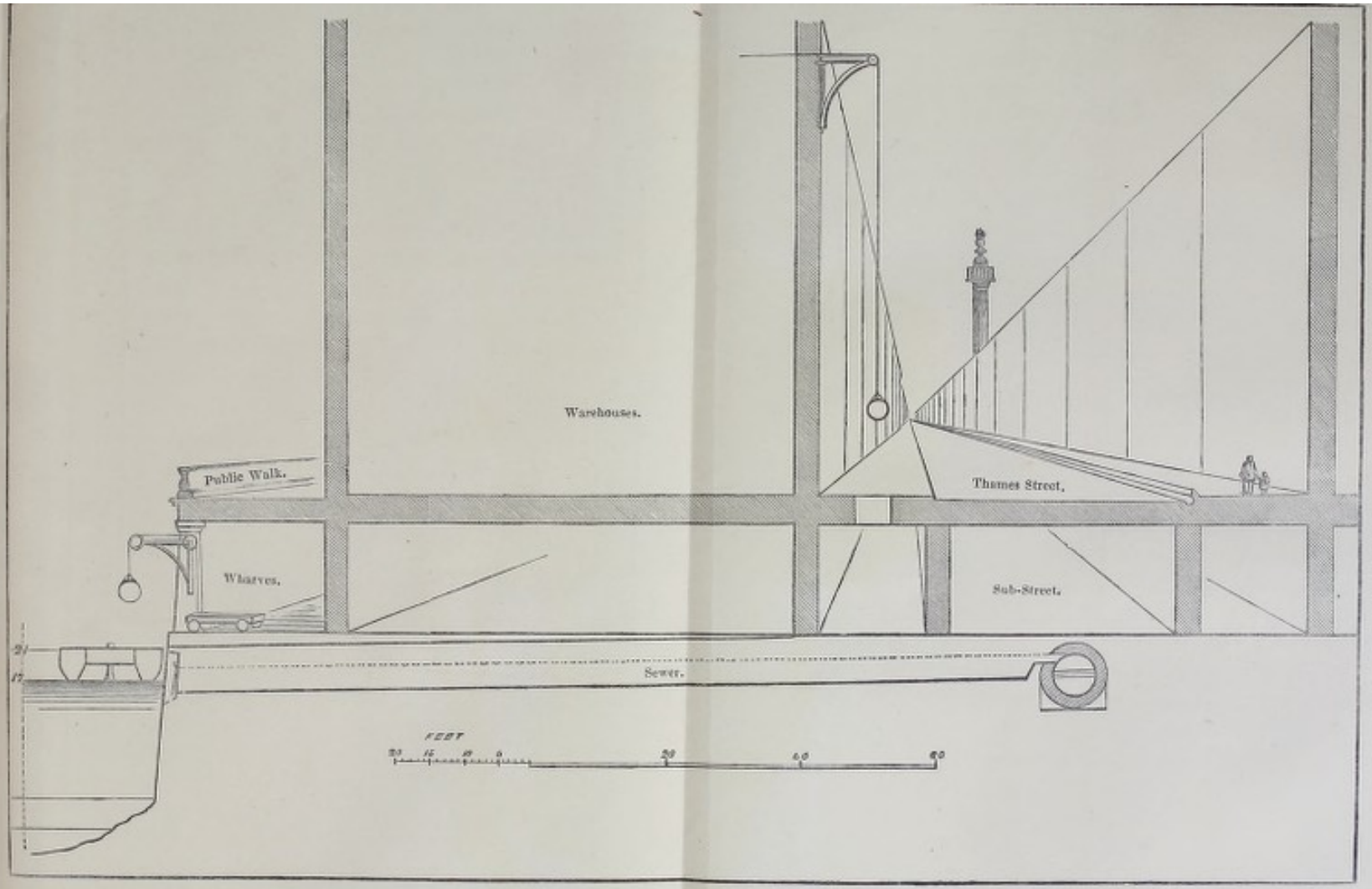
of the Ranelagh and King Scholars Pond Sewers, is indefinitely postponed, as the present engine power is entirely inadequate to the distribution of these large sewers, being indeed no more than equal to distributing the sewer water of the immediate neighbourhood round the station. Thus not only will the purification of the air and water originally promised be fallacies, but the very first experiment upon the land near London, though ostensibly a trial, can afford no just results or data for future operations—the experiment to be fairly tried must be with sewer water, and the power of the engines sufficient to force it to that distance from the town where it will be of most value, and for distributing it by hose, for which altitudinal pressure is essential, the saving of engine power being the very worst economy, as under all circumstances the working of the fluid through pipes and hose is far cheaper than any other mode that can be adopted. The delays occasioned by the vexatious proceedings of the company have been in all respects most disheartening to me, and but for the intense vitality in the object, would have fatally prevented further efforts in the cause: public attention, however, is now so alive to the necessity for improving the sanitary condition of the country, and for providing remunerative employment for the people, that I am encouraged again to hope for governmental support to my proposals, which at once afford permanent employment for the agricultural and labouring classes, augment the produce of the land, and improve the health and comfort of all. The first steps gained, namely, the embankment of rivers, improvement of the drainage of towns, and useful employment of the refuse—we may then expect more important results—that the waste lands in the hands of government may be connected with the town drainage, and placed under a comprehensive management, with a

view to instructing agriculturalists by improvements in cultivation commensurate with the science of our age; thus combining a source of useful education with the means of employing the people upon works which would eventually amply repay the outlay, add to the revenue of the country, and decrease the taxation for the support of the poor.

DESCRIPTION OF MODE OF IMPROVING THAMES STREET,

AND OF INTERCEPTING THE SEWAGE BELOW BLACKFRIARS BRIDGE.

The enormous value of the property near the river between Blackfriars Bridge and the Tower, have, hitherto, rendered futile every attempt at obtaining a good line of thoroughfare, or means of diverting the sewage. It appears to me, however, that both these advantages may be secured without interrupting the traffic or removing the present warehouses, by forming a double way in Thames Street, one line above the other—the present low roadway to remain, and the upper way, which should be on the same level as the ends of the bridges, serving for the main street, the working of the cranes, and the necessary business of the warehouses being facilitated, and great saving of horse labour effected. The accompanying engraving illustrates the proposed alteration, showing the covered wharves, with public walk above—the warehouses—the double roadway and the shops.



Transverse Section of Alteration at Thames Street, showing the covered Wharves, Warehouses, present roadway, and proposed roadway above it upon the same level with the ends of the Bridges, thus relieving the traffic by increasing the means of communication without encroaching

To accomplish these objects with security and economy, my fire proof beam of wood and iron should be employed in the following way: the level of the upper roadway being determined by the height of the ends of the bridges, the beams to support it should be laid across from one side of the street to the other, being let into and resting upon the walls of the houses, or upon cast-iron pillars where the strength of the existing foundations may be insufficient: these beams should be about 12 feet apart, and strong framed wooden planks, about 4 inches thick, and cased in sheet iron or zinc, should be fixed from beam to beam, and the whole road-way finally covered with asphalt. By having all the beams and planks prepared ready for fixing, no time would be lost, and the whole work would be effected without obstructing the general traffic below, whilst the lines of roadway being secured, the street might be widened, at any future period that such an additional improvement might be deemed attainable, and the combined economy of space and construction would render the undertaking highly profitable. One very important consequence of thus raising the traffic, is the opportunity it would afford for making the intercepting sewer, which should commence at the first sewer above Southwark Bridge, running along Thames Street, intercepting the sewage in its course towards the Tower, where the engine for pumping it off to a reserve depôt at the river Lea should be: the intercepting sewer need not be larger than the first sewer it takes up, and by directing the drainage for half a mile east of the Tower, down to the engine of the Thames Street district, one station would serve for a large section of the city, from whence the difficulty of removing the sewage has always seemed nearly insurmountable. The sewage of the most eastern district should be carried down Ratcliffe Highway to the Limehouse Canal, where the engine should

be, care being taken to preserve thorough ventilation, by allowing no air to feed the fire of the engine, but that which proceeds from the sewers. The silt well of the engine must immediately adjoin the perforated plate where the sewage enters the pump well, and as the dredging wheel would be in almost constant use, in separating those grosser parts that would not freely enter the hose, this plate must be sufficiently large to admit a plentiful supply of fluid to feed the engine, for unless the mouth of the suction pipe is completely immersed in the pump well whilst the engine is at work, air will enter the pipes and occasion great loss of power and obstruction.

PLAN FOR ALTERING AND REMODELLING WESTMINSTER BRIDGE;

The principle of construction being equally advisable for the New Bridge at Chelsea; and applicable to Battersea, Putney, and all Bridges across Rivers with low banks.

The difficulties to be met in erecting or altering a bridge at Westminster are—the lowness of the banks and of the surrounding approaches—the height required for the centre of the bridge in order to afford free passage for the craft,—and the necessity for maintaining the water way clear and unobstructed. To meet these difficulties, there appear to me but two means:—The first a Suspension bridge, which would afford not only a clear navigable way, but the greatest head way, should have the preference, but for

its defective appearance in composition at this particular spot, and the vibration inseparable from these structures, which renders them unsuitable where there is much heavy traffic. The next, and that which I think the better plan is, to remove the whole of the present superstructure, and every alternate arch and pier down to the level of the bed of the river, and to construct upon the piers left standing, a roadway formed of the fire-proof laminated beam, as beams on this construction combine the wood and iron in the position of the greatest strength and the smallest compass, affording ability to lower the roadway more than by any other method. The beams which could be made of any length by lapping over, and fixing a flat piece of iron at the junctions, with bolts to screw the whole together, should be placed from pier to pier, about five feet apart, with stay beams producing the principle of the arch;—the pressure, however, being perpendicular, and not lateral as in the common arch, this would stand alone without the support of the other arches and piers. To form the curb and parapet, a single plank of cast iron should pass right through the roadway, that for the curb being two feet above the level of the pavement, separating the foot from the carriage way without loss of room,—securing the footway from accidents, and increasing the strength of the bridge itself. To complete the roadway, cast iron planking, one inch and a half thick, should be laid transversely from beam to beam—upon this deal planking three inches thick, laid longitudinally,—and lastly, the pavement of wood and iron, coated with asphalte, mixed with whinstone or scoria from the furnace, (as a preventive to the slipping of the horses) or with a preparation of caoutchouc, the whole constituting a permanent covering to the roadway of the bridge. The entire thickness of the solid part of the superstructure of a bridge upon this principle

would be only three feet, or one foot more than that of the suspension bridge, instead of seven or eight feet, the lowest allowable in one of stone; it, likewise, possesses all the advantages of span of arch, narrowness of piers, and extended line of headway, without any of the disadvantages of the suspension bridge, and with the addition of superiority in taste, style and fitness, united with strength and durability. I propose to lower the roadway of the centre of the bridge nine feet and a half, and to raise the ends to the level of the streets, giving an incline of one in fifty, a slope no more than requisite for good drainage, instead of the present inclination of one in fourteen. By lowering the roadway so considerably, there will undeniably be a diminution in the height of the arch, but I think this will be quite counterbalanced by the width of the head-way, the arches being, nearly all, of equal height: if, however, this farther depression of the arch will still be inconsistent with actual convenience, the maintenance of the superior elevation will only cause an immaterial additional inclination in the roadway, without affecting the principle of the bridge: I am also enabled, without interfering with the existing works at the piers of the bridge, to increase the width of the roadway to sixty feet, ten feet for each footway, and forty feet for the carriage road, whilst the water and navigable way below, will obviously be nearly trebled by the alteration of the arches. As regards the external appearance of the bridge, the whole of the castings should be simple to resemble stone, with little or no decoration excepting for the cornice, and whatever ornament is introduced should be in the gothic style of art. It will, at once be seen, by examining the drawings and plans in my possession, that the strength of the bridge depends upon the principle and lightness of the beam; and that the piers, though reduced

to one half of their present number, will be more than sufficient to support the entire superstructure without increasing the strength of the foundations, thus avoiding the heaviest portion of the expense of a new bridge,—the construction of new and secure foundations. It is equally apparent that the amount of stone recovered, by removing the alternate piers and superstructure, would repay a large portion of the expense of the new erection; and I, therefore, hope that these indisputable and important advantages may lead to a favorable consideration of my proposition. As, however, the alteration I propose is so great, as the substitution of a bridge of the lightest construction and appearance, for one in all respects the reverse, it may be necessary to offer a few observations in support of a plan founded upon my conviction, that bridges should always be light in their structure. I cannot do better than avail myself of the remarks of Professor Hosking upon the subject of Bridge building generally, (Institute British Architects, May 15th.) He had on a previous occasion "urged that the piers of bridges were built of much greater substance in thickness than was necessary for either safety or general effect; that they might be greatly reduced in bulk, both for economy and for their effect upon the water way, and without diminishing their efficiency. It had been objected to him, however, at that time by some of the members—with the too common fault of architects, who would sacrifice use to effect, instead of compelling the useful to be effective—that this proposal tended to destroy the due proportion in appearance of the pier to the opening. The eye that had been accustomed to the bridges upon the Tiber at Rome, of which the piers are rarely less than one third the span of the larger of the two arches resting upon them respectively, would be offended by the absence of that proportion

of solid to void in London and Waterloo Bridges, in which the same relation is but one sixth; whilst the eye accustomed to the bridges upon the Thames at London would condemn the Bridges at Staines, and the bridges of Jena and Neuilly on the Seine, of which the piers are but one eighth, one ninth, and one tenth of the span of the arches resting upon them. Nor have we yet reached the limit to which the diminution of proportion may be reduced with safety and good effect." It needs but farther to observe, that the most beautiful and the noblest structures over the Thames at London, namely London and Waterloo Bridges are likewise the lightest, and that though this bridge of mine is even still lighter, the piers and arches bearing the same relative proportions as the bridge at Neuilly, yet as it equals them *in strength of construction*, any proportionate appearance of solidity may be given, that may be desired by those who hold that a bridge should not only *be* strong, but *look* so. I submit, however, that we do not design for the eye of ignorance,—that mere weight is no proof of strength, but often of the contrary, as in this very bridge at Westminster, where its weight is its great weakness,—and it is this weakness from overload that I propose to remove. To still farther improve the foundations of this and all the other bridges by equalizing the current, and rendering the river deeper and more navigable, I recommend placing sub-weirs about one foot above the present mean bed of the river, at regular distances from each other. As there is a fall between Westminster and London Bridges of about five feet, which these weirs would regulate and equalize. A sub-weir should be placed a few yards below Waterloo Bridge, nine inches above the mean bed, and for two hundred feet of the width of the river, and sloping from thence to each of the shores to the height of mean low water mark. At Blackfriars Bridge the weir should

be one foot, at Southwark fifteen inches, and at London Bridge two feet above the bed of the river—thus the foundations of the bridges would be preserved from the injury they at present sustain by the scour round the piers; and the whole bed of the river would always be covered at low water. A river wears its bed if it has a fall of only five inches in the mile, whereas the Thames at this point has a fall of more than five *feet!* This rapid fall particularly affects the lower side of London Bridge, where there is a hole thirty feet deep at low water, into which the foundation is being continually and rapidly swept, and if not protected, this noble structure will ultimately sink yet deeper on the the lower side, until the whole will follow, and that at no distant period, the weight of the superstructure pressing more heavily as the foundations are removed, and the heaviest body of water is besides on the upper side of the bridge.

Whilst on the subject of improving the river, I venture to add a few words relative to the present unsightly and inconvenient floating piers. No one can now dispute the advantages which floating piers possess over the old solid pier, but there can be no reason why their appearance should not equal their utility, I would therefore propose to substitute for the present cumbrous barges, simple platforms, attached to the shore by a chain or hinge, leaving no ugly space between the landing platform and the firm bank; this platform would rise and fall with the tide, and as a yet farther improvement, the outer line should be protected by an elastic band or cushion to break the sudden contact of the craft.

TABULAR VIEW OF THE BRIDGES AT LONDON, ACCORDING TO MR. BRITTON, 1828.

	Length to opposite banks.	Width.	Height from low-water to top of parapet.	Height from low-water to surface of roadway.	Height of centre arch from low water.	Span of centre arch.	Number of arches.	Span of solids, or piers in the width.	Water way.	Materials.
London	920	56	55	50	43	150	5	92	690	Granite, &c.
Southwark	700	42	53	52	43	240	3	48	660	Iron.
Blackfriars	1000	42	62	54	44	100	9	207	793	Portland Stone.
Waterloo	1326	42	54	50	42	120	9	160	1080	Cornish Granite.
Westminster	1066	42	58	50	39	76	15	246	820	Portland Stone.
Westminster as proposed to be altered by Mr. Martin.	1066	60	44 or 46	40 or 42	37 or 39	165	7	123	943	Iron, Wood, and Stone.

THE LONDON CONNECTING RAILWAY.

As it is acknowledged that the various railways leading to the Metropolis require to be connected with one another, and to communicate freely and easily with the port and different districts of London, on both banks of the river, I will endeavour to describe the line I have laid down, and a reference to the map will show that while the Railway is connected with the very heart of the city itself,—will touch every railway both existing and projected,—and border closely upon all the populous quarters,—yet that these advantages will be effected without encroaching upon private property, injuring vested interests, or interrupting present lines of traffic and communication within the Metropolis.

The following enumeration of the principal places will suffice. The Railway should commence at the River, close to the East India Docks, cross over the River Lea, and Limehouse Cut at Bromley, Mile End Road, near Stratford-le-Bow, form a junction with the Eastern Counties and Northern and Eastern Railways, and join the Blackwall Railway by a Branch down to Limehouse and the River; it should proceed past Victoria Park and Bethnal Green, Hackney, Shoreditch, and Hoxton, connecting in its course the Kingsland, Islington, Holloway and Liverpool Roads; past White Conduit Fields, Kentish Town, Hampstead Road, Camden Town, forming a junction with the Birmingham Railway; by the back of the Regent's Park, beyond Primrose Hill, the Canal, and Portland Town, to the Edgeware Road, Kilburn, across the Harrow Road and Canal near Kensal Green, joining the Great Western Railway at Kensal New Town, passing

behind the Norland Estate, and intersecting the Thames Junction Railway; crossing the Oxford Road near Shepherd's Bush, passing Brook Green and Hammersmith, continuing to North End and Fulham Common Fields, to Walham Green, the Fulham Road, Parson's Green, King's Road, to the Town Meadows, opposite Battersea; across the Thames by a Bridge serving for both Road and Railway, passing Battersea through the Fields, forming a junction with the South Western Railway near Piddoes Farm, intersecting the Kingston Road, to Nine Elms; then the Kennington Road and Vauxhall to the Great Central Depôt at the Obelisk, where all the present roads from the bridges concentre; thence to the Great Dover Road, to the Croydon, Brighton, and South Eastern Railways, and then uniting the Greenwich Railway at Bermondsey to the Coal Depôts, Dock Yards, and Trade at Deptford: thus completing the continuous line of Railway round the whole of London; communicating with the river at five distinct points, and with additional stations near each leading suburban thoroughfare; every station being, in point of fact, a Terminus, from, or at which, a journey could begin or end.

It is now superfluous for me to do more than respectfully urge the consideration of the above described Continuous and Connecting Railway, which affords all the advantages of perfect internal communication, from the facilities of approach to every station, all parts of the Court end of the town being from a mile to a mile and a half, and the business portion of the town less than half a mile, of one or the other; thus relieving the centre of the already too great press of traffic, by throwing it towards the extremities, and at the same time greatly increasing the convenience of the suburban districts; besides the vast importance of the central depôt at the Obelisk;

and the freedom from the disadvantages of broken lines of communication—of clearing away valuable buildings to form a railway terminus in the heart of the city—and the right which every railway would justly claim to advance its terminus to the seat of business—all which objections are met by such a connecting line as I have laid down.

In conclusion, I will merely urge the necessity of proceeding upon some uniform plan, and add the following extracts from the Report of the Railway Termini Commissioners, strongly recommending such a line as I have here described :—

" It is our opinion, supported by the evidence of experienced and very intelligent witnesses, that so far as an easy, unbroken, and economical communication between the northern railways and the docks, or the east of London generally, is concerned, this object can be more conveniently and surely attained by a line which should pass outside the metropolis on the north, at such a distance as to avoid interference with populous districts and thronged thoroughfares, and so connect the goods stations of the various railways from west to east with each other, terminating at some convenient point on the Thames or within the docks. Such a railway, it is true, would not bring the merchandise of the north and west so near to the warehouses in the city, as the prolongation of some of the northern lines to Faringdon Street, Aldersgate Street, Fore Street, &c.; but without anticipating the objections which we shall shortly have to make to these projects, it is sufficient to observe that the execution of any, or even of all of them, must still leave the commnnication with many of the warehousing districts of London very incomplete; and that therefore recourse must still be had to conveyance by cart through some of the most crowded thoroughfares.

" To facilitate the transfer of goods, not only between

the northern railways and the commercial parts of London, but between the northern and southern railways respectively, and thereby to make the communication between all parts of the country complete, it would be necessary that the line which we have suggested should cross the river to the west of the metropolis, to connect itself with the South-western, South-eastern, and any other lines that may approach the town on that side. The course which it should take has not come specifically under our consideration, inasmuch as it would certainly lie beyond the limits laid down in our instructions; but we have no hesitation in saying that such a line might be constructed, answering all the commercial and more important purposes of a central terminus, without being liable to the objections which arise to this latter scheme.

"We have upon this head the valuable testimony of your Majesty's Quartermaster General and of the Inspector General of Fortifications, that whilst it is of the utmost importance, with a view to the national defence, to establish an unbroken connection between the railways of the north, south, and west, a circuitous communication for this purpose round London would, for military purposes, be preferable to one which should necessitate the conveyance of your Majesty's troops or stores through a populous part of the metropolis.

"As to the interruption of important thoroughfares.—We must not dismiss this part of the subject without noticing that which forms a part of several of the projects before us—viz. the carrying a railway across the river within the metropolis. We are of opinion that there are strong reasons for discouraging such a scheme. An increase in the number of bridges already existing cannot take place without creating a new obstruction to the navigation of the river, and therefore should not be permitted except on grounds of paramount necessity. To withdraw

from ordinary traffic, and to appropriate to the purposes of a railway any of the existing bridges, would be an inconvenience and injury to the public; and no plan which has been brought before us for adapting any of the bridges to both purposes is free from serious practical objections.

"Having now given our opinions upon each railway project which has been brought before us, and the general considerations by which we have been guided in forming these opinions, it only remains for us humbly to submit to your Majesty the following recommendations:—

"1. That on the north of the Thames no railway now before parliament, or projected, be permitted to come within the limits described in our instructions.

"That if at any time hereafter it should be deemed advisable to admit railways within those limits, this should be done in conformity with some general plan, carefully laid down under the authority of your Majesty's government, and sanctioned by the wisdom of parliament; and that under no circumstances should the thoroughfares of the metropolis and the property and comfort of the inhabitants, be surrendered to separate schemes brought forward at different times, and without reference to each other.

"5. That a communication between the railways approaching London on the north and south sides of the river, and a connection between them and the docks being desirable, this should be effected by a railway encircling the metropolis, crossing the Thames at some point west of Vauxhall Bridge, and not coming within the limits of our inquiry on the north side of the river.

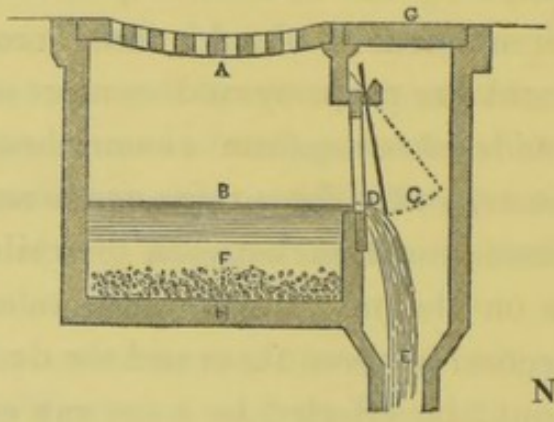
Whitehall, June 27, 1846.

"(L. S.) CANNING.
"(L. S.) DALHOUSIE.
"(L. S.) JOHN JOHNSON, Mayor.
"(L. S.) J. C. HERRIES.
"(L. S.) J. M. F. SMITH.

DESCRIPTION OF SEWER TRAPS, PIPES, AND MODES OF CONSUMING SMOKE.

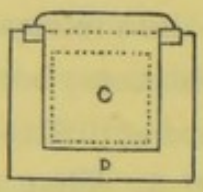
I have in all my former publications urged that due attention be paid to obtaining a proper fall for sewers, with ample room at the outlets for the escape of the flood drainage, likewise the necessity for protecting the heads of each sewer or pipe from the entrance of any thing but water and house drainage, and that all the gully holes be protected by a trap which will at one and at the same time prevent the emission of foul air, and the entrance of silt, and contribute to the end of effectually ventilating the sewers. The following diagrams represent my patent trap, which possesses all these advantages.

No. 1.

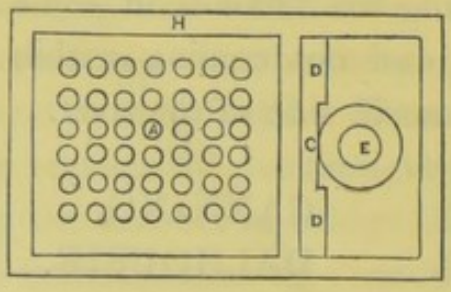


No. 1, Section.

No. 3.



No. 2.



No. 2, Ground Plan.

No. 3, Front view of Valve and Facing.

The trap consists of a square or oblong box, H, one side of which is divided into three parts, the lower division to

serve as the receptacle for the silt; and the middle division, being an opening with a slate or glass valve, C, supported by nebs, or projections, formed upon the facing, D, with a recess to allow the upper part of the valve to enter, so that the lower part of the valve may open. The valve, C, is formed with projections, which, by their rounded under-edges, rest on the nebs; it will, when at rest, remain closed, but a slight pressure from the interior of the trap will press it open, whilst any pressure coming in the opposite direction will keep it effectually closed. A is the grating through which the water and silt will run, the heavy silt depositing in the box at F, whilst the water, B, presses the valve open, and flows down through the pipe, E, into the sewer. G is the cast-iron, slate, or stone top. By placing the trap under the pavement, with the opening or grating towards the gutter, the construction will be cheaper, as the paving flag will form the top of the trap. In some cases it may be preferable to use circular, square or hexagonal perforations, in place of the ordinary grating, as straws and similar substances could not so easily enter. The advantages and peculiarities of this trap are, that it allows an equally free passage for the fluid at all periods; that it prevents the houses being flooded by any rise in the sewers, whether caused by tide or land flood; that it effectually shuts out all smell or noxious air, arising from the sewers; that it is effective in both wet and dry weather, whereas preceding traps act only in wet weather, or when filled with water; that the self-acting valve affords means of perfectly ventilating the sewers; that it is most simple in construction, and easy to get at the valve in case of any obstruction or accident; and, finally, that the sewers would be protected from the entrance of heavy extraneous substances, as the silt would fall into the trap, and be thence removed at

intervals by the scavengers, thus effecting a great saving in the cleansing of the main sewer. The trap should be made either of stone ware, slate, or brick-work with slate facing. The small sewer outlets should be faced with slate, but the large outlets should be faced with granite.

As the next important point connected with the sewers, is the best and cheapest form of pipe, it may not be out of place to insert here the following description and diagrams of my patent pipes and couplings.

The pipes may be made of cast-iron or stone ware, and of any requisite dimensions, as they are equally suitable for carrying off the collected waters of the filter land drains; for large mains and service pipes; for the conveyance of water, sewage, or gas; for the small drain leading from each house to the sewer, and to every other purpose to which pipes are applicable. The castings being all simple, and of an uniform thickness, there would be no flaws from the unequal rates of cooling; they would be lighter, and consequently easier of transport; the cylinders could be of greater length, one sixth in weight of material would be saved, and no lead would be required for joints; they would be quickly connected together or disunited; and should repairs be required, or a pipe burst at any time, the damaged part could easily be replaced without the shifting of any of the parts, or injury to the other pipe it joins; which, at present, always has to have the socket end cut off, and made good by a coupling.

The couplings are to embrace the ends of the pipe A; each extremity of the coupling should be formed with a dove-tail projection to be enclosed by a dove-tail clip, for retaining the two projections securely together. The dove-tailed projections are wider at one end than at the other; and the clip likewise is wider at one end than at the other, so that when forced on, it wedges all tightly together, and is besides more easily knocked off when it may be neces-

sary to separate the parts. In the large cast iron pipes the thickness of the coupling should be the same as the thickness of the pipe, and the width from 6 to 8 inches, but for the smaller pipes the couplings should be broader and thinner: thus, if a pipe of 2 feet in diameter requires a coupling 6 inches broad, the pipe 1 inch in diameter, would require a coupling an inch broad, and in similar proportions, the breadth of the coupling diminishing as the diameter of the pipe increases, the largest pipes needing no greater breadth than 8 inches. Thin wrought iron coupling bands might be applied to the ordinary lead pipes instead of solder, and likewise for joining stone ware pipes.

White lead or pitch combined with tar may be used as cements for the couplings, provided the parts are sufficiently true; but if the pipes are not true at the ends, it would be necessary to surround the junction with a double band of thin felt saturated with pitch, the outer band being so placed as to pass over the junction of the inner one, and preserve an equal thickness all round, so that when the couplings are put on, the pitch would be forced into the interstices, which would thus be completely and effectually closed.

A is a section of the pipe, at the joint, each extremity having a bead, formed thereon to gauge the position of the coupling.

Fig. A.

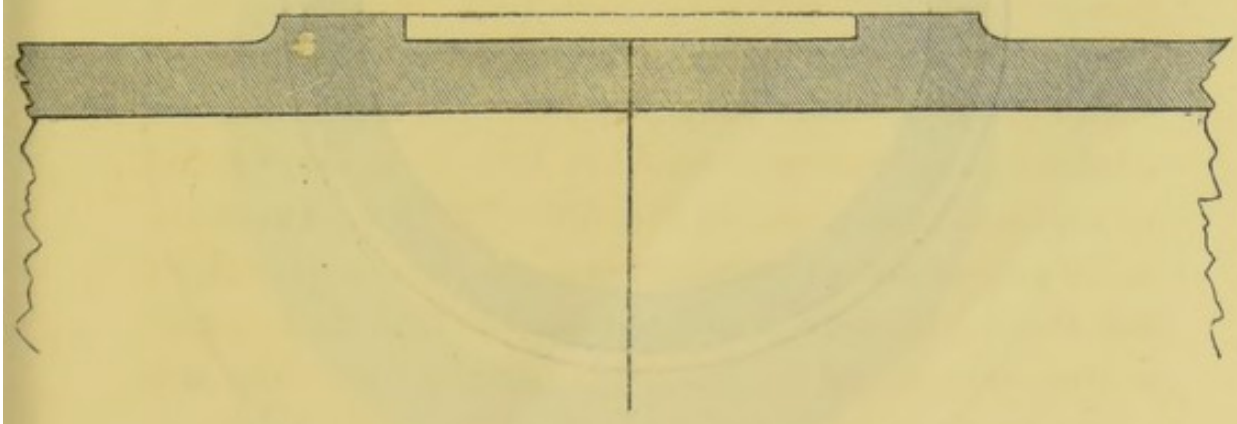


Fig. B.—Junction of pipe, with coupling and clip on.

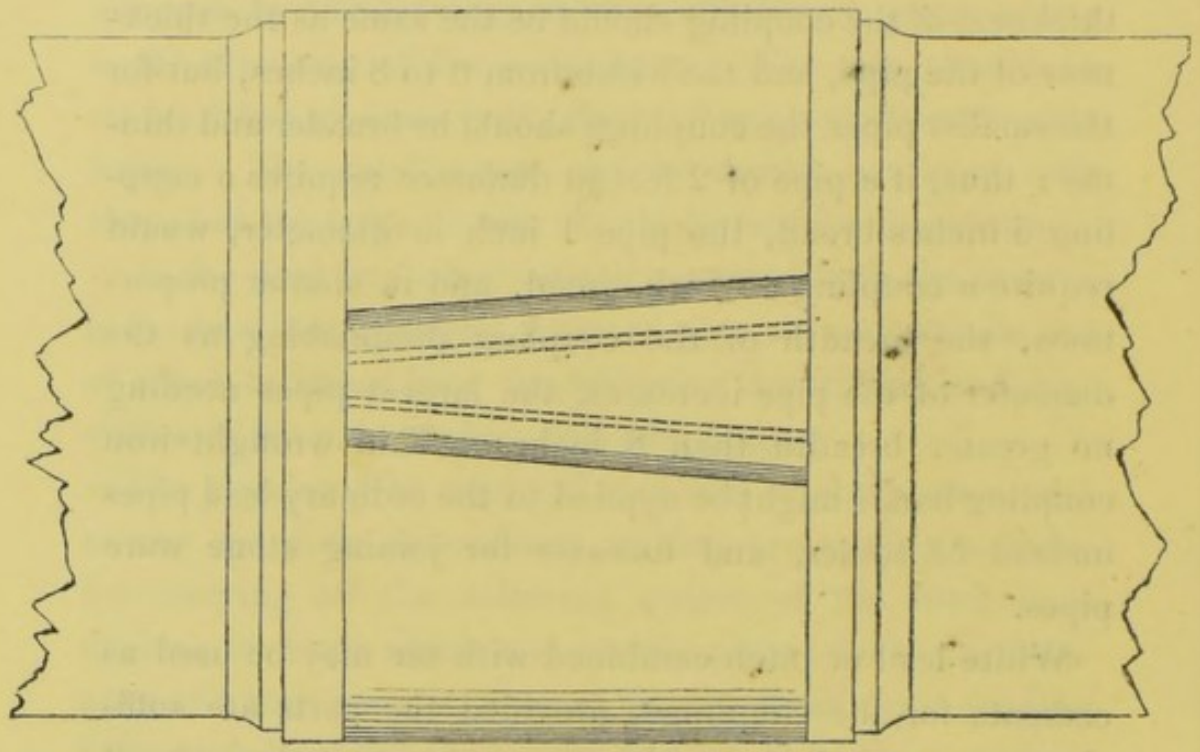


Fig C.—Section of a cast iron pipe, with wrought iron coupling, band and clip; these coupling bands may likewise be made in cast iron, see Fig D.

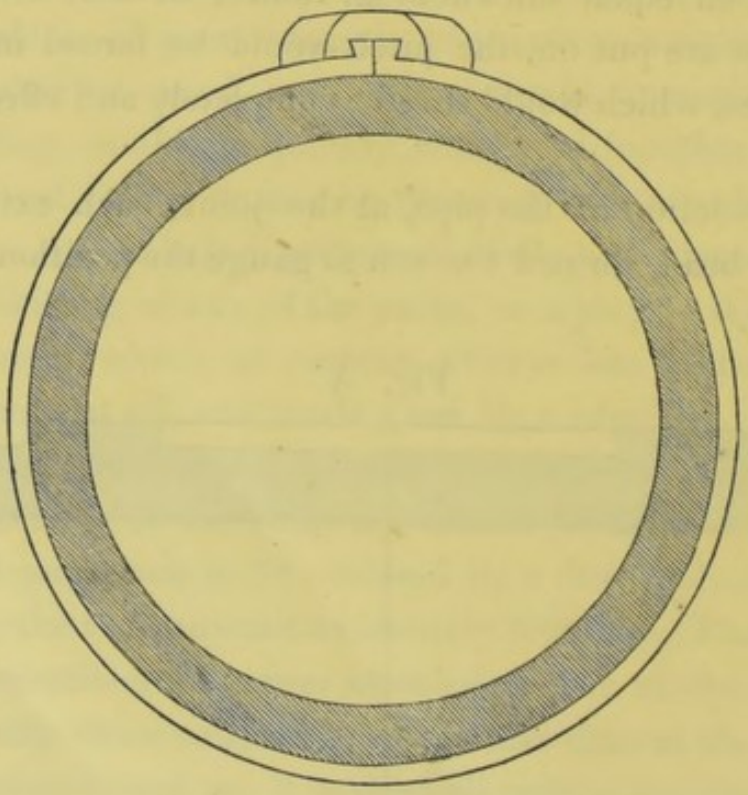


FIG. D.

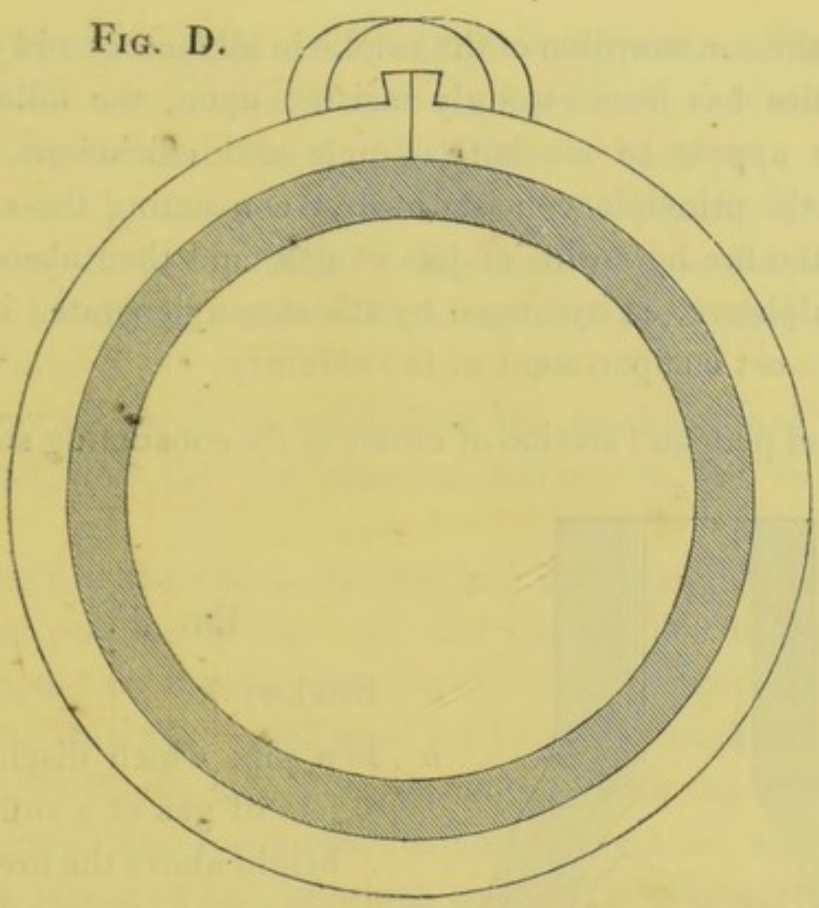
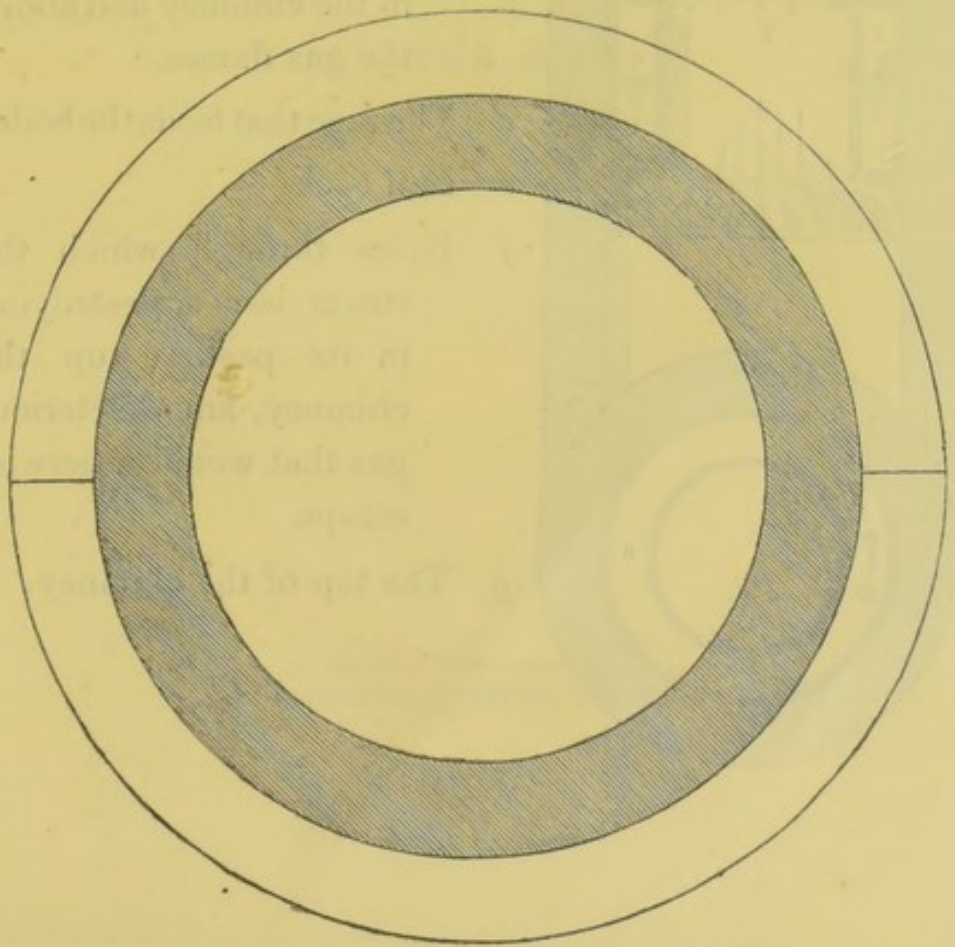


Fig. E.—Section of stone ware pipe and coupling without the clip; the coupling should be attached either by pitch or roman cement.



As the consumption of the smoke in all factory and other chimnies has been strongly insisted upon, the following modes appear to me both simple and efficacious. In fig. F the principle consists in first consuming the smoke from the fire by means of jets of gas, and then absorbing the sulphurretted hydrogen by the steam generated in the uppermost compartment of the chimney.

Ground plan and section of chimney for consuming smoke.

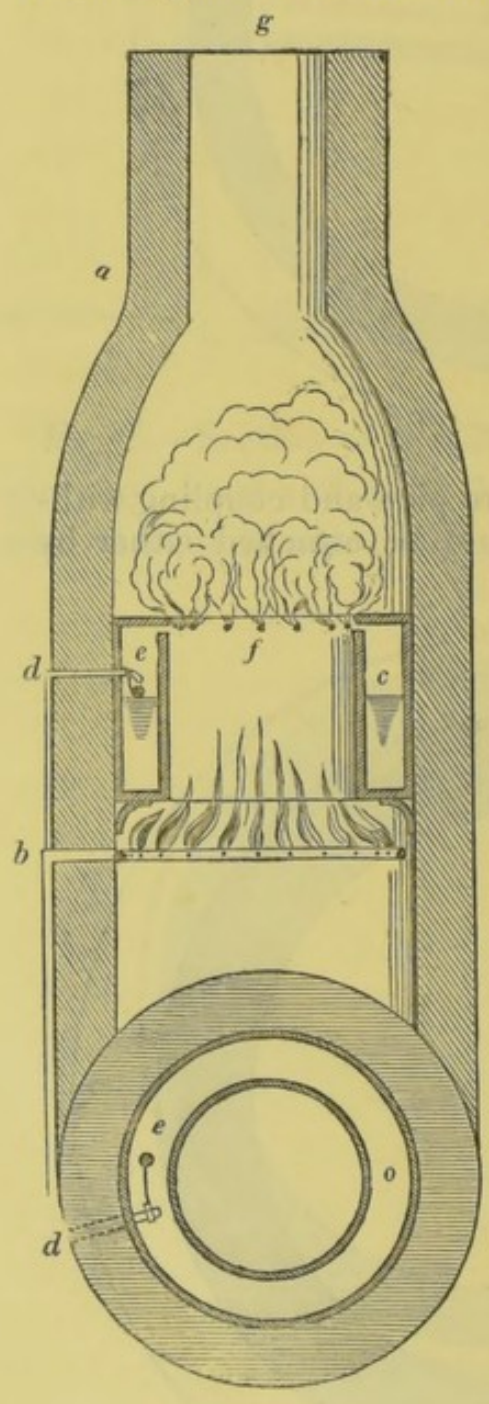


Fig. F.

a Brickwork.

b Is a pipe which discharges jets of gas at a sufficient height above the fire, thus consuming the smoke generated there.

c Is a cylindrical boiler within the chimney and above the gas flames.

d The pipe that feeds the boiler

e Ball cock.

f Holes through which the steam issues, destroying in its passage up the chimney, any deleterious gas that would otherwise escape.

g The top of the chimney.

Chimnies on this construction would not need height, as all the smoke would be consumed within. It would be desirable for each block of buildings to have one common chimney like the above, into which the smoke from the different flues should be conducted, as it would thus be economically consumed with advantage to the whole neighbourhood.

Another mode of consuming the smoke would be by constructing the fire place or furnace in the following way.

The fire place to be divided into two unequal parts, the larger portion for the coal, and the smaller for gas; the air would enter at the fire, pass through the gas, and so on up the chimney, which need not be of an unsightly height: thus the smoke in coming in contact with the gas would be ignited and consumed, increasing the heat, and effecting a saving of fuel, of which so much is now wasted, and sent forth to poison the air in every direction.

THE END.

J. PLUMMER, PRINTER, PUDDING LANE.