Hydrosthetics of the cistern, drain, and sewer

THE CISTERN.

When Thomas Tredgold defined the scope of engineering he laid especial stress upon its hydraulic characteristics. " Every kingdom, every province, every town," he observed, " has its wants, which call for more or less acquaintance with this science " In dealing therefore with the fluids of the house, my subject falls as distinctly as any part of an architect's work can do within the engineering class. The scale may be that of a miniature, but in point of number the contrivances of a modern dwelling would have made an ancient city famous. A house conforms to local generalities, but just as each inhabitant is qualified for the various offices of life by a constitution and habits of his own, so will the fitness, the wholesomeness and comfort of a habitation agree with the propriety and efficiency of its individual organization. The luxurious man soon needs a physician; the luxurious abode a sanatist to control its multifarious appliances.

It is needless to insist that an abundance of wholesome water is essential to every populous place. Cities depend on its presence, and their decay has followed the drying up of streams. The degree in which communities are affected might occupy a long and interesting inquiry, but the metropolis has no exemption from the general rule. Pestilence struck her heavily in times gone by—has cast its shadow in recent days, and is ever ready to descend. There is no second palladium but vigilance, nor weapons so efficacious as clean cisterns, unstopped drains, and ventilated sewers.

In periods now distant London had little occasion for hydraulic science. There were, in addition to the Thames, numerous springs and rivulets that long served the inhabitants, yet so early as the thirteenth century these had, through building encroachments, heightening of grounds, and other causes, been so far impaired that the citizens looked abroad for "sweet waters." In the year 1237 Gilbert Sanford, at the request of Henry III. gave permission for the conveyance of water from the town of Tyburn, by pipes of lead, into the city. The pipes were six inches in diameter, and terminated at a point near Bow Church, Cheapside, where a suitable erection of stone—the first of the London conduits—was raised. The primitive condition, disturbed by this innovation, knew only the watercourse and the fountain, the pitcher, the wheel, and the "hewed out" cistern. Sanford's grant was made for "the profit of the city and good of the whole realm, thither repairing, to wit, for the poor to drink and the rich to dress their meat." This conduit must, therefore, have been a municipal possession, and it was followed by other examples.

Stow says, "the first cistern of lead, castellated with stone, in the city of London, was called the great conduit in West Cheap, which was begun to be builded in the year 1285, Henry Wales being then Maior," and such an erection must have resembled the castellum of an ancient aqueduct.

Sanford's pipes were probably both extended beyond their original termination, and tapped in their course, so as to feed the "Tonne" at Cornhill, two conduits in Cheapside, and one in Fleet Street or Shoe Lane; but the fall from Tyburn being about forty feet, or ten feet per mile, the current would be rapid, and thus make up for the moderate bore.

The erection in Fleet Street appears to have been a handsome work of stone, surmounted by a representation of Saint Christopher, and adorned with automatic figures, "having sweet-sounding bells before them, whereupon, by an engine placed within the tower, they divers hours of the day, with hammers, chimed such an hymn as was appointed."

A conduit was erected at Leadenhall in 1655, and that may not have been the latest, though their importance was then less than in earlier days, when the Lord Mayor, accompanied by the Aldermen and a large assemblage of principal citizens, "rid to the conduit heads for to see them after the old custom." This magisterial care is not unparalleled. The renowned cisterns of Constantinople are of such high public concern, as to engage the Sultan's personal interest and receive his periodical visitation.

To the reader acquainted with those grand depositories, and the vast but simple methods of ancient supply, it demands an effort to announce the agency by which, in modern times, their claims to admiration have been equalled, and the wants of civilization met, where they would not have availed. London, it has to be confessed, owes no mean share of its importance to the pump.

The word came to us from the French, who apply the term *pompe* to things of a superior and extraordinary kind. When indeed the singular property of the machine was first noticed, it must have been utterly surprising—a phenomenon we should naturally call a *wonder!* Several localities attest the high appreciation it enjoyed. There was a Pump Court at Spring Gardens; and a quadrangle in the Temple, erected about 1680, is so called. Whatever may have been known to the ancients in general, and Ctesibius in particular, the principle was first mastered in modern times by Torricelli, and not so very long before

Pump Court was built. Seymour, in his *Survey*, recites that in 1576 " a water pump was raised near unto Lime Street corner," at the joint charge of the parish and the city, and it appears certain that the machine had a long empirical employment before the atmospheric secret of its operation had been solved. But from that event began the scientific acquaintance with a mechanical power, of essential necessity to the Metropolis and many other towns.

By the sixteenth century the population had greatly increased, streams were polluted and fatal epidemics had appeared. The hand-pump and conduit-pipe were inadequate, and the necessity for further sources imperative. Water became, thenceforward, as M'Culloch terms it, " an important commercial article." An opening for enterprise was presented, and mechanism filled the void. It was applied at London Bridge by Peter Morris, who invented the plan, or brought it from Holland, in 1582. The motive power was the tide, and the nature of the contrivance a water mill. To show the effect of these works, when the Lord Mayor and Aldermen were inspecting their progress, a jet was thrown over the church of St. Magnus, and the exhibition was repeated at the formal opening by the Queen. With this undertaking the purveyance of water took the proprietary form, the public is, at the end of three centuries, so much disposed to change.

The corporation granted Morris a lease of the premises for 500 years, and it continued in his family till 1701. It was then sold to Soams who created a joint stock company, by which the works were carried on until the reconstruction of the bridge caused their removal in 1822.

It is not impossible that this tidal force may have to be exercised at a lower portion of the river for scouring the bed, and preventing fetid deposits ; but that is a digression. The work of Morris was soon copied, and "one other new forcier," with "a large house of great height, called an engine," was established by Bevis Bulmar, in 1594. A third was constructed by Hayes, but it did not survive the Fire of 1666.

The "Water-house" is described as a lofty wooden building "which by wheels, iron chains, &c. drinketh, or rather forceth up, water through leaden pipes to the top, where there is a cistern, and from thence descendeth in other leaden pipes to the bottom, and thence received by other pipes is conveyed under the pavements of the streets, and so serveth many families in this part of the City with water, who have branches or small pipes laid from the main ones into heir houses, to their great conveniency, and no small profit of the City." In this description, however, the details and contrivances accrued in a century's use are probably included.

The construction of such works does not prove that the atmospheric principle of the suction-pump had been discovered, nor does the contemporary state of the fire engine afford conclusive evidence. The earliest example of such an instrument with a suction pipe is that of Van der Heide, in 1677. All that can be inferred is that the term *engine* lost its general application when fashion gave preference to *pump*.

Notwithstanding the relief afforded by the works at London Bridge, a presentiment of dearth arose, such as now prompts our engineers to survey distant water-sheds. Like the first prince, too, of the present day, Elizabeth wisely encouraged further measures, and with ultimate effect. To royal encouragement we doubtless owe the one triumph of gravitation, that emulates in principle and in usefulness the aqueducts of Rome. But crownly influence has now a wider realm than then. In one place it kindles mercantile ardour, in another raises a new form of monumental devotion. While Manchester is thirsting for Thirlmere, Calcutta drinks a health not known before; and Nawab Abdul Ghani presents a waterworks to Dacca!

The New River Company was established in 1619, some time after the completion of the undertaking, but before Sir Hugh Myddelton was knighted. His name, however, will be remembered while the springs of Chadwell roll to Pentonville, as they have already done for above two hundred and sixty years.

In 1723 the Chelsea Company was founded for raising a second volume from the Thames by means of a STEAM-PUMP, and upon this footing things continued till the present century.

The East London Works on the river Lea, at Old Ford, were opened in 1809, and in the next year followed the Grand Junction, and West Middlesex Companies, both taking from the Thames. The sudden activity is clearly traceable to steam. Savery and Newcomen preceded the Chelsea Company, but the improvements of Watt, followed by Wolf's crowning application of high pressure and the expansion principle, caused force and resistance to be so wonderfully and exactly reciprocated as to reduce the process of pumping to the utmost limit of economy.

The Hampstead ponds having been taken over by the New River Company, the town on the north of the Thames has been divided and apportioned between the above named bodies, with convenience and advantage to purveyors and consumers. On the right or south bank are the Lambeth and the Southwark Works, both drawing from the Thames. The Kent is on the Ravensbourne, and supplements its source by deep wells; indeed, uses them exclusively.

In some cases the fluid used to be passed to the consumer just as it entered the pipes at the intake, but most companies had provision for subsidence if no efficient means for purification. Present requisitions, however, go further, and to mechanical refinement add chemical softening.

A change of management is imminent, and every detail of expenditure is known. The capital of the eight enumerated companies, for example, is from eleven to twelve millions sterling, the gross revenue a million and a half, yielding three quarters of a million for dividend, and an average interest of six and a half per cent. Should the companies, therefore, be taken under public control, the terms and arrangements would be obvious and simple. But let the future ownership be as it may, it must be satisfactory to know that the character of the Metropolitan supply will be nowhere excelled. This is a valuable point where the daily quantity approaches 120,000,000 of gallons, four fifths of which is delivered to 520,000 houses, or at a rate of 180 gallons to each house. Had such a service existed at an earlier time there might not have been a great plague, nor a great fire. Yet deeply as we are now indebted to steam and cast iron in the business of water conveyance, they were as little thought of when those scourges took place as in the days of Claudius or Augustus. Such are the results of science; such the labours unobtrusive agents have performed. But when we reflect on the slight analogy between London, and towns served on modern plans, from sources so elevated as to descend upon the housetops (as was indeed the case in old low-seated Rome), while here every gallon has to be raised from base to summit;—when we consider this great labour, and learn that vast as the supply abstractedly may be, it is comparatively moderate, when measured by the great demand;—it will be less surprising to find the consumption of water watched with a jealousy unknown elsewhere, and that numerous inventions, called "waste preventers," are industriously forced into notice. Manufacturers would have them regarded as essential accompaniments, or preludes, to a system of constant supply. But whatever may be the significance of this term at Glasgow, or elsewhere, it does not in London mean a perpetuation of the rush we have been accustomed to for a few minutes every day. Taking the average daily supply at 180 gallons, it represents a pint per minute throughout the day and night, but no one would wait a minute for a pint of water, and the demand is for the most part limited to a few hours in the forenoon. What preparations, then, are reasonable, with a constant supply in view?

It may be answered that the district or street pipes, if always at work, might be much reduced, and the largest pipe in a house need not be more than half an inch diameter. A rising main of that size from the street pipe to a cistern at the top, equal to the day's use, would be among the chief provisions. Preparation of this nature would render the consumer independent of the company; and the latter could choose its own rate of delivery, but so that the proper quantity should not fail.

The short approximate allowance for cisterns is six gallons to the cubic foot; and a receptacle 4.0 × 3.0 × 2.6 would equal the capacity in question. A cistern, however, should not merely hold the prescribed quantity; but preserve the purity of the contents. Yet this reasonable duty

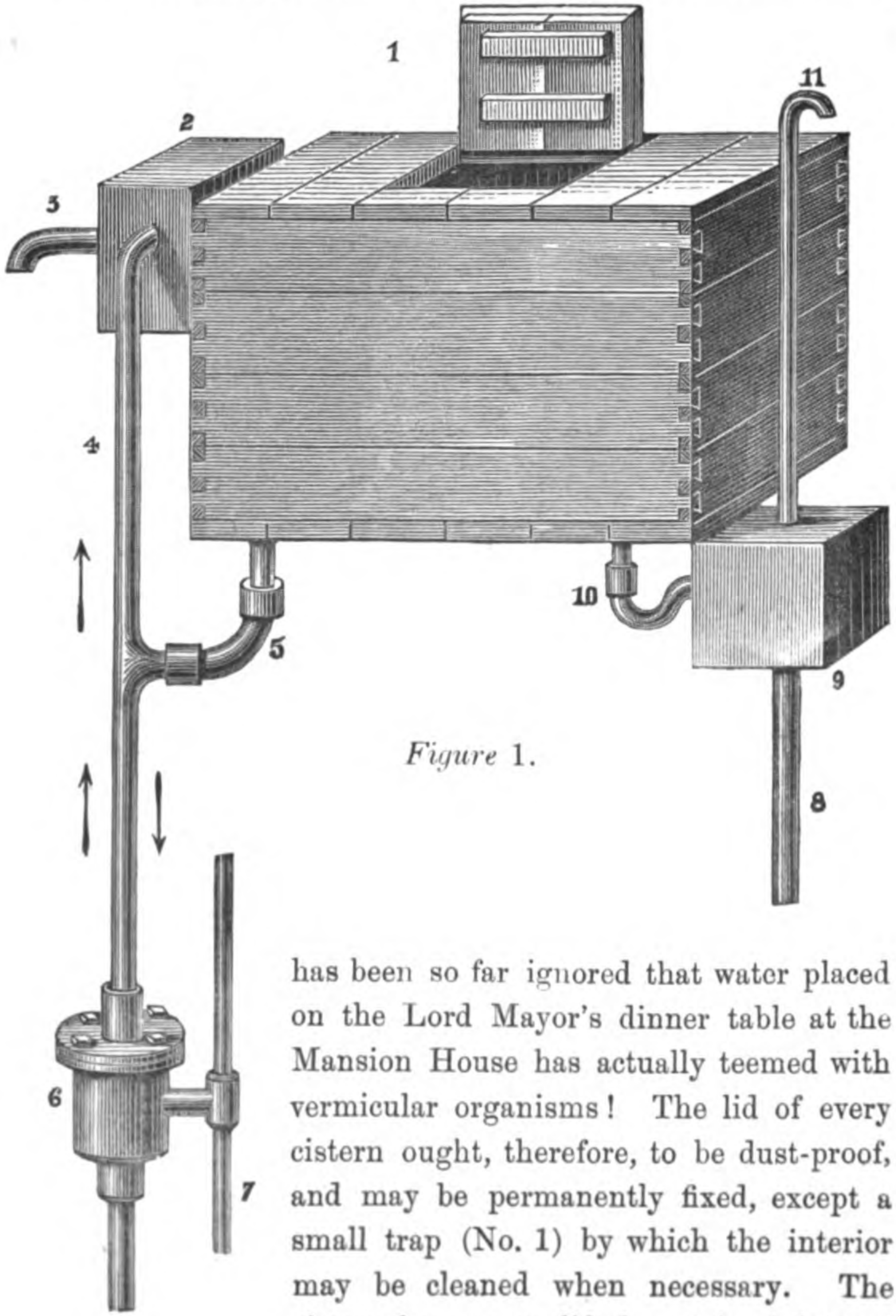

Figure 1.

has been so far ignored that water placed on the Lord Mayor's dinner table at the Mansion House has actually teemed with vermicular organisms! The lid of every cistern ought, therefore, to be dust-proof, and may be permanently fixed, except a small trap (No. 1) by which the interior may be cleaned when necessary. The cistern here exemplified contains inlet and outlet pipes, but nothing moveable, and will rarely need attention. The regulating valve is in a small separate box or cistern (No. 2) in which the rising-main (No. 4) terminates. The regulating valve, within the box, shuts off the supply as soon as the large cistern is full; but the overflow pipe (No. 3) carries off any accidental waste to a visible outlet.

The rising-main is made to serve the purpose of a down-pipe for drawing the water out of the cistern by the intervention of a valve in the connecting pipe (No. 5) which allows the fluid to pass downwards only.

Companies have objected to taps on rising-mains, but a one-way valve and stop-cock at the foot of the pipe would prevent the possible return of impure or any water to the street-pipes; and that evil could never happen, moreover, when the current and pressure were exerted towards the house.

Filtration is so effectually performed by the metropolitan water companies that further attention to that subject may appear superfluous; but otherwise, by a simple appliance of my invention (No. 6) filtered water may be had on every story of a house. A hollow cylinder of porous material is fitted into a metal case, and this is so connected with the rising-main that part of its length is really of a porous nature, allowing the water to percolate laterally through. It may be drawn off by a tap in the outer case, or a small pipe (No. 7) be carried to supply any requisite situation. This is a service it will readily perform, as the pressure is the same as in the chief pipe, and amply meet the calls of diet, kitchen, and toilet.

Lead, as a material for keeping or conveying water, was deprecated by Hyppocrates and Vitruvius, and many moderns entertain their views. No other material, however, has equal recommendations; and an exhaustive inquiry, instituted by the Town Council of Glasgow, showed the absence of all deleterious effect upon pure soft water. Millions of healthy Londoners drink only such as has passed through leaden channels. Old fittings are even preferable to new; for an impervious oxide forms by exposure and renders the metal inert. Ordinarily, therefore, no precaution is required, and, where exceptional circumstances prevail, the first gallon of the day would be a sure and ample sacrifice.

Other materials, such as zinc, slate, and iron, are occasionally used, but lead best meets the conditions of substantial construction and ready application.

It is not essential that the whole storage should be in a single cistern at the top. A small one only would be usually requisite there, and in most houses the existing fittings could be adapted to this system at a very inconsiderable cost.

THE DRAIN.

In this division the subordinate uses of water and the emission of all kinds of fluid waste are included; and though such purposes constitute a large share of the cistern's duty, they are effected without exposing the general store to injury or contamination, *e.g.*,

A small watertight box or boot (No. 9) is fixed against the cistern and fed by a bent pipe (No. 10) that renders the passage of foul air impossible. A waste preventer or other prescribed fitting may be enclosed in the box; or it may be limited to a fixed capacity, should any such necessity exist. There must be an air-pipe (No. 11) rising higher than the chief cistern. From the box descends the latrine pipe (No. 8), which, being used for flushing, should be of $1\frac{1}{4}$-in. bore; and either from that, or from the box itself, branch pipes may be laid in all requisite directions.

In the Palace of the Cæsars (according to Fosbrooke) was a W.C., but probably a lobby or vestibule, adorned with marble arabesques and mosaics, with a cistern at the back, from which water was distributed to the different seats. Such a *cabinet* should always have impervious surfaces, sash window, and provision for the constant but imperceptible change of air. The introduction of the apparatus in this country is attributed to Sir John Harrington in the reign of Elizabeth.

Of modern sorts we are indebted for the most esteemed —the valve closet—to Joseph Bramah, the eminent locksmith. The orifice at the bottom of the bason is small and fitted with a disc of brass, opened by a lever when the contents are to pass, but closed so exactly afterwards as to retain a fresh charge of water. An overflow pipe is provided near the top, in case of accident. The practical defect experienced is that small solid objects get between the valve and the bason and prevent the perfect closing on which efficiency depends.

The next class are termed "*pan closets*," because, in place of the brass valve, a tinned copper pan is applied, and moved by the lever. It fits loosely round the orifice of the bason, and contains sufficient water to make a perfectly air-tight joint. The action of this pan necessitates a much larger chamber or container than that of the valve, but the overflow pipe is dispensed with as the pan allows any surplus to escape. This freedom and inexactitude are more convenient in common use, and the pan is cheaper than the valve.

It is not sufficiently considered perhaps that the water retained in a closet is not primarily as an air trap, but rather for cleanliness of operation, and neatness of appearance. When those recommendations are disregarded the valve and pan are dispensed with, and an immoveable bason or hopper fixed upon the real air trap. This, in the two former kinds of apparatus, is made of lead, but in the latter of iron or earthenware. The most reliable appliance of the kind is of bent pipe, with a screw cap of brass for access to the inside, should any impediment happen to lodge there.

The one object common to all closets is the passage of excreta in an inoffensive way by means of the soil pipe to the drains, and without allowing foul air from the sewers to escape into the house.

Sewer gas as a body is not very strictly defined, and varies in some degree with localities and meteorological conditions. Atmospheric air impregnated with one or two per cent. of sulphuretted hydrogen may be an approximation. It is disseminated by the property of diffusion according to which gases seek to occupy all space, even in the presence of other gases though preferably in a vacuum, and the warmth of houses draws it out of pipes and sewers with corresponding damage to the atmosphere. For this reason it is necessary that the soil pipe itself should be ventilated, and made to terminate with an open top on the exterior of the building

By this simple expedient the gas rises freely, to be wafted and diffused in the aerial ocean, where all the floating elements are absorbed and rectified, When the pipe rises within the house it should be carried above any neighbouring window, but may otherwise end in a gutter, and serve to carry off the rain, being thus attended with a saving in cost. This pipe is usually about five inches diameter, and as the lengths are strongly soldered together it constitutes a jointless continuation of the drain from the base of a dwelling to the top. On account of this connexion with the drain, and by extension with the sewer, it requires to be cautiously dealt with, but simple and effectual methods are now devised, though not universally understood. Still less generally is the best form of treatment adopted.

That treatment may be said to consist in supplementing the open top by a trap at every side inlet, so that no air shall pass into the house. Then, although the soil pipe be made the ventilator of the public sewer, as at Croydon, no harm can happen, for in the latter event every house being made to take its share, the evil becomes infinitesimal.

When no part of the sewer ventilation is performed by private means, and the soil pipe can be placed on the outside, the side traps may be dispensed with and hopper heads substituted, but such opportunities are exceptional. Could drains be wholly excluded from the interior of habitations, a valuable object would be gained, but here I must assume their necessity and prescribe their formation.

It is remarkable that in the Metropolitan Building Act, 1855, the previous regulations concerning house drains are omitted, and the District Surveyor's jurisdiction over them discontinued. Authority, indeed, is much divided in London underground. The main drains are in the immediate charge of the Metropolitan Board. The district sewers are in the hands of the local authority, whose surveyor watches junctions with private drains, but within the dwelling there is no official supervisor of drains at all; coupling this with the fact that the great majority of London buildings are not under special architectural care, defective drains can hardly create surprise. Some assurance of efficiency is desirable without depriving owners of reasonable latitude in the choice of means or precluding current improvements.

In a Blue Book of the Local Government Board, 1866, Mr. Rawlinson, C.B. notes that at Alnwick, in Northumberland, with a population of 7000, a water supply of 150,000 gallons per day, and 1400 water closets, the house drains are 4-inch pipes. The sewers increase from 6 to 18 inches bore. The latter forms the outlet and has a course of 2000 yards and a fall of $\frac{1}{400}$th. They are all of earthenware pipe, and have acted perfectly during ten years.

It may be safe to regard some of these dimensions as minima, but the whole account makes a useful practical guide. The soil pipe should not be less than four inches nor the drain less than six inches bore.

In point of construction the drain should be as substantial and durable as any part of the house, since when once formed it is the most inaccessible and difficult to repair. The descent should be at least an inch in twenty feet, and the bed accurately prepared with concrete three inches thick and one foot wide. Upon that bed the six inch stoneware drain pipes should be carefully laid, and the socket joints made smooth and watertight, for which purpose there are some patented contrivances. Further concrete should then be added so as to make an enclosingmass one foot wide and one foot deep. (Figure 2.)

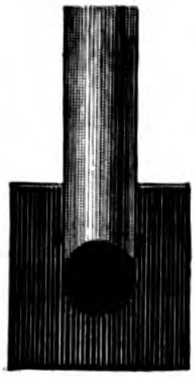

Figure 2.

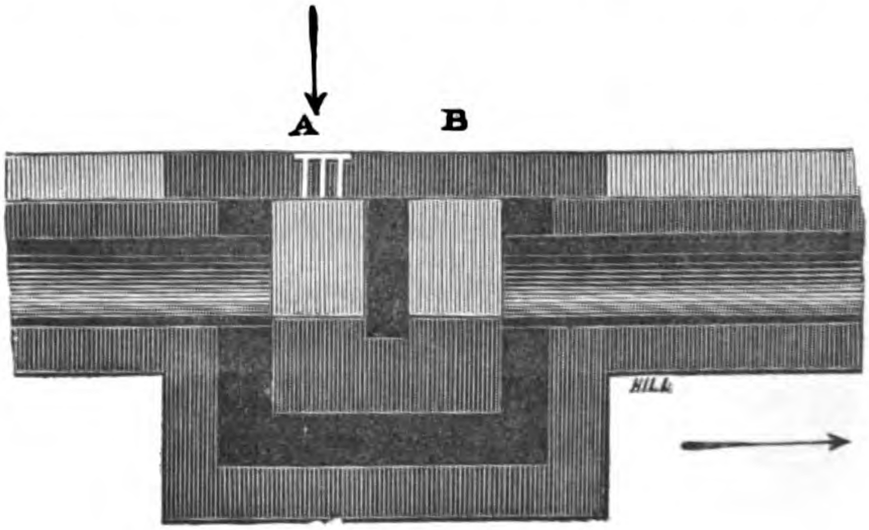

Figure 3.

It is desirable that the soil pipe should enter the drain by means of a quadrant shoe, so directed as to aid the current. Assuming the drain to traverse the basement from back to front, and to pass under the usual area next the street, the opportunity may be taken to form a small cesspool or dip trap (Figure 3), which is calculated to serve the following uses. The chamber may be of brick or stone, cased in concrete, and divided by a stone tongue. The sullage passes through this cesspool to the sewer, but the ascent of gas from the latter is checked by the tongue. A grating in the pavement at A allows the surface water from the area to enter the cesspool and pass away. It also admits the air to enter, and this being drawn upwards by the higher temperature of the soil pipe, a perpetual circulation takes place. In this way the air within the pipe is kept so similar to the general atmosphere that should it pass the traps and enter the house it would be innocuous.

The claims of simplicity have been shown by recent experiments on cowls, conducted at the Royal Observatory, Kew, by Captain Galton, C.B., F.R.S., and other experts, for the Sanitary Institute of Great Britain. The result of the inquiry being that, *cæteris paribus*, none of them cause a velocity of current exceeding that in an open pipe. Yet in the legion of testimonials constantly brought under notice I have seen no less an efficacy asserted than that of drawing people to church!

THE SEWER.

The distinction between drain and sewer is chiefly a mark of ownership, one private, the other public, and altogether irrespective of size, as proved by the 6-in. sewers at Alnwick above referred to. Londoners have ever been proud of their sewers. By comparison with other places they had cause, but the matter will not bear a retrospect. Down to 1847 there were eight separate Commissions of Sewers and large sums were expended by their means. Their action was independent and the channels they governed had no accordance. Great sewers of one district poured into smaller in the next. Sizes, shapes and levels were confused. The egg form was in favour, but favour with a difference. One commission would have the big end at the top, another at the bottom; but they had to be joined, it was cared little how, where the districts met. They all discharged into the Thames, and that chiefly at the time of low water, or for little more than six hours out of the twenty-four. As the rising tides closed the outlets the sewers became mere receptacles, and during the other eighteen hours the stagnant fluid deposited the heavier elements to the increasing obstruction of the the channel. Then from time to time the traffic would be stopped, the roads opened, and the pestilential sediment raised and carted off.

Prior to 1815 the sewers were appropriated to surface drainage only, and foul matter was provided for by cesspools. In 1847 the previous bodies were all merged in "The Metropolitan Commission of Sewers." Cesspools for which, even under houses, the Building Act of 1844 made legislative provision, were abolished, and all drainage made into the sewers. In the course of a few years 30,000 cesspools had been closed.

The natural result was that the river became foul and offensive, yet the water continued to be supplied as a potable article to the inhabitants. Cholera visited the metropolis in 1831-2, 1848-9, and 1853-4, taking off in the last case 20,000 people.

It was reserved for the Metropolitan Board of Works, constituted in 1855, to inaugurate and effect a system of drainage suitable to the wants and conditions of the period. These great ends are effected by the construction of main channels in a direction at right angles to the old sewers, and at a lower level, so as to intercept their contents and convey them to an outfall fourteen miles below London Bridge. This has been done, as far as practicable, by simple gravitation; but it is impossible for sewage to travel on that principle a distance of ten or twelve miles from places even lower than the river at starting, and yet be discharged at the level of high water, without resort to mechanical means. For the purpose of this system the metropolitan area is divided into two great parts with the Thames for an axis. All the sewage of the south division has to be lifted; and for this purpose there are pumping stations, of 500 horse-power each, at Deptford Creek and Crossness Outfall. Part only of the northern sewage has to be raised, since gravitation serves for a zone of which Piccadilly forms the lower boundary. The low level sewer has a lift of 240 horse-power at Pimlico, and then, proceeding for some distance parallel to the river, and under the Victoria Embankment, meets the high level sewer at Abbey Mills, where the principal lift is situated, and from whence the great outfall sewer, raised in the manner of an aqueduct, extends across Plaistow Marsh and East Ham Level to a point of the river near Barking Creek. At Abbey Mills there are eight engines of 142 horse-power each, and collectively capable of raising 15,000 cubic feet per minute. One hundredweight of Welsh coal suffices to raise 80,000,000 lbs. one foot. The engines are grouped in pairs and symmetrically arranged in a single building. There are boiler houses, workshop, workmen's dwellings, coal stores, wharf, reservoir, &c , spreading in all over seven acres. By this grand arrangement a constant flow is maintained beneath the streets, and, finally, by the agency of the ever-useful pump, the sewage is poured into the river at about the time of high water.

The cost approaches five millions sterling, and is to be paid off in forty years. The maintenance, with an average consumption of 20,000 tons of coal per annum, will be considerable; but, on the other hand, large areas are made habitable, and a basement story is rendered possible in every part of the metropolis.

The main drainage has been a principal reason for the Thames Embankment, and both are indissoluably associated with the name of Sir Joseph William Bazalgette, from whose papers I have drawn copious particulars. There is a singular line of connection between this gentleman and Sir Christopher Wren. The latter produced the grandest building in the City; but was also virtually, if not in name, engineer of sewers, and first projector of the Thames Embankment. The former is primarily engineer of the sewers in their new and important form, but his fame will embrace one of the most extensive and striking pieces of London architecture since the building of St. Paul's!

At a meeting (March, 1877) of the Sanitary Institute of Great Britain, Sir J. W. Bazalgette, a V.P., observed that in London was seen the best example of the water-carriage system of removing sewage into the tidal outfall. The annual cost, inclusive of interest on outlay for main sewers and pumping 136,000,000 gallons daily in dry weather an average height of thirty-five feet, was £.58,000; while in Paris, where the expenditure in main sewers had been £.4,000,000, and where no pumping was required, it was £.59,000 per annum. Sir Joseph estimates that to purify the London sewage before its emission into the tide would require an area of sixty square miles of land and a large yearly expenditure.

Upon the ventilation of sewers opinion is much divided, though merely on the method, and in no way on the paramount importance of such ventilation in the abstract. Noxious vapours are hardly generated within the house, but pass up the drain in a continuous volume from the sewers where every form of domestic fluid is received, and the far more intolerable refuse of manufactures, and commercial processes—some deadly if breathed, others explosive. In whatever way, therefore, such deleterious bodies may be passed off, the smallest practicable amount should be evolved, and nothing likely to increase evaporation adopted. This inquiry is in a nascent stage. Some efforts have been made, and much may be accomplished by easy means, without encroachment on private possessions. On the other hand it is probable, and has indeed been demonstrated, that were all the houses of a Town provided with drains and open soil pipes, as herein proposed, the emanations from sewers might be safely carried through them. The only change of arrangement would be in the area, where a trap must be substituted for the grating (A in Figure 2), and the dividing tongue or even the entire cesspool removed.

The important measures already confirmed are a foundation for future steps of necessarily gigantic character. Chemistry as yet is young, but the belief is neither new nor visionary that the vast floods of London sewage will at no distant day become sources of fruitfulness and value.

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