It appears from the observations of Professor Robinson on Rivers, that a velocity of water-flow of six inches in a second, would be sufficient for clearing away all the usual sedimentary filth, and that a velocity of a foot in a second would sweep away fine gravel. The desired velocity could be secured by means of dams placed in certain situations to collect heads of water, at less expense than by the usual method. Were a proper system of flushing adopted, it would not, we learn from competent authority, be necessary to have recourse to the operation more than once in three months.

Mr. G. Gurney has reported to the office of Works, London, a new experiment, which he has tried with success, for destroying the effluvia of sewers. The object is accomplished by means of the steam jet, which produces a current through the sewer, and conveys with it the noxious exhalations, which are often decomposed and rendered harmless by being made to pass through a coke fire, as they are drawn out. 91-4

If an arterial drainage of a city by connections with two great sewers, running its whole length, were carried into effect, permanent arrangements might be made for flushing, by having large reservoirs similar to those by which locomotive steam engines are supplied with water. The communicating branch sewers, and the private or house ones, opening into them, could be kept clear by the flush from house tanks and the public hydrants, fire plugs, or intermittent fountains in the streets, in the manner already described. The success of flushing must, however, depend mainly on the size in diameter of the sewers, for unless they are nearly or quite filed with water, suddenly let in, we cannot anticipate the desired satisfactory results from the operation. To meet this exigency, it has been proposed that tubular drains or pipes, of moderate dimensions, with smooth and glazed interiors, be substituted for the rectangular private and the very large public sewers which have been, for the most part, constructed up to this time. For house drainage, a four-inch tubular pipe has been found to answer better than a pipe of twenty inches or two feet in diameter, according to the old method. The frictional line or interior perimeter of the first of these drain-pipes is but 12½ inches; that of the two feet drain is 75 inches. The secondary pipes are six inches in diameter. In place of an old sewer, in one instance, of 4 feet high by 3 feet 6 inches wide, and varying in width to 6 and 7 feet, and in height, in one part, to 7 feet, and in which the night-soil had accumulated to the depth of 9 feet, there was laid down two nine-inch stoneware mains. The united sectional area of these last tubular drains is but one-sixteenth of the area of the small part of the old sewer, and one-half the area of the single old house drains. By this arrangement, supposing the house to be supplied with water, cesspools or common privies might be dispensed with; and a closet soil pan placed syphon fashion over a pipe communicating with that serving for the house drain. Nor would there be any necessity for flushing, as both the house and branch and even main drains would be kept clear by the increased concentration and acceleration of the flow of the waste water. In point of economy, the saving of expense is very great by the system of tubular drainage, the cost being only from a seventh to a tenth that of the old system. The pipes used for the purpose of drainage ought to be either glazed stone ware or of burnt clay and glazed in the inside. They possess yet another advantage over the common brick drains in their not allowing either of exudation of their contents or of infiltration into them. The latter has occurred in the parish of St. Pancras, London, into the sewer running through which the exudations from the church yard at a distance of three feet found entrance. Unless there be an abundant supply of water for keeping the house and branch drains free from obstruction and accumulation, they will prove to be a source of annoyance and disease. As a general rule, each house drain, at least, ought to be provided with a trap or valve, to prevent the escape of emanations from the drain into the house. Especially is this necessary, where the supply of water is not abundant enough to keep the drain clear.

It has been proposed to separate refuse sewers from surface water drains. The first kind of drainage is of *sewage proper*, the liquid and semi-liquid refuse of dwellings; and the second or surface draining is of rain and melted snow. Sewage flows continually and in measurable quantity; surface water irregularly, sometimes not at all, often copiously and at times excessively. Mr Simpson, Advocate, of Edinburgh, who suggests this division, proposes also that "the sewers for the sewage should be conduits, which from their commencement in private dwellings to their final debouchure from the main of the largest size, should not by one single open vent, during their whole course, communicate with the external air. If to these sewers a *regular* fall is given, it need not be a great one, and they are made of proper materials, and securely jointed as they are prolonged, with an ample supply of water for their

The sand and fine gravel at the bottom of the sewers, which had been carried into them by the surface water from the streets and gutters, cannot be cleared away either by the mechanical means already described or by washing. For a time, the workmen employed in the sewers shovel it to the right and left, so as to allow a freer passage for the liquid matter; but its increase compels them to drag or propel it as best they can to a spot under the man openings or gully holes in the vault of the sewer, through which it is raised up in buckets by windlass. This is the most fatiguing and dangerous part of the labor of cleansing out of the sewage, by its requiring the workmen to remain down a longer time, and by their being exposed to more acrimonious and deleterious vapours arising from substances which had been retained and covered by the incumbent sand. Not only are the men liable to asphyxia, but, also, to inflammation of the eyes, caused by the emanations of ammonia. 91-2

We learn, from experiments on the subject, that the air of the public sewers in Paris is vitiated by the loss of a certain portion, one to four per cent. of oxygen, the vital element of the atmosphere, and by the addition of the deleterious gas, carbonic acid, which extinguishes flame, and destroys life when largely inhaled, and also of the still more and eminently destructive gas, the sulphuretted hydrogen. It is worthy of remark, that both these gases, which, when inhaled, are so fatal to life, exhibit, when mixed with water, as in certain mineral springs, and taken into the stomach, most marked exhilarating and salutary effects on the animal economy.

The yearly expense of cleaning the sewers of the city of London proper, and Westminster and tha Tower Hamlets was 15,500 dollars. The total of the loads of deposit removed from the sewers of these parts of the metropolis, (three districts) which are those north of the Thames amounted to nine thousand three hundred. In the large Holborn and Finsbury district, a saving of nearly forty thousand dollars was effected in one year alone, (1843) by improvements in the mode of cleansing the public sewers. It has been estimated that, by keeping these latter clear by flushing, a saving in that branch alone might be effected equal to fifty per cent., some have said of sixty six per cent. The saving in one district, during a year, was sufficient to pay for all the flushing gates and side entrances placed on the old sewers to be used for years to come.

The construction of sewers in the city of London alone, during a period of ten years, cost 610,000 dollars. The cost per lineal foot of the first class, or largest sized sewer, is estimated by one engineer at five dollars afoot, and that of the third class at half the sum. But there must be different standards of classification, for another experienced person in such matters in London makes the rate at twenty dollars per foot for a culvert of ten feet diameter and one and a half brick thick all round. For No. 2, five feet three inches high by four and three-quarters feet wide in the clear, one and a half brick thick, semi circular bottom and upright sides, and one brick, semi circular covering arch, the cost per lineal foot was $13,50. No. 3, the size in ordinary use, five feet high by three feet six inches wide in the clear, and of construction similar to the last, cost $7 per lineal foot. No 4, the dimensions of which are four feet nine inches high by three feet four inches wide, cost $6,40 per foot. A small sized sewer, two and a half by two feet, built only a brick thick, cost about $1,20.

Flushing, of which we have made such frequent mention, consists in collecting a sufficient body of water in a tank or other reservoir, so that, 91-3

when suddenly emptied, its contents may sweep the whole length of the sewer, filling completely its interior; and thereby effectually carrying with it every impurity and accumulated matter. If the tank be intended to flush a house drain, it ought to be at the top of the house. But where an adequate supply of water can be obtained at all times, and with an impetus derived from the height of the reservoir and the reduced calibre of the conducting pipes, as in Philadelphia, New York and Boston, there is no necessity for this system of flushing. By turning the water with which each house is, or may be supplied, into drains, private as well as public, these may be thoroughly cleared of their contents and well cleansed. But as restrictions are imposed on the inhabitants to prevent their letting water run in this way, it is the duty of the city authorities to open, at stated and short intervals the fireplugs in the streets, so as to allow of a rapid and gushing flow of water into the public sewers, and in this way both to empty them of their accumulating filth and even sand and gravel, and at the same time to sweeten their acrid and deleterious air. Let us make the same good use of our fire-plugs and public hydrants as the municipality of the French capital does of its intermittent fountains—in promoting the public health as well as in furnishing the means for extinguishing fires.

PUBLIC HEALTH.

SEWERAGE AND SUPPLY OF WATER.—In terminating our remarks on the cleansing of sewers and, consequently, on keeping them clear of obstructions, we are obliged at once to insist on the necessity of a due supply of water for this purpose, whether we regard the completeness or the cost of the operation. In Paris and London, when no provision was made for washing out the sewers, or even for the introduction of an ordinary flow of surface water beyond that furnished at irregular and uncertain periods by rain, men hired for the purpose, who were professional scavengers, entered into the sewers and threw out their contents on the street. For the better performance of their work there were two sets of operators, the one below in the sewer to fill buckets with the sewer filth, and another above in the street to draw up the buckets by means of ropes and windlass and empty their contents on each side of the man-hole or opening in the vault of the sewer which had been left for this purpose. We can readily believe, even without sensual experience of the fact, that the effluvia from the matters thus spread on the street could not be very grateful to the olfactories, either of the passers by or of the inhabitants in the neighborhood. A more troublesome mode of proceeding, and one in which the men employed ran great risk, and in fact were not unfrequently victims of asphyxia, consisted in their pushing before them, with the aid of a square board fastened at the centre to a long handle, the semi-fluid mud and filth in the sewer on to its terminal opening. The men, two or three in number, stood side by side, so that the propellers should extend across the culvert. They were followed at a short distance by another file, and these, if necessary, by a third, who pushed before them the matter which had escaped those on the front line. Some idea may be formed of the immense labor in a work of this nature, when we learn that the length to which these semifluid contents of the sewers were drawn by pure force of muscle was from 13,000 to 16,500 yards, or from seven to nine miles. Sometimes the filth becomes of such a consistence, and is so impasted in the culvert, as to render it extremely difficult, if not impossible, for the scavengers to propel it onwards. They are in such a case soon relieved of their dilemma by a simple contrivance. It consists in establishing a temporary dam, in the shape of a piece of thick and wide planks, which one of the men takes down into the sewer, and sets up on edge, crosswise to the canal, so as completely to arrest the flow of the contents of this latter. In this way, the water collects at the upper part of the retained filth, and allows of the men removing the more fluid matters nearest to the board. When the obstruction and difficulty of propelling are renewed, after a little distance, the board is withdrawn, and the water, falling and flowing with some force, thins the filth in advance of it, and, in a degree, holds it in suspension, and thus greatly facilitates the propulsion imparted to it by the scavengers with their machine. So necessary is this water, thus procured, that the men are sometimes obliged to wait two or three hours, until it is accumulated in sufficient quantity. The process here described is, in fact, a very imperfect mode of flushing, which would no longer be called for if the surface flushing at the upper end and opening of the sewer, were properly performed. To this important process we shall soon advert. 91-1

The sewers in Paris are, in late times, cleaned twice a week, by what are called extraction and washing. The first consists in removing the more solid portion of the filth; the second in washing it away. The proportionate length of sewers subjected to the two methods, on each day of cleaning, is not quite a third of a mile (five hundred and forty yards), by extraction, and nearly eighteen miles by washing. The former process must be the same as that used in London, of which we have spoken at the beginning of the present article, and consists in the actual withdrawal and discharge of the sewer filth, if not in the street, at least in carts for the purpose. In this labor ninety men are employed, with four carts, each drawn by two horses. The cost of the cleansing (*curage*), in 1849, was twenty five thousand dollars.

Asphyxia used to be a not unfrequent occurrence among the men employed in cleansing the Parisian sewers, nor can they be said to enjoy exemption from it now; but the risk of this alarming and occasionally fatal seizure has been greatly diminished of late years, by the increase of the small and intermittent fountains—fire plugs we should call them. The supply of water thus furnished is not only serviceable by washing the streets and carrying along in its subterranean flow the filth of the sewers, but also by absorbing the deleterious gases given out from the contents of these latter, and thus enabling the workmen to enter and traverse them with comparative impunity. The number of intermittent fountains (*bornes fontaines*), in Paris at the present time is about 1800; they are opened and allowed to run twice a week.