

posal, and thus prevent deposit and consequent foulness within the sewer. There is a fixed relation between the velocity of the fluid and the matter which it will carry in suspension. Thus, sand will be carried along by a stream of water flowing with a speed of six inches per second, but be deposited if the velocity becomes less. Pebbles one inch in diameter are carried along by a flow of about two feet per second, and deposited if the velocity is less. The sewers should, therefore, have a certain minimum inclination or fall. They should also have a sectional form which will concentrate the sewage laterally into a compact stream, instead of allowing it to spread out in a thin sheet [Hence, the narrow bottom or egg shaped sewer is best.—Ed. C. H. J.]. All changes in the direction of the flow should be made in such a manner as to prevent eddies, or a material reduction of the velocity. The interior surface of the sewer upon which the sewage flows should be as smooth as it is practicable to make it, because roughness causes particles to be held back. It would likewise be desirable, but engineering science has not yet solved the problem, to prevent a smooth surface from allowing the adhesion of mycelial and other growths forming a slimy surface, and thereby again causing the adhesion of passing matter.

In spite of the greatest care in building and in maintenance, some decomposition will always occur in sewers, and we must, therefore, provide for cleansing, both by ventilation, to dilute and remove offensive gases, and by flushing, to produce an increase of the ordinary amount of velocity of the water, and thereby cause it to again take up and remove matter which has been deposited. Ventilation is usually obtained by facilitating the natural circulation of the air within the sewers. The circulation is caused by a difference of temperature and of humidity within and without the sewers, and under certain conditions by impulsion, due to the flow of the water. Artificial ventilation has rarely been a success, owing to the necessary complication in the arrangement of the pipes within the houses and in the streets.

Flushing is usually obtained by causing the sewer to run more than half full for a short period of time, either by temporarily damming the sewage, or by suddenly introducing other water in large quantities.

This first part of the problem, namely, the collection of sewage, is comparatively simple, but the second part, pertaining to the final treatment with reference to purification, is far less so. It has been the subject of much controversy and of many experiments. Until recently, when bacteriology had sufficiently developed to throw some light upon the matter, the discussions were generally unscientific, based upon assumptions rather than facts, and often guided by self-interest, with consequent misrepresentations of facts.

#### DISPOSAL OF THE SEWAGE.

For a long time the principal efforts were directed toward converting sewage into manure, it was thought that besides being a satisfactory solution of the sewage question, great profits could be made from such a conversion. In Europe "dry removal" of the nightsoil or solid matters was frequently urged. This allowed manure to be manufactured from sewage at a smaller cost than if the solid matter were combined with the wash water from kitchens, laundries, bed-rooms, etc. But this water was still left unprovided for, and formed sewage about as offensive as when it contained the more solid matter. . . . England, which has generally been in the lead in sewerage matters, has only a few localities retaining the system of dry removal. But in every such case it still leaves unsolved the purification of the large amount of dirty waste water which is discharged from the buildings of a modern city well supplied with water, and which virtually makes up the sewage thereof. . . .

Probably the oldest method of disposing of the waste [sewage] waters, though imperfect in detail, was the application to land, or simple irrigation. In Italy and Spain, and some parts of Germany and France, more or less crude methods were occasionally practiced. The object of irrigation was profit rather than sewage purification, and therefore the requirements