SCIENTIFIC—SANITARY ENGINEERING.

Lectures by Professor H. T. Bovey, of McGill College.

ANSWERS TO QUESTIONS IN LECTURE No. V.

4. Give some instances in which the principle of interception may be advantageously adopted.

Ans.—The principle of interception is one of the most important in the disposal of sewage. The water and sewage from the higher levels may be intercepted and carried directly away to the outfall by gravitation, without allowing them to mix with the sewage in lower districts, which very often requires artificial power to produce a sufficient fall to reach the point of disposal. Where a system of sewers has been constructed to meet the wants of any small place, whose population suddenly and rapidly increases, the sewers will soon be inadequate to supply the requirements; this method of interception enables the engineer to dispose of the extra volume, and also to utilize the sewers already built. By a system of intercepting sewers the large cities may be divided into smaller towns, and be more economically drained. Interception is of great importance in sea-coast towns, or in towns affected by the tide. Their lower parts being generally tide-locked, by the aid of these intercepting sewers the rainfall and sewage from higher districts may be conveyed directly away, and this relieves the reservoirs for retaining the sewage during the time of tide. In low lying lands the sewage may have to be pumped up and conveyed away by intercepting sewers, and in such cases the height will depend upon the distance of the outfall and the inclination of the sewer. Many more examples might be given, but these will serve, I think, to illustrate the importance to be attached to this system of intercepting sewers.

T. Drummond (2nd year.)

5. What is meant by self-cleansing sewers? Explain in detail the conditions which determine whether a sewer is self-cleansing or not, and the precautions which should be taken in its construction to make it self-cleansing.

Ans.—Self-cleansing sewers are sewers which, by certain inherent qualities discharge all the sewage at any time passing through them, whether the flow be uniform or intermittent or fluctuating; and which do not require men to enter and remove the obstructions. They must be proportionate in size, form and inclination to the volume of sewage to be conveyed away. The velocity of flow should never be less than 120 feet per minute. The velocity is greatest at the surface, decreases with the depth, and at the bottom has only about four-fifths of the surface flow. The heavier matters will naturally be near the bottom, and then a velocity of less than 120 feet per minute will not be sufficient to carry all solids with it; this refers to ordinary sewage. A velocity of 60 feet per minute is sufficient for clear watery fluid, and 90 feet per minute for sewage strained of its coarser particles. The sewer must be water-tight, or as nearly so as possible. The upper portions of a system of sewers should have a greater fall than the lower, for they convey a smaller volume of sewage. The material used in constructing the sewers has also an influence, and if rough may cause a deposit, Small sewers require a greater fall than large. Where the diameter is 6 or 9 in. the velocity must not be less than 180 ft. per minute. Sewers of various sizes, but of different inclinations, may have the same velocities. The maximum velocities to be given to small sewers or drains are estimated by efficient authorities to vary from 270 to 600 feet per minute, but the main point is to obtain a sufficient inclination to keep the sewer clean.

ANSWER TO QUESTION 3 IN LECTURE No. VI.

3. State the points to be considered in fixing the position and size of a main outfall sewer.

As the main outfall sewer is the largest and most important, to fix its position is one of the first considerations. But before deciding, the engineer must determine upon the mode of treatment. The reasons for this are: (1) The liquid refuse must finally be poured into the sea, a tidal river, estuary, an inland river, or a watercourse forming the natural outfall of the district; (2) The prevailing inclination must be towards one or other of the points of ultimate discharge, though there may be considerable variation in the direction of the internal sewers, owing to internal undulations of the land. If the sewage is to undergo any treatment, the engineer must also consider: (1) A site for the outfall which shall be free from objection on the score of nuisance; (2) The means of reaching such site, either wholly by gravitation, or partly by gravitation and partly by pumping; (3) The expediency or necessity of first depositing the whole of the sewage upon a lower level and then raising it; and (4) The price of the site. The size of the sewers must depend (1) on the population, (2) the occupations of the people, and (3) the proportion of the rainfall it is deemed best to receive. This proportion of the rainfall added to five cubic feet of sewage for each inhabitant, one half running off in six hours and the remainder in eighteen hours, will be a sufficient allowance in most cases.

John S. O'Dwyer (3rd year).

LECTURE VII.

Construction of Sewers.

To render a sewer water-tight and durable the best materials must be procured, and such as will not be affected by the chemical qualities of the sewage, by the sewer gases, by the mechanical action of the flowing stream, or by the materials transported over its bed.

The materials used in the construction of sewers are:—

"Bricks, earthenware, stoneware, tiles, stone, artificial stone, concrete, asphalte, iron, timber, and the various cements."

The forces acting upon a sewer are mostly external, and the material of the sewer is in a state of compression.

Brick Sewers.

The bricks are to be sound, well-shaped, well-burned, and to possess adhesive qualities.

Ill-burnt and soft bricks are to be rejected.

Rough bricks are not to be used for the internal lining of sewers.

With perforated bricks it is difficult to keep the work water-tight.

Radiating bricks are to be used for small sewers and sewers of oval section, the radius of the curve of the invert being small.

To obtain the maximum uniformity, the sewer is to be cast in sections in wooden moulds.

Sewers are not to be entirely built up of blocks, as there is a want of bond in such work.

The brick-work of a sewer is often built in a cradle formed of wooden laggings to the exact size of the sewer. They are useful when constructing sewers in quick-sand, bog, or other bad land. Mr. Brittain, of Montreal, has improved upon the old form of cradle, by the introduction of a cradle rib of wrought iron, the cradle being braced temporarily by a wooden brace.

Templets must be invariably used, made to the true section of the sewer.

The arches of sewers are usually turned on centres which are gradually advanced.

A brick sewer built up in a number of rings, on bad ground, is usually furnished with a collar joint in cement between the rings of brick-work to render it water-tight.

Sufficient cementing material must be used to fill up every interstice.

The joints are not to exceed ¼" in thickness, and should be stroked with the trowel point. They should also be protected in such a way as to prevent the entry of the roots of trees.

The bricks are to be thoroughly saturated with water before being applied to the work.

If much water is met with, it must be carried away by a supplementary drain, or to sump holes from which it may be pumped. The water must on no account come into contact with the brick-work until the cementing material has set.

Doulton's segmental sewers are said to be strong, readily put together, pack closely for transit, and form a perfect and unbreakable sewer.

If (d) be the depth of excavation, and (r) the external radius of the sewer, $\therefore$ the thickness of the brick-work in feet $= \frac{d.r}{100}$.

In ordinary cuttings of 20 feet in depth and less, a sewer, whether oval or circular, whose greatest internal dimension is three feet, is usually built with a 4½-inch ring of brickwork.

Sewers from three to six feet in size, with a 9-inch ring of brick-work.

Sewers of larger sizes are built with a proportionately increased thickness.

Sewers with straight sides require to be at least 50 per cent. thicker than curved sewers of equal dimensions.

Inverts.—The inverts are very liable to wear from erosion of water, and from the grinding action of the sand and solid matter transported over them. It is, therefore, advisable to use glazed bricks, or invert-blocks to form the invert.

Local bricks may be used for the sides and arches.

Blocks are of great value for inverts and in bad ground.

Invert-blocks are usually made of terra cotta, stoneware or porcelain, glazed on the inner side. They facilitate construction, are durable and smooth. They are made with butt and lipped joints, the latter being preferable, as not being liable to settle. They are made both hollow and solid, but the hollow invert blocks are very frequently found to split on acccount of the great superincumbent weight. The continuous opening through the blocks may serve as a drain, and may be closed at any subsequent time.

The inverts of large sewers should be lined with blue Staffordshire, or glazed fire-bricks, or with other bricks that are hard, smooth, and adapted for the purpose.

Questions.

1. How is the capacity of a sewer governed by the trades and occupation of the people?

2. On what grounds do some authorities propose the total exclusion of the rain-fall from sewers?

3. Determine the requisite fall to give to a sewer, circular in section, so that it may discharge sewage at the rate of—

176 feet per minute when running three-quarters full.
165 " " " one-half "
146 " " " one-third "

4. What are man-holes and lamp-holes? State their uses, and define the points at which they are to be placed.

5. Draw up a specification for the brick-work of a sewer.

H. Taylor Bovey.

14th November, 1878.

SONNET.

Bard of the Future! bear to him who toils,
The primrose and the daisy, in thy rhyme;
Bring to his workshop odorous mint and thyme;
Shine like the stars on graves, and say, "Arise,
Seed sown in sorrow! that our Father's eyes
May see 'the bright consummate flower' of mind;
And the great heart of ransom'd human kind."
Sing in all homes the anthem of the wise:
"Freedom is peace! Knowledge is Liberty!
Truth is Religion!" O canst thou refuse
To emulate the glory of the sun,
That feedeth ocean from the earth-fed sky;
And to the storm, and the rain-cloud's hues,
Saith, "All that God commandeth shall be done!" —*Ex.*

Mgr. Dupanloup, late Bishop of Orleans, left by will his heart to the parish of Saint Felix, where he was born, his body to the cathedral of Orleans, and $8,000 to his grandson, a son of M. du Boys.