system presents the more up-to-date and by far the better plan. By the combined system it is necessary to lay down large diameter pipe sewers, capable of taking excessive torrential rains, and so prevent roadways and cellars from flooding. These large sewers during dry weather are much too large for the flow of domestic sewage, the result being that the mean hydraulic depth is so small and the liquid spread over so great a surface it is incapable of carrying forward solid matter. Such sewers present channels of piled-up filth, through which the liquid simply oozes, the filth not being removed until some rainstorm comes along capable of flushing the conduits.

The natural objection to the separate system is that at first sight it appears more costly, apparently providing for two systems of sewerage. However, the cost is very little more, if any, than in the combined. The two lines of pipes can be laid in the same trench when open and smaller diameter pipes are required.

The great advantage of the separate system is, however, that if at any time sewage disposal is required, a definite amount of sewage at the point of discharge can be depended on, the amount in dry weather simply representing the water supply per capita, and in wet weather the water supply, plus the rainfall on the roof area of the town, which at no time amounts to more than three times the dry weather flow. On the other hand, if storm road and subsoil water be admitted to the main sewerage system, it is necessary to spend almost four times the amount on disposal works and build works on a scale totally much too large to deal with the real sewage of the town.

Sewers Should be Self-cleansing.

By self-cleansing it is meant that whenever possible gradients and sizes of sewers should be so arranged that the depth and velocity of the flowing liquid should be sufficient to carry all solid matter with it. It is apparent that only by the adoption of the separate system can this object be attained. In main collecting trunk sewers little difficulty is found in obtaining a volume of sewage with a sufficient velocity. But in sectional sewers, where the volume is small and often intermittent, there is sometimes difficulty. Mistakes are often made in putting in sewers for branch work of too large a capacity. The velocity aimed at for branch sewers should not be less than two feet per second when running half full. The following falls, given to 9-inch and 12-inch circular sewers, running half full, will produce the following velocities in feet per second: 9-inch, 1 in 450 = 2 ft.; 1 in 200 = 3 ft.; 1 in 120 = 4 ft.; 1 in 75 = 5 ft. 12-inch, 1 in 600 = 2 ft.; 1 in 260 = 3 ft.; 1 in 160 = 4 ft.; 1 in 100 = 5 ft.

Whenever it is necessary to lay a branch sewer, 9-inch diameter at a gradient less than 1 in 450, or a 12-inch at less than 1 in 600, producing a velocity of less than 2 ft. per second, some method of extra flushing should be resorted to.

Flushing Sewers.

The best method of flushing for branch sewers is to erect at the head of the sewer an automatic discharging tank, fed either from the water main or by collecting bath waste water. The amount of the discharge should not be less than 700 gallons for a 9-inch pipe and 1000 for a 12-inch pipe. The discharging syphon should be capable of three-quarter filling the sewer to be flushed.

Materials for Sewers.

For all conduits up to 2 ft. 6 in. diameter, stoneware salt-glazed pipes are the best; for over 2 ft. 6 in. diameter the conduits should be built in culvert of the egg shape section of either brickwork or reinforced concrete. Stoneware pipes should have a thickness of crust equal to 1-10th their diameter, and the spiggot ends threaded externally while the sockets are threaded internally. There should never be less than 2½ in. depth of socket room, and width space of at least ½ in. clear all round.

Jointing in Sewers.

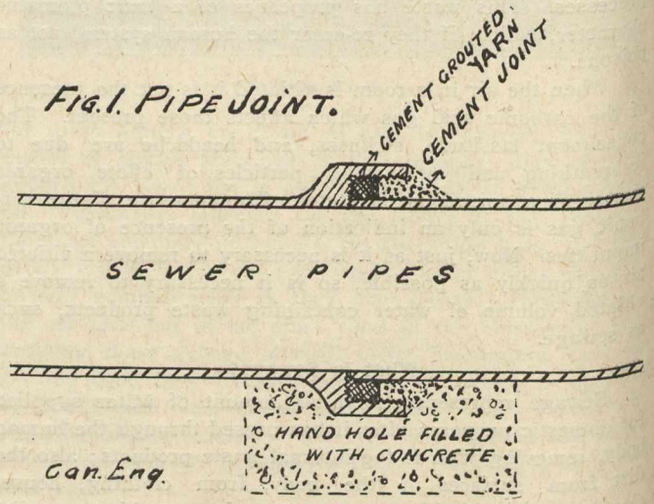
Fig. 1 shows a good, sound sewer pipe joint made with grouted yarn stemmed into about half the socket space, the remaining space being occupied with cement neatly finished. The purpose of the grouted yarn is to keep the pipe in position, so that the alignment is true and an equal socket space maintained all round the pipe. It also serves the double purpose of preventing cement from running into the pipes. The yarn is first dipped in liquid cement and then stemmed into the socket. The cement finish should be in parts of one of cement to one of sand. Pure cement is apt to crack when setting.

Laying the Pipes.

Great care should be taken that the body of all pipes rests evenly on the surface of the trench, and that holes be excavated at the sockets. No pipe must rest on its socket, or the result shown on Fig. 2 will be obtained. This commonly happens, especially when sewers are laid in rock or concrete, or other hard surface. The handholes should be filled with concrete. (See Fig. 1.)

Testing Pipe Jointing.

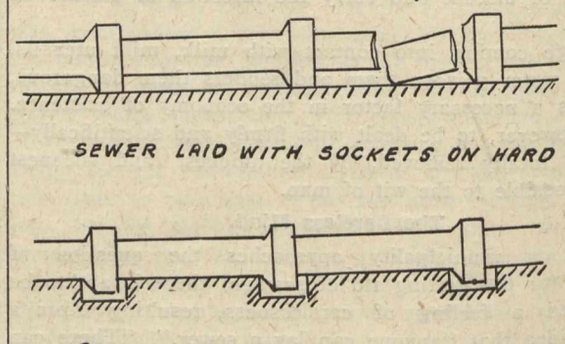
It is extremely important that all pipes be tested as to their jointing before and after they are filled in. The proper and only satisfactory test is the water test. The length of sewer as laid is plugged at the lower end and the whole length filled with water, the natural gradient providing a head



of pressure. At the top end a curved elbow pipe should be temporarily fixed so as to obtain pressure on the upper joints of the length. The length of drain must be capable of holding the water without the least sign of leak. This is the natural test the sewer will be put to if at any time the length becomes choked in practice. The reason for testing a second time after the trench is filled is that there is a chance of the pipes being disturbed, and even broken, by careless filling in.

The man who says it is not necessary to test sewer joints is the man to be careful of. He either suffers from a mental or moral twist, or perhaps both. The contractor

FIG. 2. LAYING PIPES.



who takes it as an insult to have his work tested, and says, "So-and-So has always found his work all right without testing," is the sort of man who cannot take a threshing standing up, and is really afraid of his work.