

ated with water and being of a mixed nature, a tremendous pressure was brought to bear on the struts, which were bowed from 4 to 6 inches, and the foreman of the work asserted that they were in some cases pushed right through the walings. About 50 feet of this work eventually caved in, and a new method of dealing with the excavated earth was adopted. This settling of trenches made constant watching and attention necessary, the men inserting new raking struts, and tightening up those already in. The work of drawing the shoring in back-filling the deep sand trenches has been frequently dangerous, and much timber was consequently buried. On one section, while taking out sheeting from a 35-foot sand cut, about 25 feet of it caved in, and buried a man below, whose life was saved only by the struts and timbers closing over his head. Usually sufficient warning is given by the creaking of the shoring, but this is not always so.

In laying brick sewers the trenches, if in clay or other firm soil, are first trimmed out to the shape of the invert, a template is then fixed in position, true to line and grade at from 12 to 25 feet from the previously finished work, and stretching a line tight along the bottom course, the bricklayers lay the bricks, working from each end towards the centre. The string is then moved to the next course, and the work proceeds as before. The first few courses are laid dry, and the sidewalls then completed to the springing line, the joints being made in no case less than one-quarter inch, and usually made as thin as possible on the face. The invert joints are then filled with cement grout. When bricks have frogs, these are laid up, and all bricks are pressed firmly into place. The springing course is all headers, and is the only one in the sewer. The centres used are four feet long, made with hinged legs. On the arches the key courses are also grouted. Where two-ring work is used, a half-inch collar joint is laid between the rings. This collar joint gives a good bed for the upper courses, and should not be omitted, or laxity allowed where water-tightness is desired. Even then water will find its way through at times, and the writer has one section in mind where the sewer was laid in 15 feet of clay, underlying 20 feet of sand, with plenty of water. After the work had been completed some time, the water was found in places oozing in small drops right through the bricks themselves. As soon as the earth has been rammed over the arch to a depth of two feet, the custom here has been to draw the centres. This allows the work to proceed more rapidly, and in small sewers with good backing no evil results follow from the practice.

The bricks used are made in the city, are of a white or greenish-white variety, the hardest samples being more tinged with green. Their porosity is perhaps their most objectionable feature, as they will absorb from 12 to 18 per cent. of water. Bricks made from the same clay were used in the construction of the old sewers here, some of which have been down 50 years and appear to be sound. All mortar used was mixed in proportion of three of sand to one of Portland cement—the latter being all of Canadian manufacture, very finely ground and giving good tensile tests. Concrete used for backing or foundation was generally made of 1-3-3, but on the sections now in progress, where a single ring sewer is quite surrounded by concrete, the same is being made 1-2-4.

Cradles were used wherever shaky or quicksand bottoms were met with, and were usually made of inch planks, nailed to 1 x 4-inch ribs, 18 inches apart, cut to the proper shape. The ribs were usually fastened on the under side of the planks. The cradles, which were made in the lengths of 4 feet 6 inches, were worked into the bottom by the workmen standing or jumping on them. In using cradle foundations the difficulty has not been one of keeping them up (as seems to be the popular idea), but of holding them down, and it was usually necessary here to strut them down until the brickwork was somewhat advanced. The cradles on one section, however, were made as described above, with the exceptions of having the ribs on the inside and being filled with 4 inches of concrete, which had set at least 24 hours before being lowered in the trench. The reasons for this construction will be explained a little further on.

On many sections of the work, a considerable amount of water was met, but has usually not been more than could be handled by hand pumps of the ordinary diaphragm pattern.

Frequently two of these were required. In some cases where the bottom was clay underlying sand, a pump had to be kept working over the completed portion while the backfilling was being done to prevent same being washed into the sewer. A description of the method used on sections L. and M. (which are now being built), will suffice to show how the water when met with in or near the bottom of the trench is kept from the work. This sewer is being laid along streets adjacent to and occasionally crossing the line of Carling's creek, and throughout the entire length of two miles, its invert will be from 5 to 8 feet below the creek level. The cutting is mostly sand, and so far as completed (a distance of three-quarters of a mile), there has been enough water to keep a centrifugal pump (with a three-inch discharge) working steadily. The construction consists of a single ring of brickwork surrounded by concrete of varying thickness. To get this concrete in to the best advantage, the bottom portion (4 inches) is mixed and moulded into the wooden cradles on the bank, and is allowed to set hard before being lowered into the trench. The weight of these is about seven hundred pounds, and they are made in four foot lengths. To enable them to be easily caulked small strips of canvas filled with grass are nailed to one end of each, and when the cradles are being laid they are pressed tightly together. This forms a very good joint, and is only required temporarily to allow the inside ring of bricks to be laid. The pump is set about 50 feet ahead of the completed brickwork, and when in operation draws water from both directions, that portion which is near the sewer being conveyed through 2½-inch land tile, laid on each side of the cradles. This method has proved very successful, and effectually prevents the water and quicksand from boiling up through the bottom. Occasionally entrances into the sewer were left to allow the ground water to drain away. These weepholes are afterwards closed up, but not for some weeks after the work is laid.

Glazed tile sewers were laid up to 18 inches diameter. These were jointed with neat cement—gasket being first used to pack the joints. With all 18-inch sewers and with some 15-inch concrete was used to pack the haunches. The sections show the manner of doing this. Standard pipes were used, except on one deep section, where a thickness of one-tenth the diameter was demanded. Considerable delay and difficulty were the result. Manholes were built at from 300 to 450 feet apart, depending upon lengths of blocks, the principle being to have one at each sewer junction. The greater part of these (the manholes) are rectangular in form, being 2 feet by 3 feet 6 inches inside at the bottom, and drawn in to 2 feet by 2 feet at the top to suit frames, 1 foot 9 inches by 1 foot 9 inches inside dimensions. Each frame and cover weigh (together) about 520 pounds, and ventilation is provided by 81 holes 1-inch square each. Iron steps of ¾-inch by 1½-inches iron, bent and set in the shafts every fifth course of the brickwork, provide a means of entering the sewer. The walls are of two rings of brickwork down to 16 feet depth, and below this an additional ring is built. On the deepest sewers, however, the manholes were made circular at the bottom, and were drawn in gradually to suit the square tops. Six-inch private drain connections were left at distances apart varying from 25 to 40 feet, according to the property subdivision, and where necessary enough tile was laid to bring connection to within 11 feet of the road surface. On the deepest sections no private drain connections were left, as it was thought more suitable to lay a shallow sewer later on.

Tile sewers are laid straight from manhole to manhole, the bottoms of the latter, where direction changes, being curved suitably. Change of direction in brick sewers has been made by curves of radius of from 30 to 100 feet, with a manhole placed at each end of the curve. Where the north and south sewers join at King and Ridout streets, a bellmouth junction was built, having a stone tongue 8 feet long, and a brick arch thrown over both sewers of greatest radius 3 feet. Where the main sewer is at same depth below the grade of a future branch, a drop connection is made by means of a vertical pipe outside the manhole wall. Occasionally two branch connections have been made joining with one vertical pipe, and in each case the connection is open through wall for inspection and for use if any stoppage should occur in the drop.

Flushing gates (closing against the current) were placed on