sized sewer was required. There was plenty of cover too, so a 9-foot circular sewer was built with a square bottom. The excavating was done by hand and the material carried out of the trench in buckets on a cableway. The buckets were then dumped into wagons and the contents carried away to the dump, which was a new roadway in High Park. As the material was of dry sand with small seams of clay loam, the sides of the trench had to be sheeted with 2-inch tight sheeting, while 6-inch x 8-inch timber was used for walings and struts. As this portion of the work was done in open cut, the construction material was all concrete, since the sewer is entirely for storm-water and will be in use only a few times each year. The concrete walls are 18 inches thick, and the concrete was mixed in a Wettlaufer drum mixer. The forms were built up as each section was poured, the length varying from 10 feet to 20 feet or over, as convenient. The ribs of the forms were placed in position and then lagging, levelled on two sides to form chords of the circle, was placed, a piece at a time, as the walls were built up. It is in this section that the 18-inch tile pipe sewer mentioned in the previous article leaves its position under the large sewer.

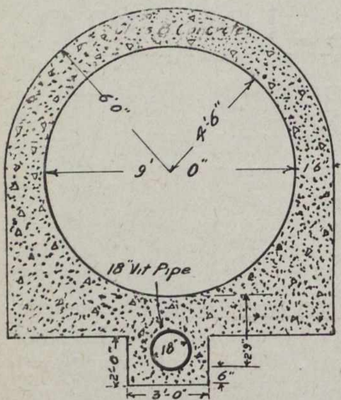

Fig. 2.—Concrete Section in Open Cut.

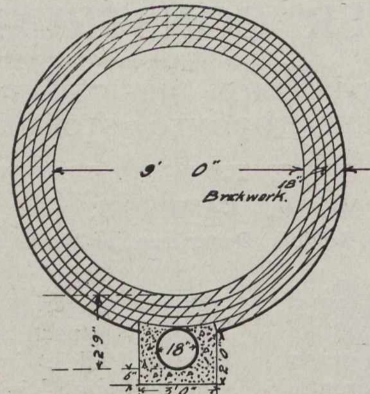

Fig. 3.—Brick Section in Tunnel.

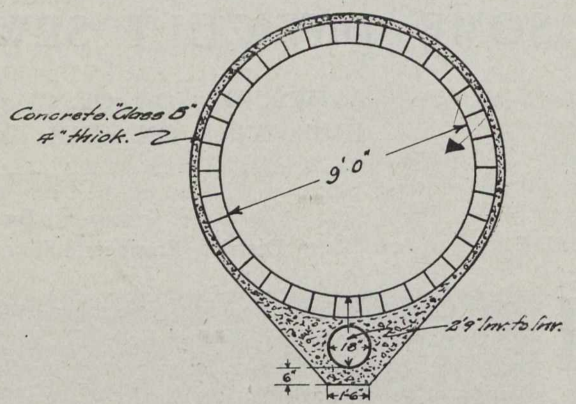

Fig. 4.—Alternative Section, Using Vitrified Segment Sewer Blocks.

In the tunnel portion of the work, the contractors sank three shafts, which we shall call Shafts No. 1, 2, and 3. The intention in constructing these three shafts all at the same time was to complete the work as speedily as possible. They expected to complete the work in eight months, and would have accomplished their object but for some unforeseen difficulties. As it was, the work was completed in nine months—a very creditable record. At the end of the 800 feet of open cut, the ground was dry sand. The contractors accordingly decided they would tunnel as far as possible, thus saving the extra haul of material and surplus which would have been necessary if the tunneling had been done from the shaft farther north. At first the tunneling was attempted by ordinary methods, but work had proceeded only a few feet when the sand became moist. The needle-beam method for supporting the sheeting was then employed.

When this method is used, a small cap and leg drift is driven ahead in the centre of the top half of the future tunnel, the caps being above the future brickwork. The needle-beam, as it is called, is in reality a large stick of timber, perhaps 16 inches by 16 inches by 20 feet, the size depending on the weight the timber has to carry. This needle-beam is taken ahead into the drift, the front end resting on a sill on the solid ground in the bottom of the drift, and the back end on blocks, etc., just inside the finished brickwork. Screw-jacks on posts are then inserted along this needle-beam and are screwed up until they take the weight off the caps. The legs are then removed and the miners begin at the ends of the caps to enlarge the tunnel. As room is made, planks for sheeting are inserted lengthwise of the tunnel and they in turn are supported and kept in place by posts from the needle-beam. Thus the work proceeds, the tunnel being enlarged gradually from the top until completed, as shown in Fig. 5. The sheeting is composed of 2-inch planks in the top half of the excavating and 1-inch lumber in the bottom. The posts are generally 6-inches by 6 inches in section.

This tunneling had proceeded 260 feet when the sand became fine and wet and the work was abandoned from this heading. A brick bulkhead was then built in the finished end. The reason for this bulkhead will be explained presently.

Shaft No. 1.—While this work was proceeding shaft No. 1, 32 feet deep, was being sunk at 16 + 60. As the workmen approached the bottom of this shaft, fine wet sand was encountered. It was, therefore, decided that it would be more economical to tunnel with the aid of compressed air. The shaft was lengthened from each end by open cut so that air-locks could be built. Hence the bulkhead just mentioned, to prevent the air from escaping as the work approached from shaft No. 1. The work on the south of the shaft or towards the bulkhead proceeded smoothly at the rate of from 5 feet to 7 feet a day and was completed with only minor difficulties. About 5 lbs. of

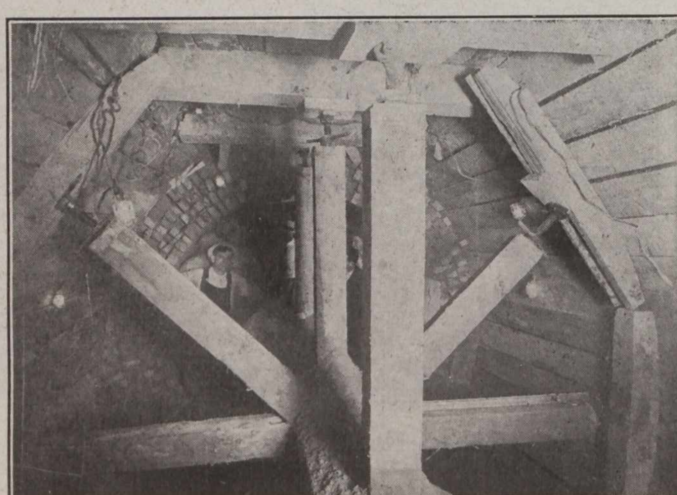
Fig. 5.—Illustrating the Needle-beam Method of Supporting the Sheeting as the Tunnel Progresses.