

compressed air were used, and the needle-beam method was employed.

North from this shaft, however, the contractors found difficulties along the path of construction in the form of old logs, stumps, old drains and an old cribwork. It would appear that this was the former head of a ravine. The cribwork had evidently been erected as a retaining wall and then the head of the ravine had been filled in with stumps and old logs, etc. Of course, this had been done

reason was that borings had shown the ground to be composed mostly of clay at the elevation of the sewer. A small amount of water was encountered but the quantity was not great enough to hinder the work. Tunneling was commenced at the north and south ends of the shaft. In the north end difficulties commenced almost at the start. It was found, as so often happens in this district, that the layers of sand and clay fold and form pockets. Water occurred in fair quantity in the sand just above the clay.

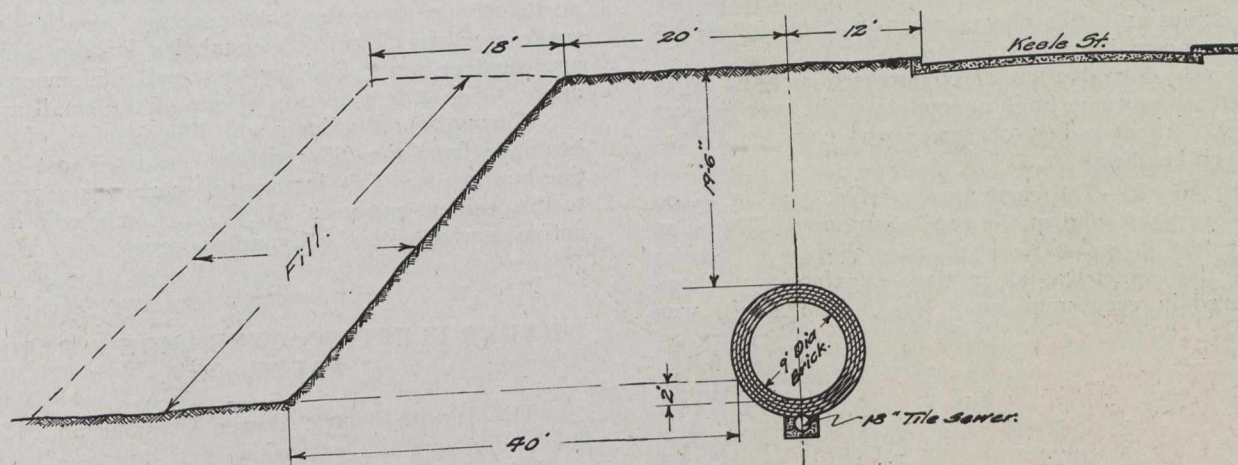


Fig. 6.—Extension of Bank Where a Ravine Closely Approached the Line of Sewer.

in past days when wood was plentiful. It was decided to open cut another portion of the work, since the sewer, being near the bank of the ravine, as shown in Fig. 6. These logs, etc., would allow the air to escape too rapidly. When the bottom was reached, there was found to be from 2 feet to 3 feet of soft, flowing sand above a layer of clay. The soft material was removed and 1:4:9 concrete put in its place as it was considered that it would not be confined. Since the bank was so near, and since logs, etc., were in the fill, it was believed that as soon as weight was put on the new sewer, the soft sand would ooze out through the bank into the ravine, allowing the sewer to settle, spread and finally collapse. There was another reason, also, for its removal. The weight of earth was mostly on one side and the soft material would allow the sewer to slide towards the ravine, in time wrecking the same. The surplus earth taken from the tunnel and open cut was dumped over the side of the bank. By this means the bank was extended and the weight equalized on the sides of the sewer.

An air lock was then built and the work attempted in tunnel with the aid of compressed air. About 50 feet of sewer was finished in tunnel but only 2 feet, 3 feet or 4 feet was finished each day and sometimes, indeed, none at all. The logs were still encountered quite frequently, as many as five or six appearing in an 8-foot length of excavated tunnel. They were vertical, horizontal, or in any position in the ground. The compressed air escaped to the surface so rapidly along these logs that it was impossible to keep up sufficient pressure in the tunnel to hold back the water. The logs had to be chopped out and they also interfered with the sheeting of the work. Everything combined, the work was so difficult that tunneling was again given up and 150 feet done in open cut to a point where the fill was passed and solid ground reached. Tunneling was then attempted again and this time was carried out favorably, with the aid of 5 or 6 lbs. of compressed air and the needle-beam to support the sheeting.

Shaft No. 2.—In sinking shaft No. 2 at 23 + 01 no provision was made for the use of compressed air. The

When 30 feet of tunnel was completed, work was temporarily abandoned. The contractors decided that their finances would have to stand the buying of a complete new air plant since their other plant was in use at shaft No. 1. Accordingly pumps and motors were ordered and in due time arrived on the scene. The work from the south end of the shaft progressed more favorably for a short time. Two illustrations are shown (Fig. 1) one of each end of



Fig. 7.—A Portion of the Work Required Very Little Sheeting Owing to the Favorable Nature of the Clay.

this shaft. They clearly indicate the change in the ground in 80 feet. About 120 feet of tunnel was built at this end when it too was abandoned for the use of compressed air. Air locks were built here in the finished tunnel. But by getting back over the arch and thence to the surface, the air escaped so rapidly that grout had to be forced in through holes bored in the brickwork to seal the space which remained between the arch and the earth. Various