January 27, 1916.

borings showing a layer of wet sand. Most of the contractors who placed a tender for this work calculated on having to install a compressed air plant to facilitate in the excavation work. This was the reason for vast differences in prices submitted, the successful bidder being nearly \$20,000 less than the second one.

The work in the tunnel was carried on from four shafts, which were situated at locations for manholes. Steam hoists were used to operate elevators, which brought the excavation from the tunnel to the surface in cars, where it was dumped into wagons, taken to Bickford Ravine and used for filling-in purposes.

The method of excavating was rather unique, having never been tried in Canada before. Contrary to the usual custom, which is to excavate the full size of bore at once, only the upper half was removed, the lower half or bench being left in place until all the excavating and concreting of the arch had been completed in that heading. Tracks



Fig. 8.—Junction Chamber at Lappin Avenue, Section 2.

were laid on this bench and the excavated material carried to the shaft in cars. This bench was also useful as a foundation for the concrete forms (Fig. 4). Lengths of 12 to 15 ft. were excavated at a time, and after each had been concreted another length was taken out, and so on until the entire drift was finished in the arch. Then the excavating of the invert commenced, this being taken out in alternate lengths of 12 to 15 ft. Trestlework was placed under the tracks as the excavation was removed. Forms were then set and filled to within I ft. of the arch concrete, this space being underpinned with brickwork after the concrete had set for at least 48 hours to allow for any shrinkage. When these alternate lengths were finished throughout the drift the intervening portions were treated in the same way. By this method of placing the invert the arch was never without support for any greater length than 15 ft., for when the alternate sections were being taken out the intervening sections carried the arch, and when the intervening sections were removed the invert had the load.

In concreting the arch, steel circular ribs of 4-in. channel iron, with 2-in. wooden lagging, dressed on three sides, were used for the form work. These steel ribs did not require any bracing (Fig. 4) and thereby allowed the cars to be taken right up to the face of the work. In the invert, wooden ribs with 1-in. sheeting were used for form work, allowance being made in placing them for the one ring of brick that was to be laid. When all the concreting



Fig. 9.—Showing Method of Excavating and Nature of Material, Section 2.

had been completed the trestlework and tracks were removed, all the surplus concrete was trimmed off and the brick invert laid. The concrete in the arch was mixed rather wet until the centre of the arch was nearly reached, when it was stiffened up and rammed back on the forms with hoes. In the invert the concrete was made as wet as possible to assure that no voids would be left, as it was being poured in a rather awkward place and tamping was almost impossible.



Fig. 10.—Tunnel Part of Section 4, Showing Method of Excavating and Underpinning.

As in the open cut, electric motors were used to drive the mixers, which were situated in a hole excavated alongside the shaft, large enough for mixer and motor. The concrete was deposited through a chute in the shaft to cars below, which conveyed it to the forms.