work of enlarging the aqueduct, brings the cost of the entire scheme to $9,537,864.

On account of danger of interruption to the hydro-electric plant, it may be necessary to have an auxiliary steam plant, which might cost a half million dollars, even after utilizing such machinery as possible from the existing pumping station.

Also, in the event of the city using aqueduct power to light the streets, squares and public buildings, there will be required an expenditure of probably $800,000 for lamps, poles, wires, sub-stations, etc., all of which are now owned by the Montreal Light, Heat & Power Co.

Adding these two items brings the probable total cost of the scheme to $10,837,864. To this should be added the difference in cost of pumping by steam for the past four years the 3,616 million gallons yearly that were previously pumped by the water-wheels. This was estimated by Mr. Janin at about $32,000 a year, making a total of $128,000 for the four years. As the enlargement cannot be completed for another three years, this adds another $96,000 to this item, thus totalling $224,000. Adding this item to the total cost, gives a sum of $11,061,864. To this must also be charged the discount on the bonds already sold for aqueduct enlargement, and also the interest during construction, all of which will probably bring the total to approximately $11,500,000. It must be remembered that this cost is largely calculated from the city engineer's own figures and assumes that they are not now underestimated. It would, therefore, appear that the engineers who claim that the work will cost from ten to twelve million dollars, may not be far wrong.

Commissioner Cote, in his letter to Mr. Jamieson, calls attention to the fact that a considerable portion of the aqueduct expenditure is chargeable to water supply and not to power development. One hundred and sixty million gallons of fair water could likely have been secured through two conduits similar to the present 9-ft. conduit which cost $660,000. This would have involved an expense of not over $1,300,000 for the two conduits. Adding, say, $700,000 for intakes, etc., means that for $2,000,000 the city might possibly have obtained an abundant supply of water. Moreover, with the $2,228,000 that is being spent on a 100-million-gallon filtration plant, at least one of the two conduits might have been unnecessary, as the filtration plant could possibly handle the kind of water that would have been obtained from the old aqueduct. However, allowing $2,000,000 chargeable to water supply, and allowing $1,000,000 of the power plant as chargeable to water pumping (Mr. Mercier's own estimate), not over $3,000,000 of the scheme appears to be directly chargeable to water supply, leaving about $8,500,000 chargeable to power development, or a capital cost of $850 per horse-power if 10,000 h.p. be developed.

Hydraulic Features.—The effective head is said to be doubtful. Commissioner Cote, in an open letter to Mr. J. A. Jamieson, consulting engineer, Montreal, claims 16 ft. head in the winter at low water, with from 10 to 12 ft. more during summer. It is estimated by hydraulic engineers that there may be considerably less effective head on account of the backing-up of the tail water due to ice jams in the river below the city, and on account of the friction loss in the long headrace, especially when frozen over. Engineers point out the fact that although much money has been expended on the headrace, the head gates and power plant have not yet been designed, which is unusual in construction of a work where all elements are so interdependent as in a hydro-electric development. Mr. Lesage tells *The Canadian Engineer* that arrangements were made with two Montreal engineers to design the head gates and power house. These men, however, were not asked to make any study or report on the whole scheme, and were, in fact, to be retained as designing engineers for that part of the scheme only. One of these two engineers has frequently stated that any power development costing not over $100 per horse-power is sound financially, but that developments costing over that sum should receive careful study. It would be interesting to know his views on this entire scheme, where the cost per horse-power is admitted to be many times $100.

Frazil.—Will frazil reduce or stop the power production during mid-winter months? There are about three miles of rapid, open water above the intake, an ideal condition for the formation of frazil. The Lachine hydraulic plant, with its intake located about 1½ miles below the aqueduct intake, is practically shut down every winter on account of frazil. The large amount of water that would likely be drawn into the aqueduct to develop 10,000 h.p.

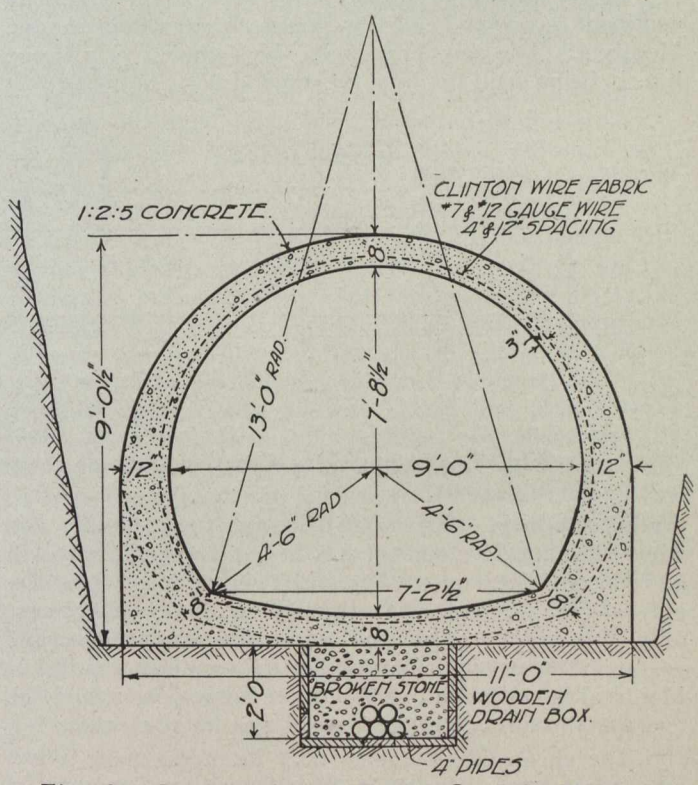

Fig. 2.—Cross-section of Intake Conduit, Montreal Waterworks.

may draw water from the open river instead of from ice-protected shore line as the aqueduct has done in the past. Mr. Lesage, however, claims that their covered forebay will protect them from frazil troubles.

Cost of Power Obtained.—Mr. Janin's report of November 3, 1910, estimates the cost of operation at $24,750, for 7,000 h.p. He figures repairs on machinery and depreciation at 5½ per cent., but applies this to only $250,000 for machinery. Applying this amount also to the additional $300,000 of machinery required to develop the full 10,000 h.p., would add an annual expense of $16,500, making total operating expenses $41,250.

It has already been shown that the possible cost of the development will be $8,500,000. At 5 per cent. this would mean a yearly charge of $425,000. Adding the $41,250 operating expense, gives a total of $466,250 per