from which these curves were plotted correspond to definite slopes, a series of curves were then plotted on the basis of slope in feet per thousand as abscissae, and the dimensions of the sections and hydraulic characteristics as ordinates. By plotting up points from the individual curves at the 85,000,000-gallon level and joining these up with smooth curves the dimensions of the aqueduct sections were then readily obtained for any slope. Similar curves were laid out for all the governing dimensions entering into the design of the sections.

For determining the discharge of the various sections, the values of coefficients as stated in several published reports on other similar structures were studied. Those of Fteley and Stearns made on the Sudbury aqueduct were used as a basis for determining the value of "C" in the Chezy formula, as the general conditions and size of this structure seemed to correspond most nearly to the Winnipeg aqueduct. The values used were determined by plotting the Sudbury results on the basis of variation of hydraulic radius to the value of "C." A conservative curve was then plotted for "C" for the Winnipeg aqueduct on the basis of the Sudbury curve, less five per cent.

Special Features.—The aqueduct structure itself has been designed to be built in two operations, first the invert, and second the arch. Alternate sections of the invert are built in lengths of 15 feet, and after several of these have been placed, the intermediate or closure sections are completed. Steel end forms or "profiles" shaped to the curve of the invert are accurately set to line and grade on 15-foot centres, and the concrete of rather dry consistency is placed between them and then screeded to shape with an angle iron screed. After this operation the surface is floated and surfaced to a smooth hard finish. Between adjacent 15-foot sections of invert a water-stop, consisting of a No. 20 gauge copper strip 6 inches wide and of a length equal to the width of the invert, is placed. Each strip has a V-shaped groove one-half inch in depth crimped in the centre of the strip, running its full length, thereby allowing the joints to open without breaking the bond between the concrete and copper.

After the invert concrete has become hard, the arch forms are then erected by means of a steel traveller running on a narrow-gauge track placed on the invert. These forms are of the Blaw collapsible type made in

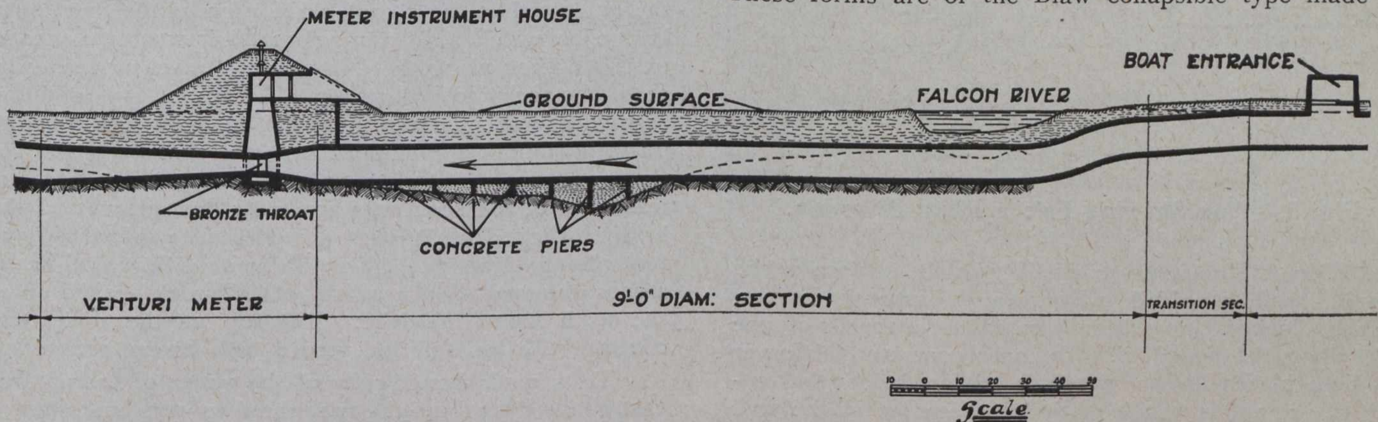

Fig. 4.—Venturi Meter and Falcon River Crossing.

After the sections corresponding to the various slopes had been determined, the whole system was laid out in profile, and the hydraulic grade was plotted for various discharges, the 25,000,000-gallon grade being carried from the easterly end of the pressure section to the McPhillips Street reservoirs, and the other discharges to the site of the future reservoir at Deacon. In order that the effect of the transition sections between the various sizes of aqueducts could be taken into account, as well as the velocity heads, this hydraulic grade was plotted back step by step by means of arithmetic integration. The manner in which this grade was plotted can be briefly described as follows: Starting from any point at which the water level is known, the depth in the aqueduct is thereby fixed and consequently the velocity and hydraulic radius are known as well as the value of "C." With these three known quantities the value of the slope is then calculated from the Chezy formula and a line is drawn upstream from the water surface for a short distance. If this line is not parallel to the aqueduct grade new values for "v," "r" and "C" are then determined upstream a short distance from the first point, and the process is then repeated and a new slope is obtained and plotted from the last point determined. In this way the surface slope is carried back step by step, giving the final hydraulic grade shown. Where a large change of section occurred between two adjacent portions of the aqueduct this method of plotting the surface slope gave some interesting results, showing up a wave in one instance at the foot of the transition section.

lengths of 5 ft. 0 in., bolted together to give a total length of 45 ft. 0 in., which is the standard length of arch poured at one time. Water-stops similar to those in the invert are placed at 45-foot centres in the arch to protect against leakage at the contraction joint. At the horizontal joint between the arch and invert a continuous strip of soft wood 7/8 in. x 1 1/4 ins. is placed half in the invert and half in the arch concrete. Numerous tests made on the sections of the aqueduct already built show that these provisions for making the joints watertight are satisfactory. At no point has any leakage been observed other than a slight dampness in a few instances at the junction of the four joints between arch and inverts.

The aqueduct in its course crosses several streams and rivers and in all cases the crossings are made by depressing the structure beneath the river beds. These sections being under pressure are made circular of reinforced concrete. Overflow and blow-off structures have been provided in the aqueduct at the upstream sides of most of the river crossings, which will serve the purpose of governing the discharge as well as for providing outlets for the water and drainage thereof for emptying portions of the aqueduct for cleaning. The discharges from these overflows enter into the rivers. A general drawing of such an overflow structure with its discharge outlet is shown in Fig. 3. It will be noted that provision has been made for the entering and removal of a small-sized boat which can be used in the aqueduct for purposes of inspection at times of partial discharge. These overflow structures have all been designed for withstanding a