pipe in trench on the lake bottom so that when filled in again the pipe was covered. Concrete in bags was placed around the pipe for 300 feet from the shore line as an added precaution. Four piles were driven in the trench in such a position that when a 140-ft. section was floated into position two piles would be at each end of the section. Across the two piles at each end a sill was bolted at grade and the pipe lowered to rest upon these sills and held in position there by wooden blocks on either side. A cap was

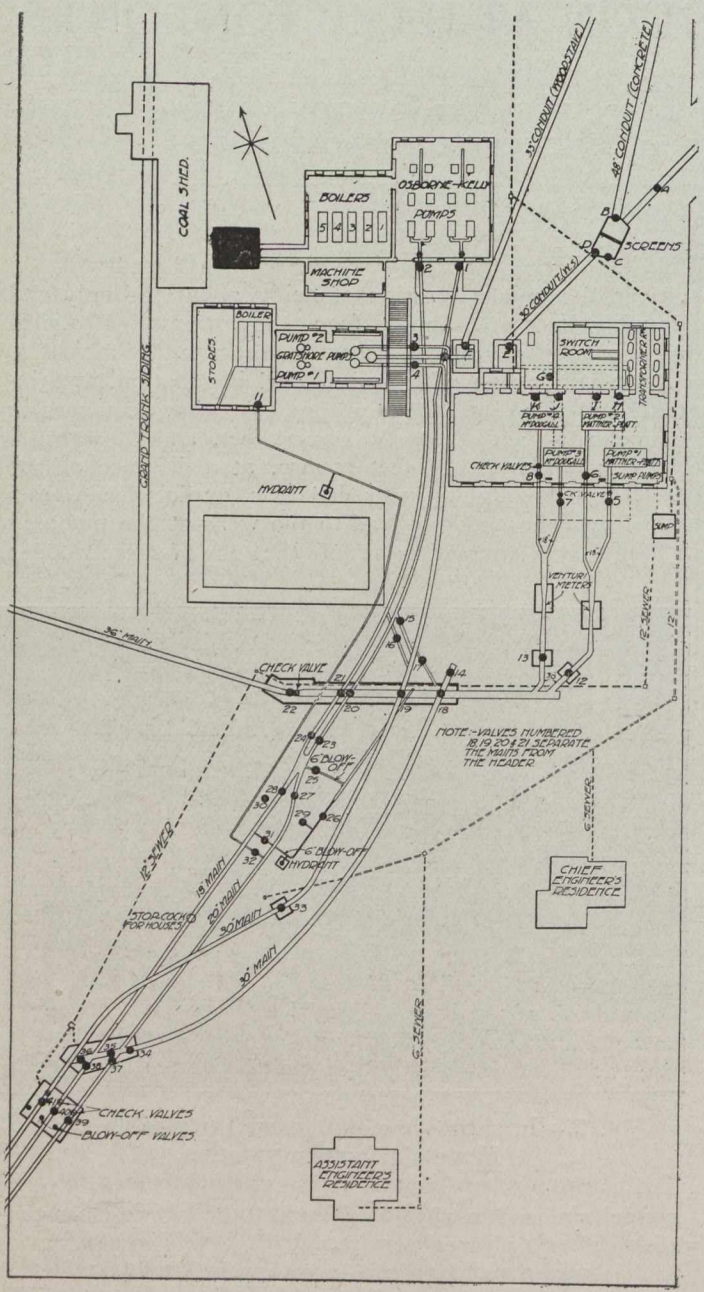

Fig. 3.—General Layout of the Beach Pumping Station and Mains, Hamilton.

bolted across the two piles over the pipe after the section had been bolted to the preceding section by the divers. Besides alignment, the object in driving these piles was twofold; first, for ease in joining up two sections clear of the sand, and secondly, to prevent as much as possible divers not bolting up the lower sections of the pipes because of difficulty of access. As there was practically little possibility of scour on account of the method of construction adopted, it was not considered necessary to space the piles closer. The above arrangement has proved quite satisfactory.

In an examination of the plans for intake cribs adopted by the cities on the Great Lakes it was found that the minimum size was 40 feet square and of sufficient height that the mouth of the intake facing upwards was at least 7 feet above the bed of the lake. This minimum size the writer did not consider necessary, but designed the intake crib to be 24 feet square, placing rip-rap around the outside, and this has since been found quite sufficient. No iron was exposed about the intake openings, but they were constructed with oak plank to prevent the formation of anchor ice. Fish screens were placed in the gate-valve house. A reinforced concrete conduit 4 feet in diameter and 2,000 feet long was constructed to the large well at the pumping station. This conduit, before reaching the pump well, passed through a screen chamber through which the two old wooden conduits also passed. At the intake and outlet of each conduit was placed a sluice valve so that any conduit could be cut off or either part of a conduit. Each of the turbine pumps feed from a small and separate well connected with the main well by a gate-valve cut-off. By this method any foot valve could be inspected and repaired if necessary without interfering with the water supply of the other pumps.

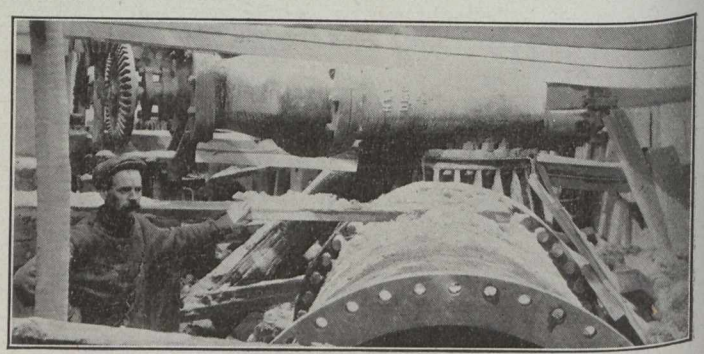

Fig. 4.—Installation of Header for the Beach Pumping Plant.

In the construction or reconstruction of any waterworks system the pumping plant is of paramount importance. What power used— steam, gas or electric— will depend principally upon the cost of these motive agencies delivered on the shaft.

Other considerations will be the capital cost of installation, including size of relative buildings and cost of operation with depreciation.

It should also be borne in mind that if the electric power be brought from a distance that it will be subject to interruptions and is consequently less reliable than the other agencies mentioned.

In Hamilton, on account of the low cost of electric power ($16.50) per annum it was decided to increase the number of electrically driven pumps to meet the future demands and the pumping station for the units already installed was enlarged. Two new electrically driven turbine pumps were installed, each of 6½ million Imperial gallons per 24 hours, or of the same capacity as two units already in operation. There is a steam plant also, having a capacity of 13½ million gallons per 24 hours, which is generally held in reserve to carry the peak load during periods of heavy consumption.

The subject of plunger pumps has been well covered in several text books, but the development of the centrifugal into its present efficiency is less known. This ap-