tempted. This motor is started by first an auto starter in the stator. This is simply a series of transformers so arranged that the line voltage may be applied to the stator windings in gradual steps. This arrangement prevents the sudden rush of current so objectionable to the line and so frequently found in starting smaller induction motors. In the meantime the rotor is an open circuit, which after the full line volts have been applied to the stator is closed gradually through the resistance of a water rheostat. The starting current of this motor is only 30 amperes. It would, of course, have been preferable from an operating point of view to have had this machine two-phase like that below, but, in order to meet the condition of the electric company supplying the power, three-phase had to be adopted. This machine is considered a very satisfactory one, remembering that it was the first; the city motor has some slight mechanical improvements. There has been no trouble like that experienced below in the operation of this motor. A strong, short circuit on the line for a few moments makes no trouble in the pumping station. The starting device is much simpler and less liable to get out of order. Even if it did, the motor could still be started by applying the full line voltage at one step. This would, however, not be agreeable in all probability to the central station people.

EFFICIENCY.

With good steam coal at its present price delivered at that station, the duty of this pump corresponds to 162,000,000 footpounds per 100 pounds of coal approximately. The difference in duty on this basis between the two installations is due, of course, to the higher price of power below and slightly lower cost of coal—the latter on account of the difference in hauling and the former because some 24-hour power is used there. The stator is in two parts divided along a diameter. The rotor is in one piece. The diameter of the shaft through the bearings is 10 inches. The bearings are not self-aligning, which, for a direct connected machine like this, is considered an advantage. The approximate weights of the parts are as



Water End View of Electric Pumps at St. Gabriel Station.

follows: Stator—Top half, 23,500 pounds; bottom half, 29,500 pounds; rotor, 25,000 pounds. As will be observed, the peripheral speed of this machine is fairly high, being over 6,500 feet per minute. This, however, in spite of the minute clearance and large diameter of the rotor, causes no anxiety with modern methods of rotor construction. This equipment would have been most satisfactory from an operating standpoint if it had been thought possible to consider all metal gearing at the outset. Double reduction gearing was ruled out, both on account of its inefficiency, cumbersomeness, and liability to additional disturbance.

THIRD ELECTRIC PUMP.

The third electric pump was installed at the lower station, due to the following considerations: The additional force and supply mains above mentioned between the lower station and Clarke Ave. reduced the load by more than 30 per cent. on the lower motor. The power contract entitled the company to more than it was possible to use under the new conditions in the same proportion. On this account additional pumping capacity at this station was contemplated in the scheme which included additional force main capacity. To take full advantage of the capacity of the electric motor already installed, and at the same time utilize all the power available under the old conditions, it was apparent that an additional power pump of one-half the capacity of the original low-level electric pump was possible. The limits of the building did not admit of a direct connected pump. Accordingly the additional pump now running was placed "back" and rope driven from a friction clutch rope pulley carried by an extended shaft of the original 480-h.p. S.K.C. motor.

POWER PUMP AT ST. GABRIEL STATION.

The chief consideration here was compactness in proportion to capacity. A 161/2-in. by 18-in. duplex, double-acting centre packed pump was adopted, having a capacity of 2,500,-000 Imperial gallons. The general water end design is similar to the foregoing pumps. The pinion shaft was carried back on the cross-head guides to allow of sufficient centres for an efficient rope drive. A feature of this pump, due to the limited space available, was an annular suction air chamber, cast about a section of the 12-inch discharge pipe. The gearing is essentially a double-reduction arrangement, the ratio between the rope pulleys on the motor and on the jack shaft being 1.36, and the spur pinion and gear of the pump 4.19. The spur gearing was as follows: One mortise wheel 9 feet 11.04 inches (83.04 inches), pitch diameter, 88 teeth, 41/2-in. circular pitch, 161/2-in. face. Machine-cut steel pinion, 28.41inch pitch diameter, 21 teeth. Total reduction ratio between motor and crank shaft, 5.698. Speed of crank shaft, 32 revolutions per minute. The wooden cogs fared no better than those at Clarke Ave, and failed in much the same way. A loose and badly made key of the pinion shaft pulley might be sufficient account for the failure. This gearing was, however, replaced by that now running, which consists of a machine-cut cast-iron gear with 112 involute teeth, 3.2975-in. pitch, 117.56-in. pitch diameter, 17¹/₄-in. face, driven by a steel pinion, 29 teeth, 30.42 pitch diameter. Ratio 3.86. As far as this can be seen, this is a satisfactory arrangement. The piston speed of this pump is 96 feet per minute at 32 revolutions per minute. An additional 5,000,000 Imperial gallon electric pump is now under consideration for this station to meet the growing demand, and at the same time a 12,000,000 Imperial gallon reserve steam plant for use in emergency only.

THE MOUNTAIN SYSTEM PUMP.

The electric pump used at the Mountain System Station is a small 8 by 10-in. single-acting, vertical triplex, driven through double reduction gearing by a 7½-h.p., 500-volt. S.K.C. induction motor. The capacity of this little pump is approximately 100 Imperial gallons per minute. As mentioned above, this supplies the people living on the Westmount Mountain. There are no special features about this equipment. An exact duplicate can be seen in dozens of cotton mills, etc., throughout the country. They differ from each other only in size and type of drive. No trouble has been experienced with this apparatus.

NEW ELECTRIC PUMP FOR THE CITY OF MONTREAL.

Before closing, mention should be made of an important similar installation now being erected for the City of Montreal at its high-level station. The pump is, briefly, an 18-in. by 24-in. double-acting, horizontal triplex inside plunger packed pump. This is to deliver 5,000,000 Imperial gallons in 24 hours, and will be run at a piston speed of about 115 feet per minute. The general gearing arrangement is similar to that finally adopted at Clarke Ave., except that a hand-dressed mortise wheel and steel pinion will be used. Pitch diameter gear 188.44 inches, 148 maple teeth, 4-in. pitch, 20-in. face. Pinion, steel, 31.83 inches pitch diameter, 25 teeth. Ratio 5.9-As mentioned above, the motor is electrically identical with the Clarke Ave. machine. A change in the method of adjusting the rotor in its housings has been adopted, so that in case of wear at the journals the motor can be easily raised by the wedges and screws for the purpose. The housings or cheeks have been flared outwards and the sole plates widened to give greater stiffness.

The chief problem encountered with large reciprocating electric pumps is in suitably reducing the speed of a compar-