Electrical Power from the Welland Canal.—I.

DE CEW FALLS have had "greatness thrust upon them." From time to time during several years news items have appeared relative to a great development of water power at De Cew Falls and its electric transmission to Hamilton, Canada, some 35 miles away. As a matter of fact, the falls are quite innocent of all this, and the water for the power development comes from Lake Erie by way of the Welland Canal.

Beaver Dams Creek is one of the small streams that rise in the high tableland between Lakes Erie and Ontario, and its waters tumble down the escarpment that lies several miles inland from the shore of the latter. Near the brow of this escarpment, at a point about three miles from the small but ancient and interesting city of St. Catharines, the creek is received in a reservoir that has been constructed to supply that city with water. Below this reservoir its overflow follows the old bed of the creek, and in so doing plunges into a deep gorge that the stream has carved out of the escarpment on its way to the lower lake during past ages, much as the Niagara River has done on a far greater scale a few miles to the east. This small overflow from the city reservoir, together with the discharge of a brook that joins the creek a little below the reservoir outlet, is all of the water that passes over De Cew Falls, and in dry summer weather the bed of the stream is bare.

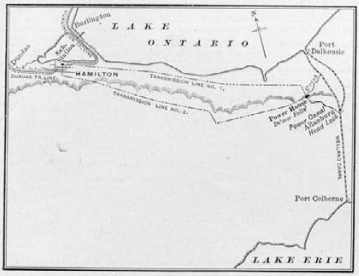

FIG. 1.—MAP OF WORKS, LINES, ETC.

Turning from the mythical water power at De Cew Falls, the real development is found at the foot of the escarpment, on Twelve Mile Creek, a little more than half a mile away. This creek is as free of capacity for power development as the one above named, but its bed is only thirty-odd feet above the surface of Lake Ontario, and thus forms a cheap and convenient tail-race for water from the power house.

Water for this power development is drawn from the old and new Welland Canals close to their point of junction near Allanburg, Township of Thorold, County of Welland, Ont., about four miles distant. All save about 800 ft. of this distance, which represents the approximate length of the steel pipes between the forebay and the power house, is traversed by a canal that widens into reservoirs at several points. During the past year the canal and these storage reservoirs have been much enlarged, so that the latter, which formerly had an area of only 40 acres, now measure 450 acres, and contain 50,000,000 cu. ft. of water. Taking the normal surface of Lake Ontario as zero level, the elevation of water in the power canal at the intake weir is about 325 ft., at the forebay the elevation is 306 ft., and the elevation of the tail water in the creek below the power house is 38 ft. Between the surfaces of forebay and tail water the difference of elevation is thus 268 ft., from which a small deduction must be made for loss by friction in the pipes, in order to get the effective head on the wheels. This hydraulic development has been constructed under the right to draw water continuously from the Welland Canal at the rate of 700 cu. ft. per second during a period of 63 years. The storage basins are designed for a rise and fall of 3 ft. in their water level when in use, and the volume of water that may be drawn from them during a period of heavy load is thus 450 × 3 = 1,350 acre-feet, besides the constant diversion of 700 ft. per second from the Welland Canal. As one acre-foot equals 43,560 cu. ft., a reduction of 3 ft. in level over the 450 acres of the reservoirs would yield 5,880,600 cu. ft. of water for the power plant, a volume equal to that which may be drawn from the Welland Canal during 23.33 hours.

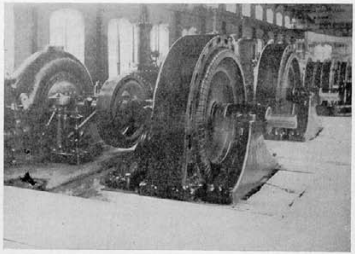

FIG. 3.—INTERIOR OF DE CEW FALLS POWER HOUSE.

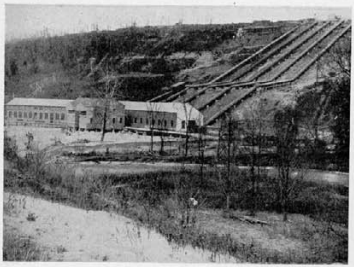

FIG. 2.—PENSTOCKS, POWER HOUSE AND TRANSFORMER HOUSE.

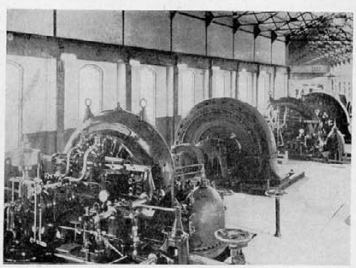

FIG. 4.—INTERIOR OF DE CEW FALLS POWER HOUSE.

Allowing 8 ft. of head for the losses in the pipes and draft tubes

that connect with the turbine water wheels at the power house, so that the effective head is 260 ft., the 700 cu. ft. of water per second that may be drawn from the Welland Canal, at 62 pounds per cu. ft., will develop 20,516 hp. If the turbines have an efficiency of 80 per cent., the allowable draft on the Welland Canal will thus develop about 16,000 hp for electric generators. This output may be multiplied several times by use of the stored water during short periods of several hours each.

The forebay on the brow of the escarpment, some 250 ft. above the power station, terminates in a heavy masonry wall that is pierced by four steel pipes of 8.5 ft. inside diameter each. Provision is also made for two more of these pipes that will be installed later, and each is provided with a head gate. Somewhat more than halfway down the face of the cliff the direction of the pipes changes, so that they make only small angles with the horizontal for some distance, to correspond with a natural shelf of the escarpment. On reaching the power house the pipes pass underneath the main floor, and to water wheels that are arranged in a row along its more distant side. A. Riva, Manneret make, single-runner, single-discharge type, and each is rated at 286 r.p.m. and 3,300 hp. Each of the other four main wheels was built by J. M. Vaith, of Heidenheim, Germany, has a double runner and double discharge, and is rated at 7,100 hp and 286 r.p.m. For the operation of exciters there are two Stilwell-Bierce turbines, each rated at 800 r.p.m. and 50 hp. A 30-kw Crocker-Wheeler exciter is direct-connected to each of these turbines. All of the above water wheels operate under the approximate head of 268 ft.

To each of the 1,700-hp wheels a Royal Electric inductor alternator is direct-connected, and each of these alternators is rated at 1,000 kw. A Canadian General Electric alternator of 2,000 kw capacity is coupled to each of the 3,300-hp turbine wheels. The 7,100-hp wheels are intended to drive four alternators of 5,000 kw capacity each, and two of these alternators of the Westinghouse make are now in position. All of the alternators just named are of the three-phase type, and operate at about 66 cycles per second and 2,400 volts. The combined rating of the six alternators now in position is 11,000

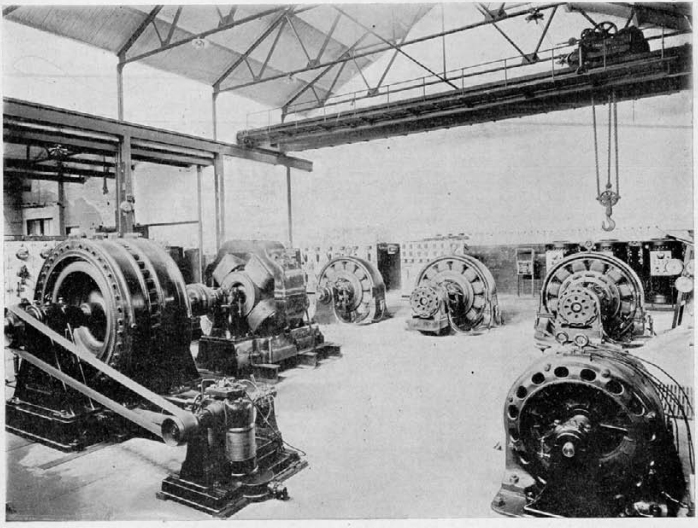

FIG. 5.—MOTOR-GENERATOR SET AND 300-KW ROTARY CONVERTER, SUB-STATION "A."

The power house is a long, narrow, one-story brick building, with its longer sides approximately parallel with Twelve Mile Creek, which serves as the tail-race, and at right angles to the general direction of the steel pipes. Steel trusses support the roof of the station and beneath them a traveling crane sweeps the entire space occupied by the water wheels and electric generators. The wheels and generators are in the same room, each generator is direct-connected to its own wheel, and all of the units thus formed are horizontal and are arranged in a row parallel to the longer sides of the station. At one side of the station is the transformer house, a separate building, where the high-voltage lines that transmit the energy to Hamilton terminate.

Eight main turbine sets are provided for the operation of an equal number of electric generators. Two of these turbines are of the Stilwell-Bierce make, single-runner, single-discharge type, and each is rated at 1,700 hp and 400 r.p.m. Another two wheels are of the kw, and the other two 5,000-kw generators for which provision has been made will raise this total to 21,000 kw.

Much the greater part of the electric energy developed at this water power station is raised to 22,500 volts and transmitted to Hamilton, 34 miles away, but a portion of it goes to the city of St. Catharines, about three miles distant, at the generator voltage of 2,400 for electric supply there. In the transformer house at the generating station there are at present 25 transformers for raising the generator voltage of 2,400 to 22,500, or to 45,000 for the transmission. Twenty of these transformers are of Royal Electric make, oil-insulated, water-cooled, and step the voltage from 2,400 to 22,500, three-phase. Ten of these twenty transformers have an individual capacity of 200 kw, and the other ten an individual capacity of 400 kw, so that the combined capacity of the group of twenty is 6,000 kw. Five other transformers, also of the oil-insulated, water-cooled type, are of Westinghouse make, are rated individually at 2,500 kw, and