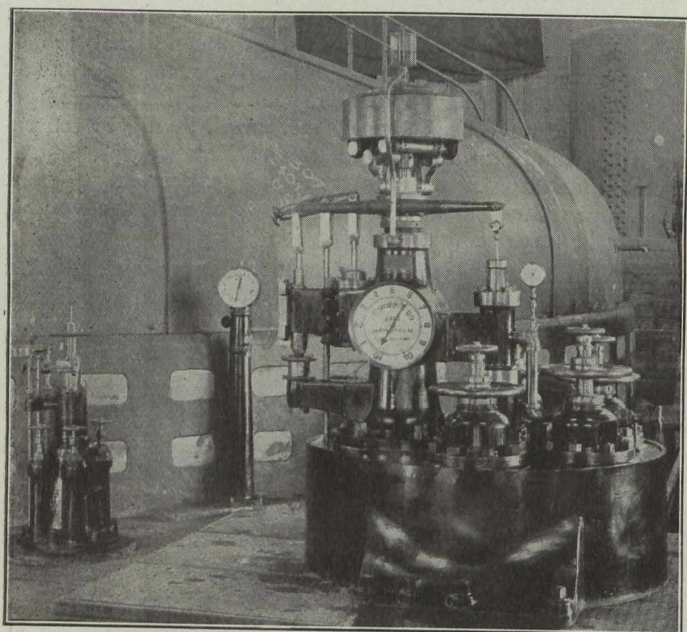
potential of 6,600 volts; that full load rating in amperes at a voltage of 7,200 volts must be carried for several hours without damage; that the temperature rise must not exceed 45 deg. C. at end of a 48-hour run; that the



One of the Main Governors (Unit No. 9.)

iron losses must not increase more than 5 per cent. after two years' operation.

The efficiency guaranteed at full load was to be 94.5 per cent. at 75 per cent. power factor; 95.5 per cent. at 90 per cent. power factor; 96.1 per cent. at 100 per cent. power factor. The highest efficiencies guaranteed—at ¼ load—were to be 95 per cent. at 75 per cent. power factor; 95.8 per cent. at 90 per cent. power factor; 96.4 per cent. at 100 per cent. power factor.

The units installed have met the most sanguine expectations. The outside diameter of the stator is 37 ft. 4 ins., and the unit is the largest in diameter which has been installed to date. The height of the stator frame from the floor line is only 33 inches.

Excitation.—In providing for the excitation the usual practice of installing large D.C. units, water-wheel driven, was departed from. In their place were installed three A.C., 1,250 kv.a., 2,300-volt, 3-phase units, excited by an 18-kw. D.C. generator on same shaft and turbine-driven, also a bank of three 1,000 kv.a. transformers, which permits of one of the large units being used for excitation purposes in emergencies.

These A.C. generators furnish the energy for driving the individual motor generator sets for exciting the large units. This method was adopted because in case of trouble on an individual exciter set only one main unit would be affected; all auxiliary machinery would be A.C. motor-driven with low operating costs; it is easier to obtain automatic voltage control with individual generator exciter sets; the investment in cables, switches, etc., is lower; the cost of spare apparatus is reduced; and in emergencies one of the large units can be used.

Switchboards and Switchgear.—The dominant point kept in mind in design of switchboards and accessories was to obtain the most flexible system consistent with minimum initial cost and continuity of service. The double busbar arrangement was adopted and designed in such manner that a failure on any one section would not cripple the next unit. One main control and instrument board is installed in the power house. In the transformer house a control desk and instrument board are installed for controlling the step-up transformers and out-going lines. All switching apparatus has been installed in such manner that extension to the plant can be made without interfering with operation of present units.

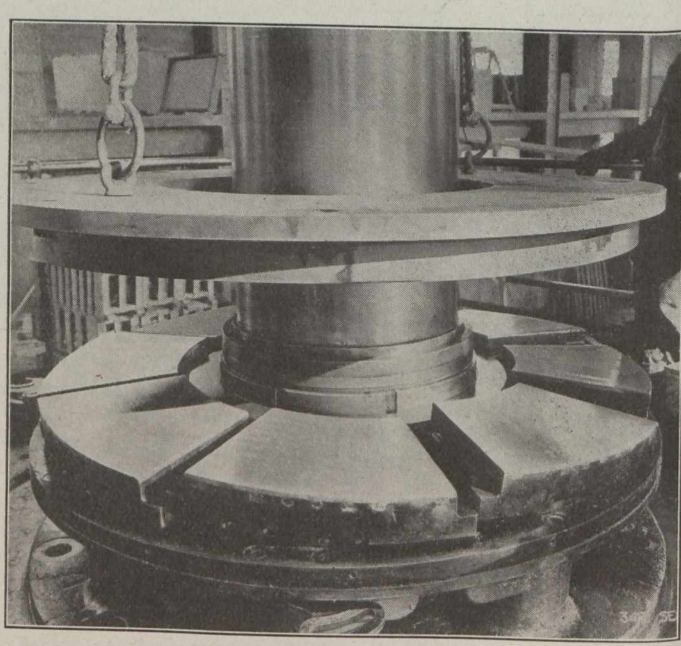
All busbar and switch structures are of reinforced concrete, which was adopted in place of brick because barrier work could be made thinner, loading on floors was much less, and it was easier to obtain greater clearances for live parts to ground in same space. For switch cells and busbar structures, 277 cu. yds. of reinforced concrete were required, at an average cost of $58.70 per cu. yd.

The generators, exciters, switchboard apparatus, etc., were supplied by the Canadian General Electric Co., Ltd.

Cables.—All cables used on the main generators operating at 6,600 volts were installed for 13,200 volts pressure. Cables used for 2,300 volts operation are installed for 4,400 volts. The increased cost is more than offset by insurance against failures. Lead-covered, paper-insulated cables were used in all places subjected to moisture. All cables were designed with cross-sectional area of sufficient size to carry 50 per cent. over normal current continuously. All large single conductor cables on A.C. circuits have rope cores to minimize skin effect. In designing cables, 1,200 c.m. per ampere was generally allowed.

The most important part of the cable design was the size and kind to use on the main units connecting power and transformer houses. The final adoption was four 3-conductor, 300,000-c.m., lead-covered, paper-insulated cables per unit.

Some of the reasons governing this decision were: (1) Increase in apparent resistance of single-conductor lead-covered cables, carrying heavy currents at 60 cycles was found to be abnormally high; (2) the three-conductor cable was slightly cheaper in initial cost; (3) in the event of failure of one of the four cables, partial service could be obtained during repairs.



The Kingsbury Bearing of Unit No. 5, During Installation Operations.

Where the cable runs were comparatively short, single-conductor cable was used to facilitate handling, and on account of the fact that the outside diameter was less, thus taking up less room.