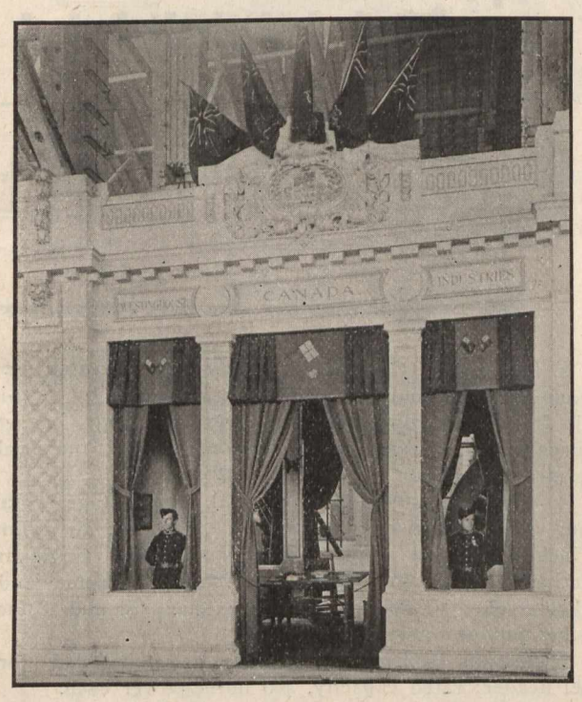
over the network of underground cables at a potential of 6,600 volts, transformers being used only at distributing points. All Exposition power is controlled from the twenty-nine-panel marble switchboard on the upper gallery over the west end of the main aisle. The electrically operated oil switches are behind the operating panels, the busses and instruments on the lower gallery, busses being in duplicate, and housed in a structure of masonry with intermediate barriers. All main generator and feeder switches are installed in independent fire-proof vaults, and are electrically operated from the main panel, indicators showing whether a switch is open or closed. Remote control of high tension current is exclusively employed, the switchboard being supplied with high tension, oil-immersed, automatic circuit-breakers, and with ammeters and voltmeters for each space.

Starting the Cascades.

The three 2,000 horse-power Westinghouse induction motors which operate the cascades pumps, estimated to have a capacity of 90,000 gallons of water a minute, are started very gradually at the advertised hours throughout the day and evening, the current being slowly raised to normal, the starting rheostats under Festival Hall, because of the exceptionally large size of the motors, having very many steps. Integrating and indicating wattmeters at the ends of the cables in Machinery Hall record the motor load when the cascades are in operation.

Generating Units.

The four main units are alike in capacity and general design. The engines are of the vertical "cross-compound" type, built vertical to economize floor space, and compound



Canadian Booth in Westinghouse Street of Nations, Palace of Machinery.

in order to secure greater economy of steam, and operate at a speed of eighty-five revolutions a minute. As the generator and flywheel are mounted between cylinders, a connecting "receiver" is necessary, which is built of riveted boiler steel plate, and conducts the exhaust steam from the high pressure cylinder to the inlet of the low pressure cylinder. Bed plates, one on each side, support in order the journals, engine frames, cross-head guides, and cylinders. The shaft, which is nearly three feet in diameter at the centre, is forged hollow from open hearth steel, fluid-compressed to ensure perfect homogeneity of metal. On account of the long span the bearings are self-aligning, having spherical instead of cylindrical seats, resembling the ball and socket arrangement, this permitting slight flexure of the shaft, due to the load concentrated at the centre. Both the bearing shells and the cross-head guides are arranged for water cooling.

Rocking valves of the Corliss type are located directly in the cylinder heads, which connect with "side pipes" paralleling the cylinder walls, a trip release gear on the inlet and a toggle motion on the exhaust controlling these valves. The gear permits a maximum cut-off of three-quarter stroke, enabling each engine to sustain for short periods a load of 5,000 horse-power. The speed of the unit is controlled by an enclosed type self-oiling centrifugal governor, adjustable while running for spring tension and sensitiveness.

In order to operate the generators in multiple, a small motor is provided at the engine, which moves an adjustable weight on the governor mechanism. This motor is controlled from the switchboard, so that the engine speed may be adjusted until the incoming generator has been synchronized and connected to the system. An automatic speed limit is provided on the engines, which instantly closes the throttle should the safe speed be exceeded through breakage of the governor mechanism. This mechanism may be operated also by the engineer from the main floor by means of an electric switch.

The generators, which are rated at 2,000 kilowatts at the usual temperature rise, are of the engine type, revolving field construction, with laminated armatures and fields, the armatures strap wound in partially closed slots, and the fields wound with copper strap on edge. In order to obtain access to the winding the entire generator frame may be moved out of position parallel to the shaft. Three 80 kilowatt, 125-volt Westinghouse engine type units furnish exciting current for the generator fields.

Condensing System.

All main and exciter engines, as well as auxiliaries in Machinery Hall, operate condensing, two complete central condensing equipments being installed, each of 7,000 horse-power capacity, and serving one-half of the plant. They are of the Worthington elevated jet or "barometric" type, provided with entrainers and rotative "dry air" pumps for removing air from the condenser cones. Both horizontal and vertical types of pumps are in operation, one of the three being held in reserve. In case of loss of vacuum an automatic relief valve allows the exhaust steam from the engine to escape through the roof. A motor-driven valve, operated from the floor below by a switch, controls the steam inlet to each condenser. Circulating water is supplied to the condensers by a centrifugal pump of the Worthington turbine pattern, direct driven by compound engine. The hot water discharged into the condenser hot wells is not thrown away, but is cooled for further use in four specially designed cooling towers adjacent to the boiler-room. A second turbine circulating pump elevates the hot water into the towers, and, in falling, the temperature is reduced by evaporation, which process is further aided by forced draft from the fans located at the base of each tower and driven from the boiler-room by a Westinghouse compound engine. A third turbine pump unit is held in reserve, and may be employed on either condensers or cooling towers. Motor driven valves operated by a switch from the floor control the outlet of each pump.

Steam System.

Two complete systems of steam mains, twelve inches in diameter, convey steam to the main engines. The mains are carried beneath the floor in pipe galleries, anchored firmly to prevent creeping, and supported upon rollers to accommodate expansion and contraction. Entrained water collecting in the boiler-room piping is drained out and automatically returned to the boilers by a steam loop and gravity return, which may be seen in continuous operation in the boiler-room.

A similar system of piping for the boiler-room and pumping auxiliaries is connected to the boilers between the drums and main valves, so that steam is always available at the boiler-house auxiliaries. These operate non-con-