means of which the entire inside water system, including racks and gates, can be completely unwatered.

Each unit has three openings, about 13 ft. in width, each of which is provided with two gates, upper and lower, the combined height of which is 27 ft. There are, therefore, six gates for each unit. Two different schemes were adopted for their manipulation. The bottom gates descend by their own weight and are raised by motor-driven drums. The upper gates are provided with screw hoists. A reinforced concrete beam, located about half-way down in the entrance to the wheel chamber, supports these upper gates. It requires a 15 h.p. motor to operate the three lower gates and a 30 h.p. motor to operate the three upper gates.

The exciter turbines are provided with two gates, operated by a screw hoist similar to that used by the main units.

Studies of friction between gates and guides were very carefully conducted and the efficiency of the hoists exhaustively studied.

Mr. Smith devotes some space to the factors governing the selection of the vertical type of unit in place of the horizontal, observing that he had previously been an advocate of the horizontal unit on account of the various difficulties with the thrust bearings and the operating experiences of many in connection with the vertical unit. The horizontal unit has the advantage of being very much more accessible, both as regards water-wheel and generator, while in the case of serious repairs, the vertical machine must be almost entirely dismantled.

In the Cedars development it was decided to limit the number of units to eighteen. If the horizontal machine had been adopted, these units, of over 10,000 h.p. each, would have necessarily required at least four runners. The diameter of the single runner at its widest point is nearly 18 in., and it is evident, states Mr. Smith, that a single runner cannot be turned up on edge and used in a plant, the total head acting being only 30 ft. A very exhaustive study was made of this four-runner design, and the results were so much in favor of the single runner that the vertical type was adopted.

The main unit consists of a single runner vertical wheel supported on a thrust bearing carried on the top of the generator. The shaft is held in line by one babbitted guide bearing immediately below the thrust bearings and one lignum vitæ water-lubricated bearing just above the wheel. The speed of operation is 55.6 revolutions per minute.

The shaft is a solid forging, with a coupling at the lower end, where it is bolted to the water-wheel runner. It is 32 ft. long, 25 in. diam. and 24 in. diam. at the lower and upper guide bearings, respectively, and 27 in. diam. in the hub of the generator.

A unique feature is the provision of a cast-iron speed-ring, located just outside the movable guide vanes to provide support and to guide the water in the proper direction.

These movable guide vanes control the amount of water admitted to the wheel. They are operated by two trunk piston operating engines connected to the operating ring at points 180 degrees apart.

The runner is the largest in dimensions yet constructed, being 17 ft. 7 in. in diam. The total weight of the revolving system is 550,000 pounds. This weight is carried down through the bridge on top of the generator and through the generator frame itself to the cast-iron pit liners, which, in turn, transmit this load to the speed-ring and the speed-ring carries it to the concrete foundations of the power house.

On account of the characteristics of the thrust bearing and in order to save time in shutting down each unit, a system of grates, operated by compressed air, was installed. There are six break-screws of hard rock maple, each with a face of 225 sq. in., pressed against the lower edge of the specially designed generator rim. Compressed air at 90 pounds pressure brings the revolving mass to rest in less than five minutes.

The power-house is served by two cranes of 150 tons each, among the largest in Canada, each with an auxiliary hoist of 10 tons. The span is 61 ft. 3 in. and the lift 49 ft. Each crane is operated by four 3-phase, 60-cycle, 220-volt motors. A 30-ton crane operates in the gate-house with 32 ft. span and 40 ft. lift.

The governor system supplied by the I. P. Morris Co. is the open system, consisting of pumps applying pressure direct into mains, which convey the pressure to the governor engines and governor control apparatus. The discharge from the apparatus flows back into an open tank. In this extensive Cedars system considerations of water hammer had to be gone into carefully, the medium used in the governor being water. A unique feature of the system outside of the large sizes of pumps, which are six-stage centrifugal, with a maximum pressure of 250 pounds and a capacity of 1,100 U.S. gallons per minute, is the use of a reinforced concrete flume lined with copper extending the whole length of the power-house and acting as a storage for water for the governors.

One special feature of the entire arrangement of the power-house is that all auxiliary apparatus is on practically the same level as the main units, and no machinery vital to the operation of the plant operates in lower levels, tunnels or inaccessible places. The exciter machine, motor generator sets, pumps and other auxiliaries are all under the eye of the men in charge of the main units.

The lubricating system is an extensive one. The thrust bearings of each main unit require 15 gallons per minute and that of each exciter unit five gallons per minute. The guide bearings of the main and exciter units require 3 gallons and 1 gallon per minute, respectively. Sufficient storage is supplied to operate the plant for 30 minutes in the event of the stoppage of the electrically-operated centrifugal pumps, which bring back the oil to the filters, from which it flows by gravity through storage tanks to the different thrust bearings and guide bearings.

Mr. Smith's paper concludes with a brief summary of construction. The first work started in June, 1912. Power-house excavation started in the spring of 1913. The first concrete was placed in August, 1913, and the power-house was completed in October, 1914. The canal was flooded on October 29th, 1914, and in December the entire plant was turned over for operating.

The American Well Works Co., of Aurora, Ill., are establishing a branch at Chatham, Ont., having purchased the factory formerly occupied by the Defiance Engine Co. They intend to add to the buildings and equipment of this concern at once, and will begin operations at an early date. They will start with a force of about 60 men and will manufacture various lines of pumps, making a specialty of deep-well pumps. Their sales agents are R. H. Buchanan and Co., of Montreal; Gorman, Clancey and Grindley, Limited, Edmonton and Calgary; and the British Columbia Equipment Co., of Vancouver.