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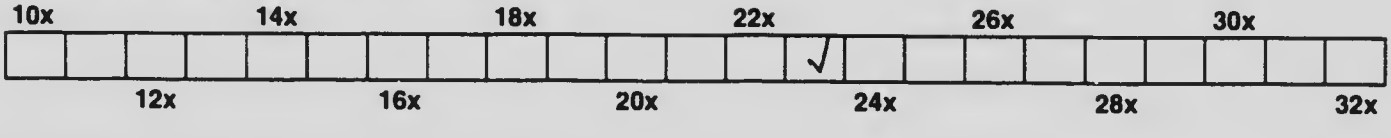
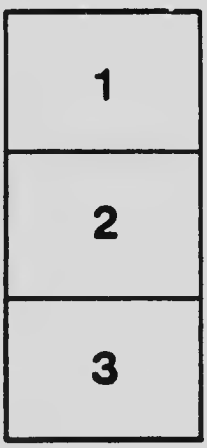
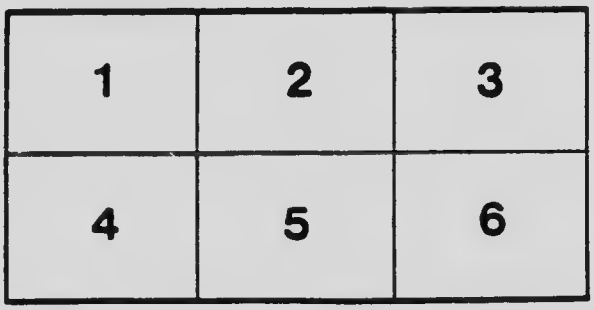






NIAGARA FALLS SHOWING POWER PLANTS ON CANADIAN SIDE

The Ontario Power Company of Niagara Falls.

THE grants from the Government of the Dominion of Canada, under which this Company is making its development of 180,000 horse-power, were secured in 1887. These concessions were the first, for the utilization of Niagara River power, granted in Canada, and were contemporary with the first concessions granted in the United States.

The plan of development as at first contemplated is only partially followed in the design of works now under construction, the headworks being situated at the upper end of the Park instead of at Chippawa at the mouth of the Welland River. In general, the present design consists of Headworks located in the smooth water of the upper river above the first line of rapids opposite the Dufferin Islands, three Main Conduits or flumes leading the water through the Park to a point on the cliff below the Falls, thence by Penstocks in tunnels through the cliff to the Generating Station in the gorge, with its water wheels and electric generators, and lastly the Distributing Station situated on the high bluff directly above, to which the electric cables are carried from the Generating Station in inclined tunnels. The Company still retains the right to draw additional water from the Niagara River at Chippawa and to develop power therefrom in the Park in addition to the 180,000 horse-power now under construction.

The details of the present construction are briefly outlined in the following general description :—

HEADWORKS

The Headworks consist of an intake proper, and outer forebay, screens, an inner forebay and control gates.

The intake, 618 feet long, consists of concrete piers supporting a continuous, reinforced concrete curtain wall which extends vertically downward seven feet below the normal surface of the river, to within six feet of the river bed, and upwards five feet above the normal river level, which at this point is about 559 feet above sea level. More than double the quantity of water

to be utilized at the water wheels is intercepted by the upstream face of the intake, and much is there deflected to form a cross current which will carry away ice. This is brought about by the curtain wall construction and the placing of the structure at an obtuse angle to the natural direction of the current in the river.

The outer forebay, which contains an area of eight acres, is bounded by an artificial island and the original river bank on the one side, and by a long concrete gathering wall on the other. A supply of water is provided for the restoration of the Dufferin Island channel, which is controlled by sluices on either side of the island mentioned.

Except during extremely low stages of water in the river, the outer wall of the forebay will be constantly submerged, water spilling freely over it into the river, as over a weir, carrying floating ice and debris with it. The top of the wall is at an elevation of 553 feet above sea level. A section of this wall, 100 feet in length, adjacent to the screen house, is constructed with the top depressed below the crest of the main portion. When water at the intake is at extreme low level, there is thus an additional discharge area of approximately 300 square feet cross section over the depressed section. This spillway creates a strong surface current across the front of the screens, tending to sweep out into the river all ice that may have passed the ice curtain at the intake and escaped the general spill over the wall.

The screens are in the form of a steel grillage, set on inclined guides in concrete masonry, and are removable by means of a crane. The apparatus is covered by an artistic stone building, the roof of which forms a broad promenade, commanding an exceptionally fine view of the rapids.

The inner forebay, with an area of two acres, extends from the screen house to the gate house. The landward wall and the river wall are formed partly by the rock face after excavation had been made in the river bed, and partly of concrete. On the land side, excavated material has been dumped and graded to bring the general surface of the islands in this vicinity up to the same level as the top of the concrete wall, at elevation 560. The original Dufferin Islands have been increased in area, and several entirely new islands of considerable size have been made from the excavated rock, approximately 150,000 cubic yards, taken from the bed of the river in deepening the two forebays.

ONTARIO POWER COMPANY, MAIN CONDUIT
EIGHTEEN FEET DIAMETER

SITE OF GENERATING STATION OF THE ONTARIO P[illegible]

The quantity of water that will be drawn into the inner forebay when the entire capacity of the plant is being generated has been calculated to be in the neighborhood of 12,000 cubic feet per second. The depth of water in the headworks under normal conditions of river gradually increases from 13 feet at the intake to 30 feet at the gate house. The velocity of flow is about three feet per second at the intake; it is swiftest, 4.7 feet per second, through the central portion of the outer forebay, and it drops to two feet at the screens, then gradually increases to 3.4 feet per second at the gate house.

The gates at the entrance to the conduits are three in number, one for each of the main conduits. They are of the Stoney pattern, of square form, full size of their respective conduit and counterbalanced to run between roller guides. A substantial and artistic building covers the gates, and an equipment of boilers and steam pipes provides against freezing.

The design of all buildings throughout the works has met the approval of the Park Commissioners, who require preservation or enchancement of the æsthetic effects that prevailed in the Park before present construction began, and it is felt that their object is fully attained.

THE MAIN CONDUITS AND PENSTOCKS

Starting from the gate house, the main conduits, three in number, follow the river bank through the park to the top of the cliff opposite Goat Island. The distance to the nearest penstock is 6,180 feet, in which length the fall in grade is 28 feet. The first of the three conduits which is now nearing completion, is 18 feet in interior diameter. When flowing at full capacity it will pass about 3,900 cubic feet of water per second.

The main conduit now constructing is built of steel plates ½ inch in thickness with double riveted joints. To secure additional stiffness, seven inch bulb tees or deck beams are riveted to the upper half of the circumference of the pipe at intervals of four feet throughout its length. The pipe is erected in a trench excavated in the Park, and before backfilling, is thoroughly cleaned with sand blast and covered with three coats of paint both inside and out. Conductors are arranged to protect the steel conduit from stray electric currents, which might otherwise cause damage by electrolysis. An open relief and spillway through a tunnel to the river is provided at the lower end to reduce fluctuations of head and pressure at increase and decrease of loads.

From the under side of the first main conduit, six penstocks, each nine feet in diameter, drop in pairs through vertical shafts and out through horizontal tunnels in the solid rock of the cliff to the power house. Each penstock supplies water for a 10,000 horse-power unit. The vertical distance from the center of the main conduit to the center of turbine is 133 feet. Two small penstocks, of 30 inches diameter, lead from the main conduit through an inclined tunnel to the power house and supply water for the two exciter turbines.

A chamber beneath the main conduit at the junction of penstocks accommodates the 108 inch penstock gate valves and operating mechanism.

GENERATING STATION AND APPARATUS

The building is 76 feet wide and 65 feet high, and for the full capacity will be about 1,000 feet in length. The roof is flat and the general style of architecture is massive and somewhat after the Egyptian order. The front wall is designed to withstand pressures that may result from ice gorging and rising in the river in front of the building. The floor level is 25 feet above the normal level of the river.

The main generators and their turbines, directly connected, are the only machines placed on the floor of the station. Each turbine unit consists of a pair of Francis turbines, mounted on a horizontal shaft, operating at 187.5 revolutions per minute, and rated at 11,400 horse-power. Before reaching the turbine, the penstock supplying it divides into two branches leading to the separate wheels that constitute one complete turbine. After passing through the wheels, the water flows through concrete draft tubes, terminating in tail races in the foundations of the generating station, which in turn discharge over a weir wall into the river. The crest of this weir wall is at elevation 349, and under full load conditions water rises on it to about elevation 353, giving as the gross head, between forebay and tail water levels, 200 feet. Of this head, 175 feet is effective on the turbines.

Six of the 20 main generators provided for by the general plan, make up the first installation. Each of these generators is rated at 7,500 kilowatts, to deliver three phase current of 25 cycles per second at 12,000 volts. They are of the rotating field type and have 16 poles each, the external diameter of the armature

casing being about 21 feet. The floor space they occupy is about 26 x 20 feet each, the shorter dimension being along the shaft. The total floor space occupied by a unit, consisting of a generator and its turbine, is about 26 x 50 feet.

On a raised gallery, 11 feet above the main floor, and extending along the rear wall of the station, are located the exciter turbines, the direct connected exciting dynamos and the governors that regulate the speed of the turbines. This arrangement permits of an attendant watching the operation of the entire station, while within easy reach of important control elements of the apparatus. Contrary to general practice, however, the actual operation or management of the generating station is not conducted within its walls, but from a separate control and distributing station at a distance from the generating station. The placing of main switches, indicating instruments and similar apparatus elsewhere was necessary on account of the limited space available at the station site. The removal, however, permits of the convenient placing of this apparatus in relation to transformers and high tension switches.

Each exciter turbine and dynamo is of 500 horse-power capacity, and operates at 300 revolutions per minute, generating direct current at 250 volts. They are used for the operation of lamps, motors, oil switches, and for charging storage batteries, as well as for exciting the generator fields. One alone has sufficient capacity to excite the fields of six main generators, but two are provided for each group of six units.

Certain features of the controlling apparatus are naturally inseparable from the power house. These include 250 volt switches for the circuits from direct current dynamos to generator fields, to lighting circuits, storage batteries and the like, also switches for the circuits operating the valves in the nine foot penstocks. Time limit and overload relay switches for the protection of the main generators are also placed in the power house.

CONTROL AND DISTRIBUTING STATION

At a distance of 550 feet back from the generating station and on the bluff at an elevation of 250 feet above it, is situated the control, transforming and distributing station, as shown in the ac-

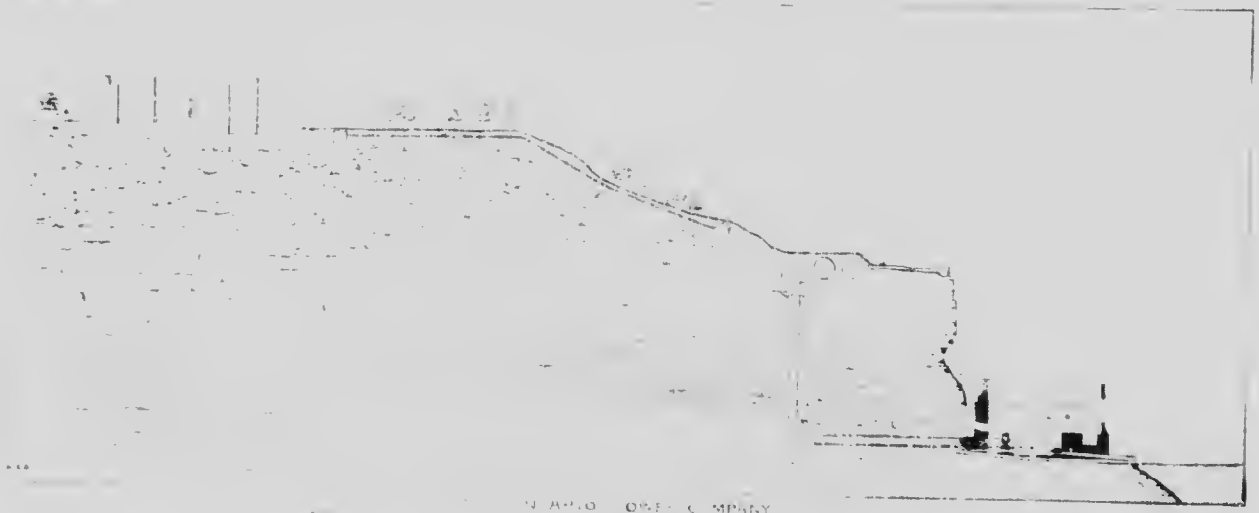
companying illustration. This distant control removes from the generating station the possible dangers incident to the operation of high voltage switches for generators, as well as for transformers, and also concentrates the management of both in a single operating room. On a raised gallery, indicator switches on individual pedestals afford control of speed, voltage and connections. Just back of each control pedestal there is an instrument stand which carries a full set of indicating instruments.

The control circuits pass from the generating station in insulated cables carried through inclined tunnels in the cliff, extending to a point on the hillside a little above the main conduits, thence up the bluff under ground to the distributing station. The electrical energy from the generating station is transmitted by heavy cables, insulated with paper and lead, and protected with layers of jute and steel, which follow the same route to the distributing station. They are laid in tile ducts imbedded in the sides of the tunnels.

In a separate switch room at the distributing station, the automatic oil switches for the 12,000 volt circuits from generators, are mounted in concrete cells, an isolated group for each unit. They are of the vertical plunger type and are magnetically actuated.

Transformers occupy the central place through the length of distributing station building, except in the middle, where space is given to the control gallery. Fireproof masonry walls separate low tension switch room, control gallery, the two transformer rooms and high tension switching rooms, from one another. The rating of each transformer is 2,500 kilowatts, or 3,350 horse-power, and each one weighs about 40 tons. They are set in concrete pits, in groups of three, and are water cooled. The potentials for which they are designed are 30,000 and 60,000 volts.

Three pole high tension switches of special design, to break a maximum current of 10,000 horse-power, thus necessarily involving some novel construction, connect the secondary coils of transformers to high tension bus bars. Transmission circuits will be taken off from these bus bars, although current may also be delivered to transmission circuits at generator voltage direct.



The distributing station building is of imposing appearance, as it occupies a prominent position on the bluff overlooking the Park and Horseshoe Falls. A wing to accommodate the offices of the Company extends forward in the center.

The works are being constructed by the Niagara Construction Company, Limited.

The Directors are :—

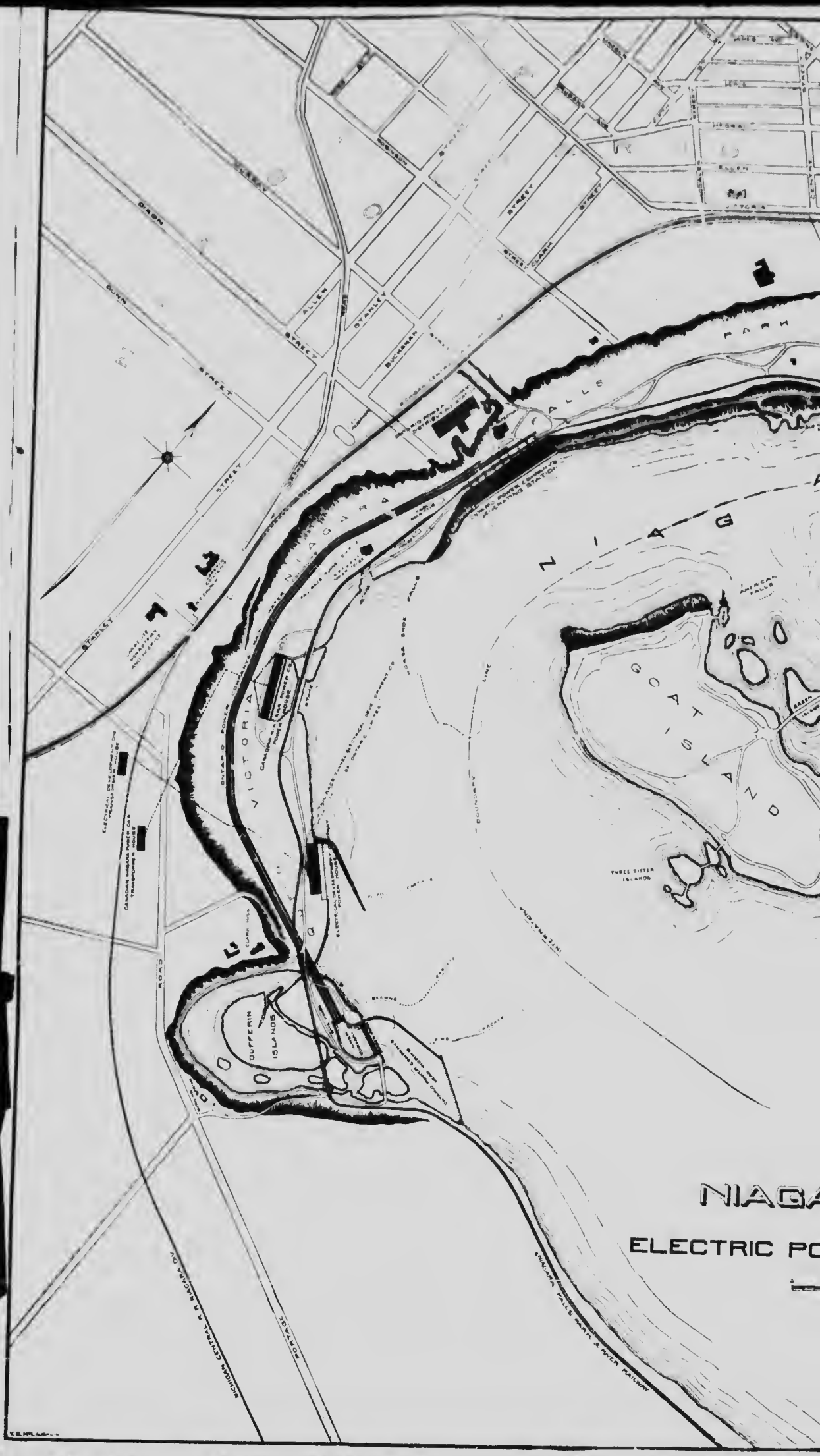
John J. Albright, Francis V. Greene, Edmund Hayes, Raymond K. Albright, Evan Hollister, Harry E. Nichols.

The Officers are :—

Francis V. Greene, President; Edmund Hayes, Vice-President; H. E. Nichols, Secretary; R. C. Board, Treasurer; Banker R. Paine, Manager.

The Engineers are :—

P. N. Nunn and L. L. Nunn, Engineers; O. B. Suhr, Engineer in Charge; V. G. Converse, Electrical Engineer; C. H. Mitchell, Mechanical Engineer; J. B. Bailey, Field Engineer.


PARK
GOAT ISLAND
DUFFERIN ISLANDS
VICTORIA
ROAD
STREET
NIAGARA
FALLS
NIAGA
ELECTRIC PO

AGARA FALLS

SHOWING

C POWER DEVELOPMENTS

SCALE OF FEET

SEPTEMBER
1904