The Utilization of Niagara's Power

By Coleman Sellers, E.D.

FOR the first time in the history of Niagara Falls, attractions other than those furnished by nature are offered; not only to the mere pleasure seeker, but to the scientific world generally, in the attempt that is now being made to utilize some small portion of the power of the great cataract on a scale that is vast compared to all previous attempts at such utilization. This is to be done not by diminishing the beauty of the Falls, but by adding to what would otherwise attract the visitor to the place, the visible progress of a gigantic engineering enterprise that has no precedent in the civilized world or that can be compared to any of the other similar works of man in the results that may flow from the venture.

"What is the power of Niagara Falls?"

One fantastic computation, perhaps reliable, sets it down comparatively as being so great that if all the coal mined in the world each day should be burned to make steam, it would barely suffice to operate pumping machinery, to pump back the water from the lower river to supply what passes from Lake Erie into Lake Ontario at the Falls of Niagara. The difference of level between the still water above the Rapids and the River at the base of the Falls is about 216 feet. If we could with certainty determine just how much water per second passes the Falls, knowing the difference of level, every cubic foot per second would represent theoretically about 26 H. P., or if used to operate water wheels of 75 per cent. efficiency, each foot per second would be worth in power about 18 H. P. Unfortunately the whole head cannot be used. The mills on the banks below the Falls which are fed by the hydraulic canal use only 90 to 100 feet fall, or even less, and all the water that passes through such wheels gives power due to the fall used, and the remaining fall is at present wasted so far as its power is concerned. The work being done by the Cataract Construction Company for the Niagara Falls Power Company, whereby the power is to be developed above the American Rapids is based upon power that is obtainable by means of a tunnel for a tail race, the hydraulic slope of which leaves, with certainty, only about 140 feet available as a working head, and every cubic foot of water per second must be made to yield not less than 12 H. P.

In the Census Report of 1880, two large folio volumes were devoted to the water powers of the United States, and that of Niagara Falls is credited with a

theoretical value of 5,878,100 H. P., representing in fuel consumption (at three pounds of coal per horse power per hour) about 211,611 tons of coal per day. The mills already located on the bank of the stream and fed by the hydraulic canal take from the Falls at present about 6,000 H. P., so that 200,000 H. P. more may be taken for man's use and leave 5,678,100 H. P. to be represented by the stream that will still pour over the crest of the Falls. The water to be taken represents an insignificant amount as compared with the whole torrent; in fact the daily fluctuation of the stream, owing to the action of the wind and other causes, while seeming to make little change in the water level of the upper river, still causes a far greater increase or diminution from time to time in the water passing over the crest than will possibly occur continuously by the abstraction of all the power that can be utilized by man.

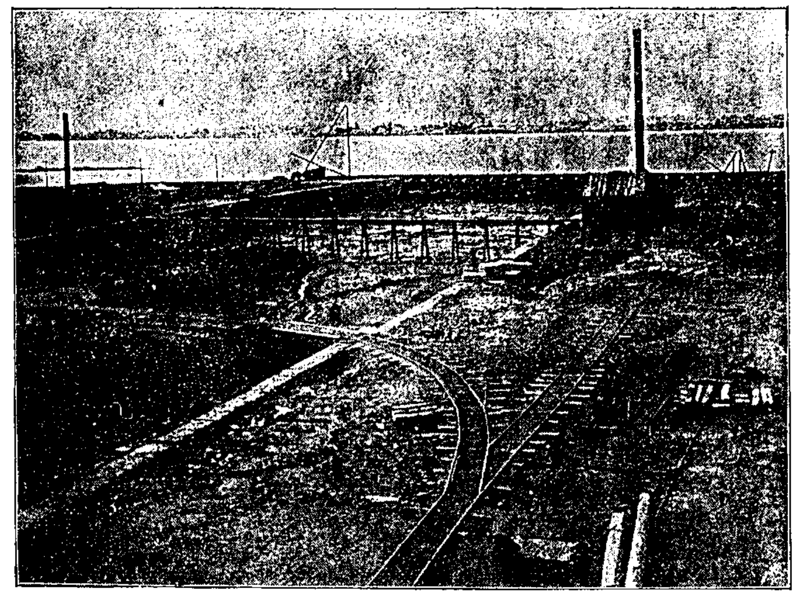
To meet the demand for some reliable information as to what is proposed by the Niagara Falls Power Company, the main features of the enterprise will be given so far as they can be stated in advance of the actual completion of the works themselves, which are being erected to permit extension in accordance with the progress of the arts during the time of erection, and to meet the wants of those who will seek the neighborhood of the Falls as an advantageous location for mechanical, chemical and metallurgical industries.

Beyond this local supply, time alone can solve the question of just how far the power of Niagara Falls can be carried profitably. What is being done in preparing for long distance transmission is in perfect harmony with the use of the power at the Falls, and many cities of the State may soon share with Buffalo the benefits of cheap power electrically transmitted from Niagara.

The chief objects of interest connected with the new development of power at Niagara Falls are: the tunnel, now finished for 7,000 feet of its length; the main canal to carry water to the wheels; the excavation that is being made to receive the ten water wheels each of 5,000 H. P., which will generate the electricity by which to transmit power to a distance or to works near by; and the extensive establishment of the Niagara Falls Paper Co., the first to anticipate the new development and to risk, before the completion of the tunnel, the erection of an industrial plant that will at the outset use 3,000 H. P. generated by three separate wheels, with the capability of extending to six or seven thousand horse power; all of the wheels required for this establishment, designed and built in America, being under the personal control of the paper company.

The tunnel is a remarkable piece of engineering work, over a mile and a quarter long, the upper end lying more than 150 feet below the inlet canal, and thence sloping gradually towards the lower river where

its discharge portal is visible a short distance below the Upper Suspension Bridge adjacent to the Government Reservation. The cross-section of this tunnel is



INLET CANAL AND NIAGARA RIVER.

of horse-shoe form, and is lined with brick throughout, the sides and roof being of the best quality of hard burnt brick, the concave floor or invert being paved with vitrified brick of great endurance. It is without curve in its entire length of 7,000 feet but its slope is not entirely uniform, being at the rate of 4 feet per 1,000 at the upper end, and the lower half sloping approximately at the rate of 7 feet to the 1,000 towards the mouth, where for some few hundred feet the floor slopes still more rapidly and is plated on the bottom and sides with steel, forming a wavelike curve that brings the extreme end a number of feet below the mean water level of the river. The back water standing in the tunnel at the mouth presents a water cushion to the outgoing stream as it leaves the tunnel and passes the open cut beyond the portal. An hydraulic gradient of seven feet to the thousand has been assumed as necessary to give the required velocity to the out-going water, hence the tunnel in its length of 7,000 feet already built consumes practically about 49 feet of the total difference of level between the upper and the lower river.

The nature of the rock through which the great tunnel was driven necessitated careful support of the roof and side walls by strong timbers, with a final lining of brick of sufficient thickness to insure durability. During the progress of this work, careful supervision of the hydraulic cement used, resulted in a structure in which the joints are as strong or stronger than the very excellent quality of bricks used in the lining. This was proven whenever it became necessary to cut through the walls to make lateral connections, the hard brick yielding more readily than the cement.

To obtain a comparative estimate of the durability of the building material used in the various parts of

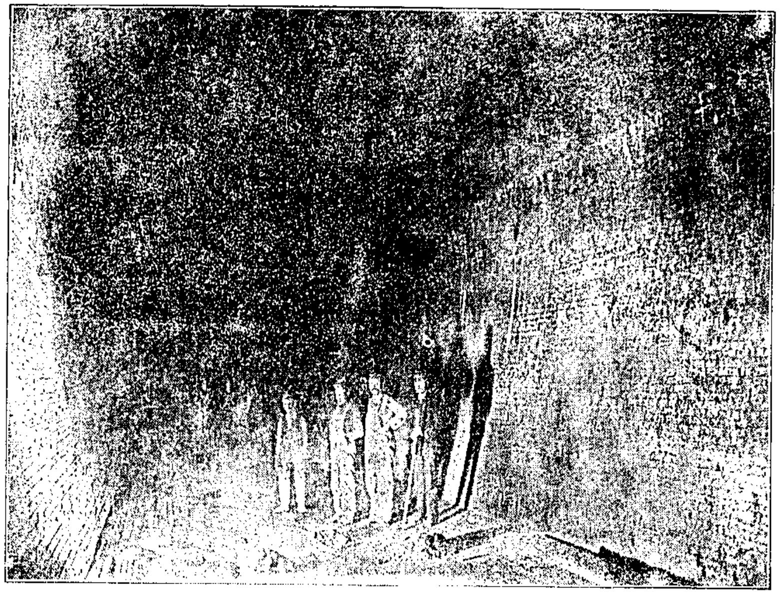
the work, numerous specimens of cement mixtures, as well as the bricks and stones required were subjected to the action of a sand blast, peculiarly arranged, so that a comparison was made of the ability of the material to stand attrition was tested by the projection of a given weight of sand driven under uniform pressure of blast, in often repeated trials, carefully weighing the specimen between each blast to determine the amount of material removed by the attrition of the sand. Before this test was adopted as reliable a succession of experiments demonstrated that with uniform material treated uniformly, a uniform amount of wear was shown to occur—as for example, in applying the sand blast test under the same conditions to various qualities of plate glass.

Without going into the detail of these experiments or giving the actual results, it is to be understood that the experiments so tried enabled the engineers to arrange the material in the progressive scale as to durability, also to confirm, with exactness, their judgment as to what mixtures of sand and cement, and with what treatment the condition equivalent to the strength of granite or brick or any other material to be united had been obtained. The tests so applied were conclusive as to the standing quality of each material and the method in which it was used in all cases. The adoption of vitrified brick for those places liable to be subjected to the greatest wear was warranted by the fact that such bricks stand at the top of the list of the materials used, resisting the sand blast and therefore well fitted to resist any wearing action of sand or other material rapidly driven through the tunnel by the speed of the current.

The Power House on the west bank of the great canal is to be built of stone in harmony with the stone work of the walls of the canal itself, and lined with enamelled brick. The steel roof trusses of over 60 feet span rest upon steel posts that serve to carry the girders to sustain an electric traveling crane of 50 tons capacity. At the north end of the Power House a massive stone building of much greater width will form a prolongation to the north with an L extension eastward up to the edge of the main canal. This L and the extension of the Power House, forming the entrance front of the building, will present gable ends to the east and west. To the left of the entrance archway, the offices, four stories in height, will be located wholly in the L, while to the right, including the archway, the whole height of the Power House to which it is attached consists of one large room in which the 50-ton traveling crane commands the entire floor. An arched portal or main doorway of great height forms the entrance vestibule. Cars loaded to the limit permissible on the railroad can pass through this vestibule and then through a lower arch into the main Power House, where the load can be handled by the traveling crane. Over

this second doorway, which in summer will be closed with iron grill work and in winter by doors, the archstones radiate fan-like to the roof of the main vestibule, and in the centre of these radiating archstones will be displayed as a medallion the semblance of the seal of the Company, designed by Frederick McMonnies, the American Sculptor. It represents the Indian chief Ni-a-ga-ra standing in his canoe, paddle in hand, shooting the rapids. The circular border is alternately the Muscalonge, the King-fish of the river, and the prevailing fossil shells of the Niagara group, *delthyis Niagarensis.* A doorway through the left wall of the vestibule gives entrance to the offices which occupy the four-story building on the canal, and also gives access to visitors who, passing the ticket office, can by an easy flight of stairs gain a platform level with the second story of the office building and thence by a second short flight of steps gain a bridge that crosses the great end room of the power station. From this bridge a view can be obtained of the electrical generators and of the various machinery required to effect the transformations from the alternating current of high potential to currents suited to the various uses, with the capability of delivery in just such quantity and force of current as may be required for the purposes to which electricity can be applied.

The electric generators in the Power House will of themselves show perhaps little that is especially attractive, either as to massive proportions or intricate and curious machinery, but they will be wonderful for their simplicity, and the thoughtful visitor will be interested to know that each of the 80 odd thousand pounds of steel to be seen rapidly revolving like gigantic spinning tops is perhaps delivering a current of ten or twenty thousand volts pressure directly by cables that are concealed beneath the floor of the Power House, and



INTERIOR OF TUNNEL.

thence carried into an underground space below the bridge upon which the visitor will stand. Nearby will be seen the switch-boards with all the dangerous con-

ductors entirely concealed from view. The operators handling the distributing devices will do so by means of silk cords attached to the various levers and other devices that must be moved to effect the distribution of the current.

In this room will be arranged all those instruments that will enable the electricians in charge to know exactly what is occurring at every part of the electrical system. Every centre of distribution, whether it is nearby or a hundred miles away, will be in direct communication and visibly record its condition to guide the operators in this Power House. There the currents can be controlled and the speed of the wheels regulated to suit the conditions required. Massive resistance coils will be provided to enable any one of these 5,000 H. P. generators to exhaust its entire power in heat or be instantly switched into the line requiring the additional supply.

From the Power House underground conduits will extend, in which on insulated benches on either side will be arranged all the distributing conductors, and through the main conduit will be passed an electric car upon which the linemen can ride between wire screens that protect them from the dangerous currents between which they pass, and yet allow every portion of the line, brilliantly illuminated by the passing car, to be inspected with absolute safety. Arrangements will be made whereby the current can be deflected from one side of the conduit to the other in order that access may be given for attachments or changes at any point of the line. The extension of this conduit will be first through the ground owned by the company, and thence on a smaller scale through Tonawanda to Buffalo, or a pole line similar to those in use in long distance transmissions in Europe will be erected.

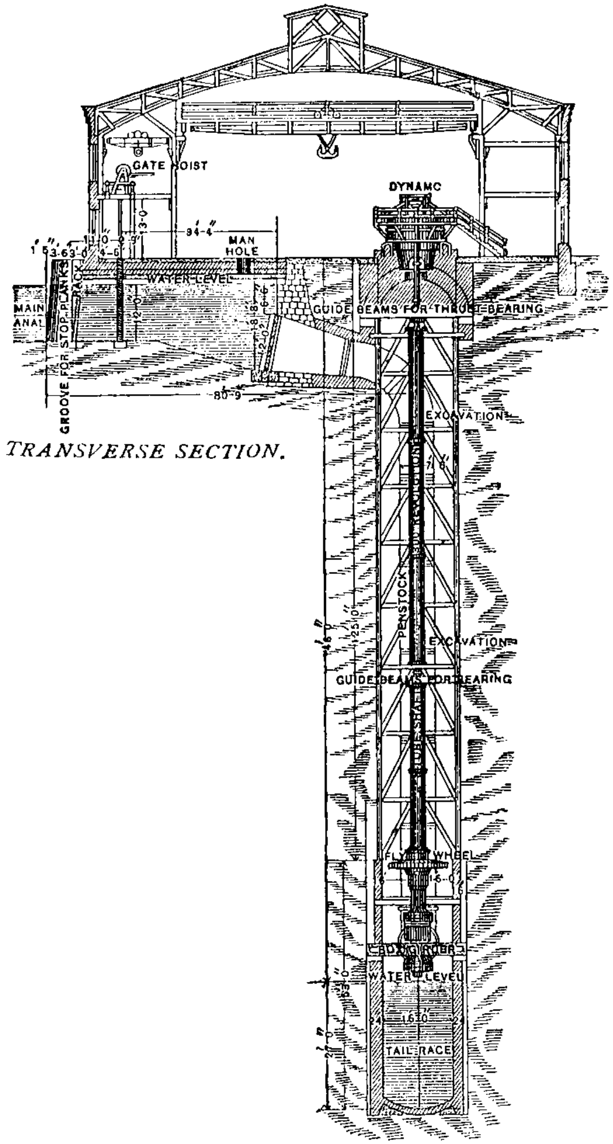
It is the intention of the Company to employ a current of high potential and to so protect its transmission as to make it absolutely safe to human life and absolutely reliable in its continuity to those manufacturers at a distance who, renting the power, must feel that the supply can be relied upon. In no single case will any one machine or device be depended upon for power or for transmission; always spare machinery in excess of the actual need will be provided to permit stoppage for alterations or repairs.

Electricity has been adopted as the means of distributing the power from the central stations as promising the least loss of power, and the minimum cost in devices for its transmission. Compressed air may be used where advantageous.

When the Power House is finished to its ultimate length of over 400 ft., the greatest interest will centre in the ten great generators, each of 5,000 H. P., and each driven by a separate water wheel system. From the inspecting bridge, looking south along the building at intervals of about 40 ft. on the east wall towards

the canal, that is to the left of the observer, machinery will be seen that is placed to operate the sluice gates which are used to partly regulate the water admitted to the wheels, or when need be, to shut off the whole supply. The actual regulation of the speed of the wheels will be effected at the wheels themselves by balanced gates which control the amount of water escaping from them, not by regulating the admission of water to the wheels. The amount of water required for each wheel is about 25,000 cubic ft. per minute, flowing to the wheels through channels from the main canal, each 17 ft. deep by 14 ft. wide, walled up of dressed stone with an average depth of water of about 12 ft. The position of these channels will be indicated by the gate machinery only, as otherwise they are hidden from view, beneath the floor Ten such channels are devoted to the Power House, while at suitable intervals on the main canal many other channels of similar size are provided for future use. Two gateways arranged with similar operating machinery to that in the Power House will control the admission of water to the long canal which feeds the Niagara Falls Paper Company's extensive works.

Weeds, grass and floating matter that might pass into the wheels and obstruct them are prevented from entering the inlet channels by means of racks or iron gratings, which are located at the mouth of each one of the entrance canals and arranged in such manner as



Transverse Sketch Showing Inlet from Main Canal.

to admit the floatage to be easily raked off and the water-way kept clear. The sluice gates already mentioned to roughly govern the water that passes to the wheels are of steel moving in planed cast iron guides, and resting against sets of loose rollers which permit easy movement of each gate under the enormous pressure of 75 tons of water that has to be restrained when closed.

Before describing the wheels that are to be used in the Power House it may be well to call attention to the fact that the conditions controlling the use of Niagara Falls for motive power are peculiar. The land on the American side of the river is a vast plain extending for miles in every direction. The Niagara River below Buffalo flows through this plain, a broad, comparatively quiet stream, breaking into rapids at the head of Goat Island, and from thence for a distance of three-quarters of a mile, the foaming torrent falling a number of feet reaches the crest of the fall to take its leap of 160 feet into the narrow gorge of the lower river. The deep cut below the Cataract into which this torrent pours has been formed by the gradual wearing away of the rocks of the Niagara group, as the breast of this mighty barrier has for ages past crept little by little towards its present site. The point where the Niagara Falls Power Co. must take the water from the still pool above the rapids is a mile and a quarter from the gorge below the Falls at its nearest point. The appurtenances of manufacturing are thus far removed from the Falls and its scenery. To develop power on the shore of the upper river, the water from wheels located in deep pits will be carried away through the seven thousand feet of tunnel that passes under the City of Niagara Falls, as already mentioned, and this tunnel is expected to develop 100,000 horse power with wheels that operate under an average of from 136 to 140 ft. head. In ordinary locations where natural differences of level in land exist, a water course raised above extensive plains available for building factories or mills, water wheels of any kind convenient for the purpose may be located close to the machinery that is to be driven, and the choice of the kind of wheel to be used is less restricted than in the present case. In California the simple and efficient Pelton wheel, so often mentioned as suitable for Niagara Falls, finds conditions exactly suited to its use, with unlimited space for its application.

Any wheel, however, with horizontal axis, buried 150 feet underground in restricted space, will need transmitting gearing and shafts or belts to carry the power to where it is to be used above, unless the driven machinery can be located in excavated chambers below. Many kinds of water wheels, such as the ordinary overshot, undershot, and other wheels revolving on horizontal axes, can only be used in the positions for

which they are designed, while the modern turbines may be operated either vertically or horizontally, and in many cases the wheel with the vertical axis presents peculiar advantages. In the present case, considering the great amount of power required at once, with perhaps a market for over 50,000 horse power in the city of Buffalo alone, units of 5,000 horse power have been adopted after a most careful study of the subject in this country and through the International Niagara Commission in Europe. The water wheels for each unit are made in pairs on one vertical shaft; the water enters the wheel case between the two wheels from a vertical penstock made of steel 7½ feet diameter. The constant water pressure in the penstock due to the head of about 136 feet serves to support the entire weight of all revolving parts, viz: weight of the wheels, the vertical shaft and the revolving parts of the generator that is to be driven by the wheel.

The great steel shaft upon which these wheels are placed is solid and of from 11 to 12″ diameter in some portions of its length, the solid parts occurring where journals are needed at intervals to steady the vertical shaft on fixed bearings; the shaft in the long intervals between the bearings is increased in diameter and made hollow for lightness, the hollow part of the shaft being formed of carefully rolled tubing, without any riveted vertical seams, so as to give the required strength and rigidity with diminished weight, lessening by the stiffness of the tubular shaft the number of supporting bearings that would otherwise be required for a shaft of uniform diameter so employed.

The mechanical problem to be solved in this case is very like that of a steam-ship where the motive power in the form of an engine, say 5,000 horse power, delivers that power through a long horizontal shaft to the propeller at the stern of the vessel, with the difference that at Niagara the engine is represented by the water wheels and the propeller by the revolving part of the generator, and the connecting shaft which is horizontal in the steamship is vertical in the case of the Niagara power. The arrangement of the machinery as adopted reduces the friction to the minimum as all the revolving parts, the water wheels, the vertical shaft and the revolving portions of the dynamo are all supported on a vertical axis and conditioned like a top spinning on water, the whole weight of the revolving mass being carried by the hydraulic pressure of the column of water that gives power to the wheels.

The accurate governing of the speed of the machinery is a problem that has received the most careful attention and is in this case, met by the use of devices that have established their reliability by long service in Switzerland, where the wheels for Niagara were designed. To effect this comparatively accurate maintenance of speed requires a fly wheel as part of the system, this fly wheel being needed to prevent the access-

ion or loss of speed when work suddenly varies. Fortunately in the present case the fly wheel capacity is obtained in the weight of the revolving part of the generator and that part alone will be seen in the operation of the generators in the Power House. Near to each generator will be located the governing machinery, which, though seemingly complicated, is nevertheless simple in its operation. The weight of the revolving part must be great enough in each case and the speed per second sufficient to insure over 18 millions of foot pounds of work to be stored in the revolving mass, resisting by inertia any sudden increase or decrease of the speed and permitting time for the governing machinery to move the gates that control the water escaping from the wheels below. The balls of the revolving governor, very similar to that used upon a steam engine, do not directly control the gates themselves, but control the powerful actuating machinery that continues to act only so long as a difference or variation of speed occurs in the rate of rotation of the governor balls, and ceases to act when these balls are revolving at their normal speed.

To insure the best results the specifications furnished to the builders of the machinery, required physical tests of strength so high as to deter some manufacturers from bidding, and in construction the high tests have been rigidly adhered to with the most satisfactory results. Where any doubt existed as to the kind of material to employ, preference has been given to that which would put the durability beyond any doubt. This is particularly the case in regard to the water-wheels themselves. The design was made with the expectation of using the best quality of cast iron, but from excessive caution, the order was issued that they should be made of bronze of the same quality as is used in the heavy propellers for steam ships. This adoption of bronze was on account of the failure of many of the cast iron wheels under a head of only 90 to 100 feet in use at Niagara, but the designers of the wheels for the Cataract Construction Co. hold that the failure of such wheels was due to the form of the blades and not to the material, and instanced wheels made of cast iron working under very much greater head and without any appreciable wear when properly proportioned. Bronze, however, was adopted at a very great increase of cost to render failure from any cause impossible so far as the wheels are concerned. The tests of material used in the construction was followed by the inspectors, from the mills to the manufacturing establishment making the wheels and other machinery, with the most careful precision and rigid adherence to the requirements of the specification.

Out of the seeming chaos of the work now littering up the ground about the great canal will soon grow harmonious order. The Power House in the beginning will be extended only to cover three generators

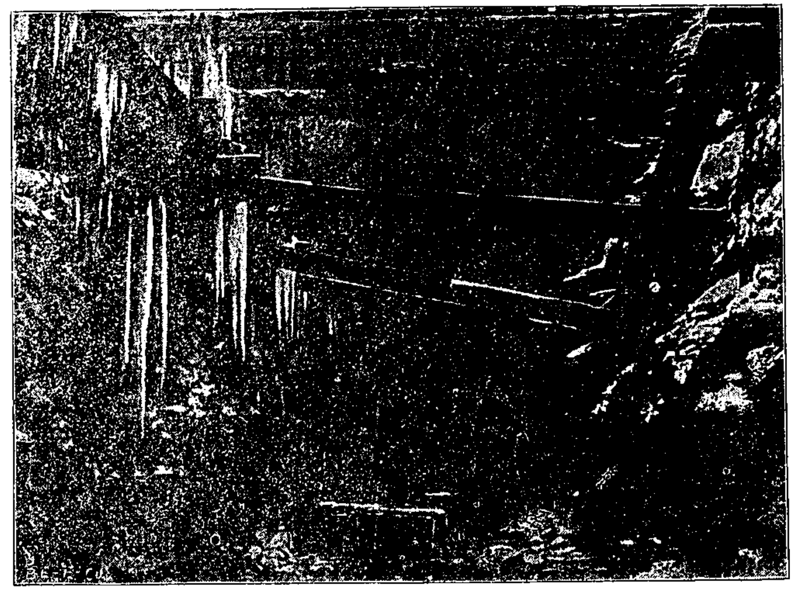
and three sets of water wheels, and power created by these wheels will be used to operate the channeling machines and the hoisting machinery which will be required to continue the excavation of the wheel pit for the receipt of the additional wheels and generators; also to continue the driving of the tunnel beyond the 7,000 ft. station to those points where other wheels may be required, either for additional electric power or for operating separate wheels under the control of manufacturers who rent them. The initial plant representing 15,000 horse power in the Power House and 3,000 horse power at the paper mill will be but part of the early installation. Groups of wheels arranged in sets of five to each pit will be arranged to give power in blocks of 1,000 horse power to a single manufactory, or blocks of less amounts to establishments that will have one wheel in common with two or more. This will suit the wants of manufacturers who desire to control in a measure their own power and to use it directly from the wheels without the intervention of electricity, compressed air or other modes of transmission. In all cases, however, where power less than 500 horse will be wanted, the electrical transmission will be resorted to.

One of the most striking uses of electricity will be exemplified in the great metallurgical works which will be erected on the bank of the river more than a mile away from the central station. In this establishment electricity will be used as a motive power and also for direct application to metallurgical processes, and though the power required would be more than sufficient to warrant the use of wheels devoted wholly to this purpose and controlled by the operators, preference has been given to the transmitted power on account of its exceeding convenience. It is worthy of note that at the present time many of the large establishments, both in this country and in Europe, are recognizing the advisability of creating their power at one locality where fuel can be handled cheaply and water for condensation obtained in abundance, the distribution of this power being entirely by electricity and the use of motors scattered about the establishment wherever required. Every great manufacturing establishment that has attempted this mode of operation has not only continued it, but from a small beginning has increased the electrical plant, as offering great advantages and convenience, as well as economy.

A junction railroad six miles in length has been constructed through the company's lands to enable all the main railroad lines passing Niagara Falls to deliver freight or to take goods from the factories to be established there. At present steam locomotives are used on the Junction road, but in the near future it is expected that it will be operated by electricity from the central power station.

The municipal water works that supply the City of

Niagara Falls, including the lands to be improved by the Niagara Falls Power Co., and also by a development company, have been removed from their old lo-



DISCHARGE PORTAL.

cation at the basin of the hydraulic canal to a point nearer to the new canal above the rapids and will eventually be transferred to a point still higher up the river where the best water can be obtained. The pumping is at present done by steam and will be until electricity can be furnished from the Power station.

A very complete trolley road has been established to carry passengers to and from the Falls and to all points of the City of Niagara Falls. Many convenient dwelling houses have been erected by the land improvement companies, and factories are to be built of convenient size, each capable of extension as the demands of the tenants call for additional room. This feature of the enterprise will make Niagara Falls attractive to manufacturers on account of the cheap power and reasonable rent, with no possible geographical objection to the location for any of the industries that can flourish in the Northern States. Proximity to the British possessions, as well as nearness to the home markets by rail and by water, with cheap power, is attractive, and abundance of labor will flock to a locality that has all the advantages incident to one oi the wonders of the world and climatic conditions that are exceptional for the invigorating healthfulness of the air.

Bulletin No. 34, issued Feb. 26th, 1891, by the Census Bureau, gives information of importance in reference to the position occupied by Niagara Falls in relation to the population of the country. It must be borne in mind that the whole area of the United States, considered as a plane of no weight, has its centre of area somewheres in Kansas, but the centre of population lies to the west of Niagara Falls, latitude 39° 11′ 56″, longitude 85° 32′ 53″, in the southern part of Indiana, a little west and south of Greensburgh, the county seat of Decatur Co., and twenty miles

east of Columbus, Ind. This centre of population has, in advancing westward since 1799, deviated but little in parallel of latitude, oscillating slightly on either side of latitude 39, but proceeding westward at an average rate of about 50 miles in each decade, sometimes less and sometimes more, as between 1850 and 1860, when the jump was 81 miles, caused by the sudden accession of population to the Pacific Coast. Niagara Falls falling to the east of the centre of population, bears a relation to the number of inhabitants in two important particulars, first as its being close to the densest population, and second, being so situated as to have remarkable advantages in railroad and water communication by canal, by the lakes, and by all the great trunk lines of railroads that run east and west.

The important consideration in estimating the value of this stupendous water power is its ability to distribute that power where it can be used to the best advantage beyond the local development at Niagara Falls itself. It is absolutely certain, from what has already been done elsewhere, that profitable transmission to a distance of 150 miles is only within the existing practice of distributed power. This 150 miles from Niagara Falls in a straight line brings us to within ninety miles of the city of New York, and if we assume as probable economical transmission to a distance of 320 miles, we have an area, including the densest population, taking in Columbus, Ohio, touching Washington, D. C., including Philadelphia and New York, and the whole of the states of Pennsylvania, New York, part of Maryland, the northern part of Virginia and West Virginia, more than two-thirds of Ohio, fully three-quarters of Michigan, beside reaching to Montreal in Canada, thus showing that the situation of Niagara Falls is phenomenal in its ability to distribute the power over an area that furnishes the most desirable market for its profitable development. If in the near future Chicago can receive its power from Niagara, then the whole of New England, with the exception of Maine, will come within reach of the Falls. Is it possible to conceive of a location more nearly central to the densest population and the greatest need for distributed power than the location fixed by nature for this development? Niagara Falls would still be the great Falls of the world with a distribution of power more than equal to all that the coal mines of Pennsylvania can supply.

Wind and water form the two natural sources of power. Water when used with water wheels yields its power solely from gravity, and yet, all things considered, it is the most economical source of energy. Water power alone without some economic mode of transmitting its energy has, however, the disadvantage of being fixed as to location. As compared to coal it is not transportable. Coal mined in Pennsylvannia

can be used for power in any locality, the cost of power created by the combustion of coal being influenced only by the first cost of the fuel and its added cost of transportation. Each pound of coal burned can yield only some fraction of its total heat value as power, and when so used, so far as we know, there seems to be no tendency in nature to restore the coal that has been burned. Water cannot be transported as coal can. The value of a water fall being measured by its head, its quantity and its uniformity represents the force of gravity only. In using water for power we are using the constantly acting attraction of gravitation. A reliable, uniform water supply, such as is ideally represented at Niagara Falls, is the nearest obtainable approach to perpetual motion.

The water yielding its power by gravity at Niagara Falls, speeds away to the ocean, where it is vaporized and passes inland to be deposited on the rainshed that inclines towards the Great Lakes that feed Niagara Falls. Niagara Falls owes its power to the orderly operation of the laws that govern the Universe. The immense size of the lake reservoirs and the volume of water stored in them above Niagara Falls, insure conditions of stability. That the Niagara River does not vary materially from day to day is on account of the enormous area drained and the varying climatic conditions that effect the condensation of the vapor passing inland from the ocean. The water from a portion of Canada flows down to the lake and each of all the watersheds that tend towards the lakes delivers the rainfall by rivers and streams that flow into these lakes. A small impounded mass of water seldom represents a uniform water power, as it is likely to be affected by drought or suddenly increased by floods, both conditions detrimental to the stream as a source of power. Over such an area as is represented by the watershed of the Great Lakes these varying climatic conditions average themselves, and the rise and fall of the water in the lakes is less noticeable on account of the area covered, just as the ocean seems not to vary except by the tidal disturbances, so is the steadiness of the flow from Lake Erie to Niagara Falls seemingly uniform, warranting unusual care to insure uninterupted transmission of the power to those who will in the future demand their share of this great natural souce of power now for the first time to extend beyond a local use.