NIAGARA FALLS HYDRAULIC POWER PLANT.

From many points of view the development of the power plant at Niagara Falls is of special interest. The undertaking from its outset was conceived on original lines, and even in the purposes to which it is applied, such as the production of aluminum, of calcium carbide, and of carborundum, there are elements of novelty and interest. We have already illustrated and described the overground plant, which, with its fine electric machinery, switchboard and accessories, is already regarded as one of the local attractions of Niagara. But the casual visitor fails to see the best of the work. Out of his sight, below the solid floor, and directly beneath the dynamos, a great rectangular pit descends nearly two hundred feet through the solid rock. Near the bottom of this pit the 5,000 horse power turbines are established. Electric elevators traverse the shaft carrying those who have to inspect the wheels and shafting. The aspect of things in the pit is quite impressive, and would be more so were it not that the rapid descent in the elevator prevents the realization of the depth attained.

The development of the water power has involved the solution of many problems in engineering. The astonishingly rapid development of electricity during the last few years has operated to materially change the plans of the engineers. The station now appears as a purveyor of electric energy, while originally it was intended rather to sell hydraulic power. It now sells both, but its electric power plant is the most striking and important development. The power company has installed in its own immense wheel pits near the bottom the great turbine water wheels, from each of which a vertical shaft rises to the ground level to directly drive the rotating fields of the 5,000 H. P. alternators, vertically above and directly in line with the wheels. Both wheels and dynamos are of the horizontal type. For each wheel there is a single dynamo, and each pair coupled together represent a unit of the plant.

In our issue of January 25, 1896, we described and illustrated the power house with its water connections and electric plant. The illustrations showed the relation of the surface canal, which takes water from the Niagara River above the Falls, to the power house, and our issues of March 5, 1892, and of October 20, 1894, may be referred to as giving the general aspect of the tunnel and canal. The present article describes the turbine water wheels, to see which, our readers must descend with us to a point nearly two hundred feet from the surface of the earth, near the inner end of the tunnel.

The turbines were designed by the firm of Faesch & Piccard, of Geneva, Switzerland, and were built by the I. P. Morris Company, of Philadelphia, Pa. It seems a pity that the plans could not have been executed by American engineers, but the point was made that practice in this country has been in the line of supplying turbines from stock on hand, while the Swiss engineers are more in the habit of making special calculations for various cases. The problem to be solved was a difficult one, owing o the high unit of power and to the 140 feet of shafting, whose weight had to be carried. In the accepted design the wheels are double Fourneyron horizontal turbines, one placed vertically over the other, the upper one being inverted. The circle of buckets of each wheel is divided into three horizontal divisions or stories. The water delivered by the penstock enters the space between the wheels, which is inclosed by a casting, constituting a sort of drum. About half of the water rises and, rushing out through the upper wheel, actuates it, while the rest of the water drives the lower wheel. The rising water, pressing upward against the disk of the upper turbine with the stress due to nearly 140 feet of head, supports a variable portion of the weight of the shaft.

Each of the wheels includes two circular portions, one a fixed central guide wheel carrying a peripheral circle of curved buckets through which the water escapes, its direction of escape being determined by the shape of the buckets. In the Niagara wheels these buckets are 36 in number. This guide wheel with its circle of buckets is surrounded by a second circle of buckets arranged on the periphery of a disk, and this disk with its buckets rotates and constitutes the turbine proper. It has 32 buckets curved in the reverse sense referred to those of the stationary one. Each turbine system includes, therefore, the upper and the lower couple, each comprising a guide wheel and turbine, marking the top and bottom of a cast iron drum, into which drum the seven foot penstock of sheet steel enters. The smaller cut shows in section the disposition of parts. On studying this cut it will be seen that the stationary or guide wheels would close the ends of the drum, except that the upper guide wheel is perforated, so that the water passes through it and presses upward against the rotating disk of the upper turbine. Were it not for these apertures, there would be no vertical water pressure upon either upper or lower turbine.

The small cut shows bars running diagonally up and down within the drum. These support the lower guide wheel, which is subjected to the hydraulic head produced by the penstock. The relation of guide wheel buckets to turbine buckets is shown in the small partial horizontal section in the same cut.

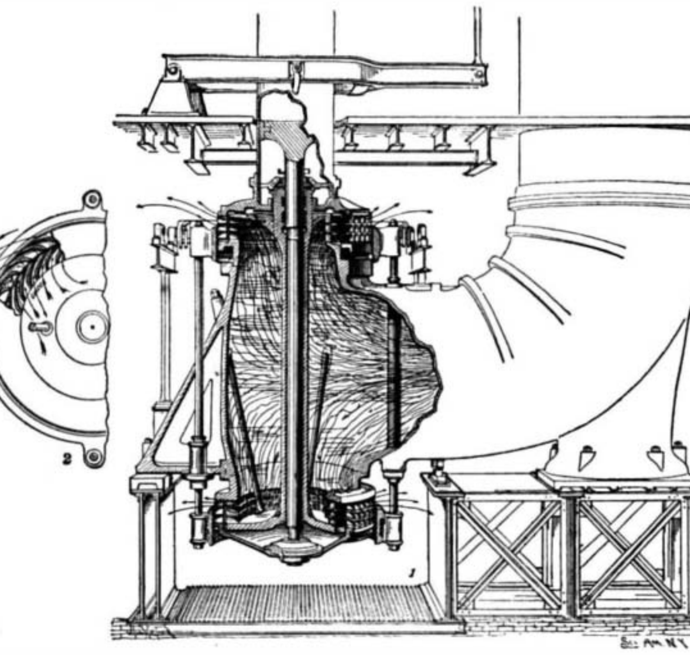
The vertical shaft which transmits the revolutions of the wheel to the dynamo is of sheet steel riveted up to form a tube 38 inches in diameter, except at two intermediate bearings and at the upper terminal bearing. At these points reduced sections of shafting 11 inches in diameter are used.

To regulate the speed of the wheel a governor is provided, which operates by raising and lowering a double annular speed gate. This works up and down outside of the peripheries of the upper and lower turbines, cutting off the outlet for water as it rises, and giving a larger opening as it descends. In the sectional view the speed gates are shown closing about two-thirds of the orifice, and on the deck above is seen the bearing for the speed gate lever, which is shown extending horizontally across the cut just above the floor level. The governor is guaranteed to keep the speed within two per cent of the rate desired under ordinary conditions.

Should the work be suddenly increased or diminished to an extent of twenty five per cent, the governor will hold the speed variation down to four per cent.

A vertical thrust bearing, similar, except that it is vertical, to that on the shaft of a screw propelled ship, is provided near the upper end of the shaft. This is necessary, because the varying inflow of water causes the pressure exerted by the shaft to vary. This pressure may even sometimes be negative or upward.

The wheels discharge at full load 430 cubic feet of water per second and utilize 136 feet of head, the wheels rotating 250 times per minute. At seventy-five per cent efficiency they give 5,000 horse power.



SECTIONAL VIEWS OF ONE OF THE NIAGARA TURBINES.

The original idea was to have a ten ton flywheel 14½ feet in diameter on the shaft. The rotating field of the dynamo takes the place of this.

Our large cut shows the great wheel at work. The water is seen escaping from the curved buckets. Bars of iron are seen running up and down the outside of the barrel, which bars operate the annular speed gates, the lower one of which appears below the outflowing water. The speed gate lever and sheet steel tubular driving shaft are seen above the wheel, and the penstock rises on the left hand. The outflow passes through a curved sluiceway into the tunnel. By rock shafts and levers the bars for working the speed gates are increased in number. From the governor, directly over the top of the shaft, a single bar connects with the speed gate lever. From this lever two bars descend to the gates and connect also with the rock shaft, throwing other bars into action. The governor works centrifugally.

The total horse power of Niagara Falls in a recent paper was put at 6,750,000, due to a descent of 275,000 cubic feet of water per second. This is taken as representing a coal consumption of 65,000 tons per day. The tunnel is the factor which determines the fraction of the power which can be utilized, and, as calculated, it can deliver sufficient water to generate 120,000 horse power. This exceeds the developed horse power in eleven of the principal water power sites in the United States. The power company have further rights affecting operations on both shores, which will make possible the development of a total of 450,000 horse power. This represents over one-third of the power of all the water wheels in the United States by the census of 1880.

The power plant in most of its parts was installed by the Cataract Construction Company for the Niagara Falls Power Company.

A Geological Expedition to Patagonia.

Princeton College has planned another important geological expedition. Prof. J. B. Hatcher, Curator of the Museum of Vertebrate Palaeontology, accompanied by Mr. T. A. Paterson, formerly connected with the American Museum of Natural History in New York, has sailed for Patagonia. The explorations on the coast of Patagonia which were conducted by Prof. Darwin in his famous voyage in the Beagle, nearly half a century ago, first directed the attention of geologists to the great scientific importance of that inhospitable land. In later years the work which he inaugurated has been prosecuted by the Argentine palaeontologists Burmeister, Moreno and the brothers Arneghino.

The latter brought together a large collection of fossil mammals and birds and made important studies upon them, although they labored under great difficulties on account of the absence of material from the northern hemisphere for comparison. Two years ago St. Morens, the director of the Museum of La Plata, invited Mr. Lydekker from England to study the collections of that museum and to employ his extensive knowledge of the collections of Europe and Asia with the purpose of comparison with the fauna of South America. Mr. Lydekker has published two large volumes as the result of his studies, which, though interesting and important, show that a vast amount of work remains to be done on the geology of Patagonia.

Princeton has now taken advantage of this opening and has sent out a well-equipped expedition. After studying the collection in Buenos Ayres, Mr. Hatcher will sail for Patagonia and then strike inland; the principal objects of the expedition are to make a thorough study of the Patagonian geology, which has not as yet been undertaken by a competent observer, and secondly to make as exhaustive a collection as possible of the fossils which are so abundant there, and which will be brought to Princeton for study and comparison with those of the North. Though the principal objects of the expedition are thus seen to be geological and palaeontological, the other natural sciences have not been neglected. Preparations have been made to form extensive collections in the mineralogy, zoology and botany of Patagonia and Terra del Fuego to enrich the Princeton Museum. A complete photographic apparatus has been taken along so as to get a large collection of views illustrating the geology of the country and the customs of the natives. Mr. Hatcher also holds two commissions from the United States government, one from the Department of Agriculture and one from the Bureau of Ethnology, and the officers of the government have done everything in their power to render the expedition successful. Mr. Hatcher goes with practically an unlimited leave of absence, and the results of his researches promise to be very interesting.

The Work of Bees.

A writer in the Revue des Sciences Naturelles makes the following calculations in regard to the work done by the honey bee: When the weather is fine, a worker can visit from 40 to 80 flowers in six or ten trips and collect a grain of nectar. If it visits 200 or 400 flowers, it will gather 5 grains. Under favorable circumstances, it will take a fortnight to obtain 15 grains. It would, therefore, take it several years to manufacture a pound of honey, which will fill about 3,000 cells.

A hive contains from 20,000 to 50,000 bees, half of which prepare the honey, the other half attending to the wants of the hive and the family. On a fine day, 16,000 or 20,000 individuals will, in six or ten trips, be able to explore from 300,000 to 1,000,000 flowers, say several hundred thousand plants. Again, the locality must be favorable for the preparation of the honey, and the plants that produce the most nectar must flourish near the hive. A hive inhabited by 30,000 bees may, therefore, under favorable conditions, receive about two pounds of honey a day.

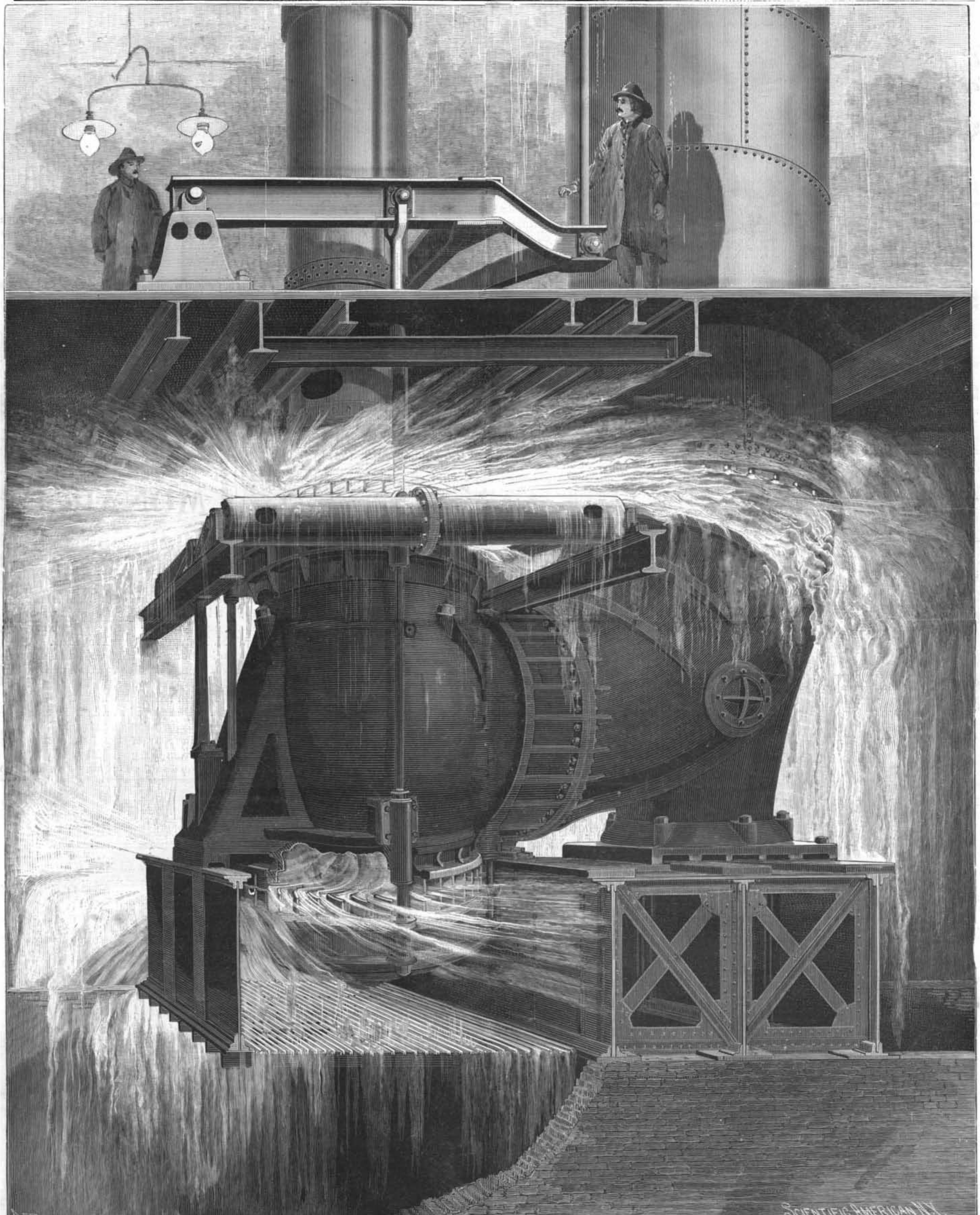
THERE are to be about 200 railway stations distributed over the new Siberian railway. The rolling stock will comprise 2,000 locomotives, 3,000 passenger cars, and 36,000 goods wagons. The passenger traffic will be almost exclusively confined to third and fourth classes, and the tariff will be very low. The works in connection with this great undertaking are being pushed on with much energy, and the work is expected to be completed in from five to six years. The opening of this line will shorten the journey round the world by about 20 days. The speed on most of the line, however, will not generally exceed about 15 miles an hour.

Scientific American

[Entered at the Post Office of New York, N. Y., as Second Class matter. Copyright, 1896, by Munn & Co.]

A WEEKLY JOURNAL OF PRACTICAL INFORMATION, ART, SCIENCE, MECHANICS, CHEMISTRY, AND MANUFACTURES.

Vol. LXXIV.—No. 14.] ESTABLISHED 1845. NEW YORK, APRIL 4, 1896 [$3.00 A YEAR. WEEKLY.



NIAGARA FALLS POWER PLANT—ONE OF THE 5,000 HORSE POWER TURBINE WHEELS.—[See page 215.]