ELECTRIC POWER DEVELOPMENTS AT NIAGARA FALLS.—II.

125,000-HORSE-POWER PLANT OF THE ELECTRICAL DEVELOPMENT COMPANY.

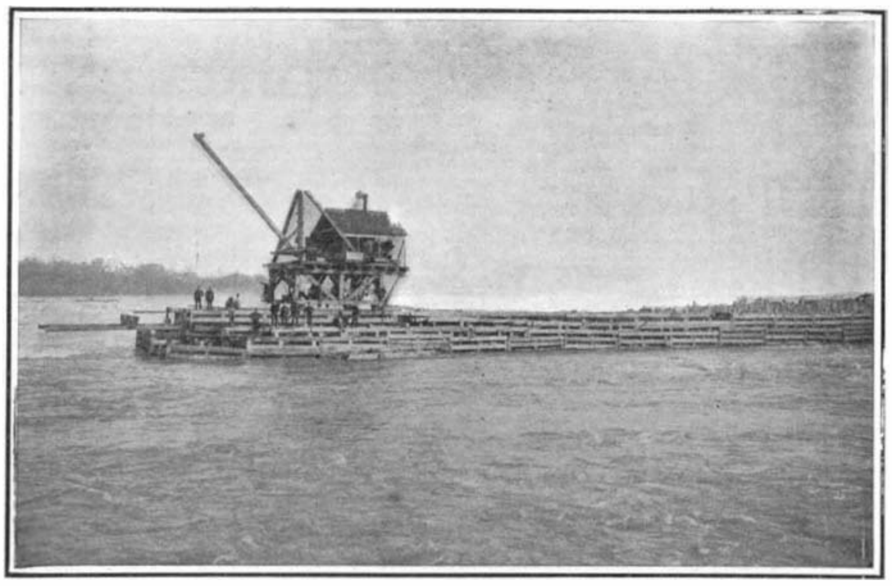
In our first article on the electric power development of Niagara Falls, published in the Scientific American, August 12 of this year, we gave a general survey of the situation, in which it was shown that at the present time there are in operation, or under construction, on both sides of the Niagara River, electrical power plants whose combined horse-power is about 500,000, and that if to this amount be added the total amount of power for which charter rights have been granted, the total development at Niagara, when the full limit of these charters has been reached, will be about 900,000 horse-power.

At present, the principal scene of activity is the stretch of foreshore on the Canadian side, reaching from the commencement of the upper rapids to the huge power station of the Ontario Power Company which extends along the foot of the cliff between the Falls and the new steel arch bridge.

Following down the shore line of the Niagara River for a distance of 1,500 feet from the intake of the Ontario Power Company, whose plant was described in our issue of August 12, we come to the huge plant of the Electrical Development Company, where the work of developing 125,000 horse-power is being pushed to completion with remarkable activity. There are some respects in which this plant is the most original and interesting work of the kind that is being done at Niagara Falls. Briefly stated, it includes, first, a massive concrete gathering dam which extends out from the river bank, and curving upstream thrusts its arm boldly, for a distance of 700 feet, into the deep and swiftly rushing waters of the rapids; second, a vast wheel pit, with hydraulic turbines at the bottom connected to electric generators located in a magnificent power station above at ground level; and, third, a tail-race tunnel which has been carried in a direct line beneath the river, 150 feet below its surface, to discharge the spent waters at the base of the perpendicular wall over which the Horseshoe Falls descend.

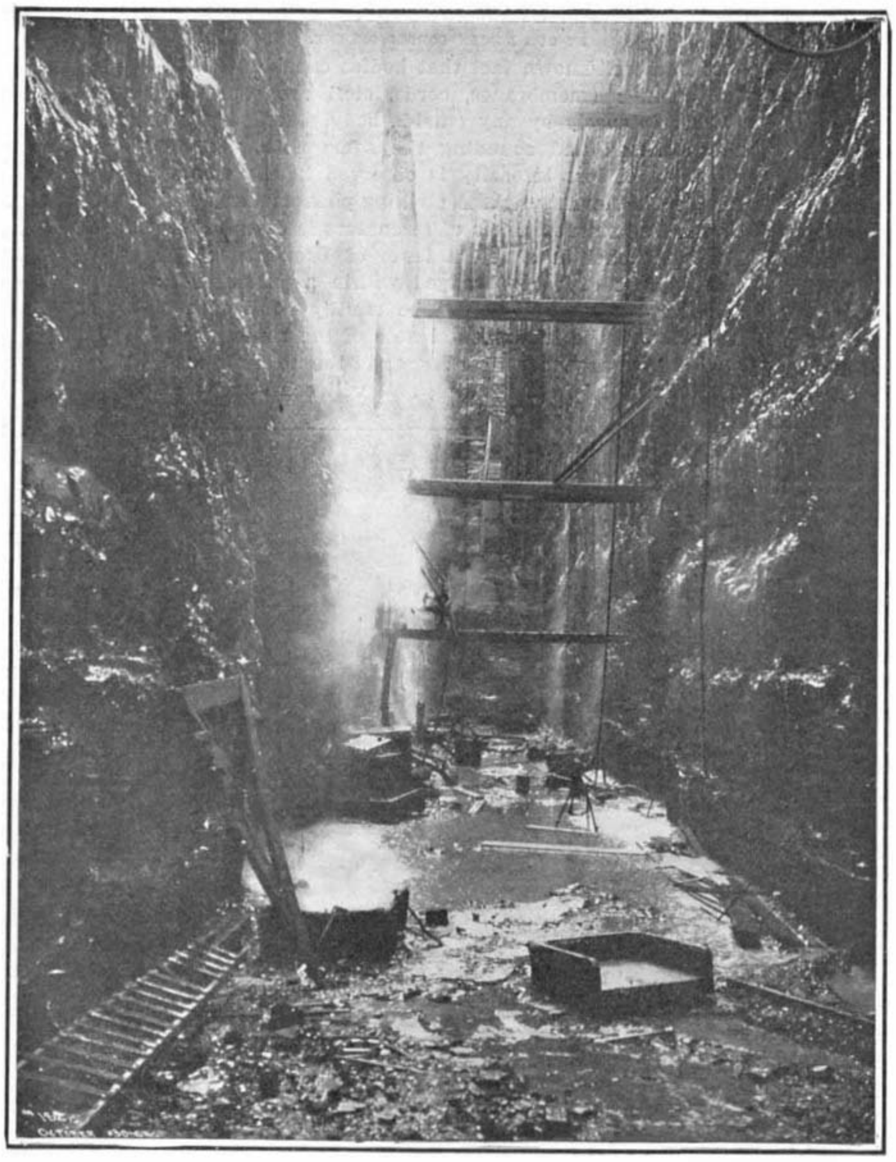
Not a little of the expense and difficulty attending this great work was due to the necessity of building out into the rapids a massive cribwork cofferdam, with which to thrust the rushing waters of the rapids aside, and uncover the river bottom preparatory to building thereon the concrete gathering dam. The space to be unwatered was about 12 acres in extent, and the dam, in spite of the fact that it was a merely temporary construction, varied from 20 to 46 feet in width, and had a total depth of water against it, when it had reached out into the deepest part of the rapids, of 26 feet. Its length from the shore to its extreme point is 2,115 feet. For the greater part of this distance the cofferdam is 46 feet in total width, consisting on the outer or river side of a structure 24 feet in width and 32 feet in height, and on its inner side of another structure 16 feet in width, and of about the same height, with a 6-foot space between them filled in with puddle to render the cofferdam watertight.

The construction of this work in still water would have been a matter of considerable magnitude; but when we bear in mind that it had to be carried out into a mighty cataract which was running 26 feet deep at a velocity of 15 miles per hour, the daring of the work and its inherent difficulties can well be understood. These difficulties were aggravated by the fact that the river bottom was extremely rough and uneven, full of boulders and deep fissures. The dam was built out in 16-foot sections. Each section was constructed in the still water under the lee of the dam, and then launched into place; but before



This structure, 46 feet in width, and 2,115 feet long, was built to divert the water from the site on which the gathering dam was built.

The Main Cofferdam.



This excavation is 421 feet long, 27 feet wide, and 138 feet deep.

At the Bottom of the Wheelpit.

This shows the condition of the river bottom on the site of the outer basin.

Bottom of the Niagara Upper Rapids, Unwatered.

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building the section, it was necessary to make a survey of the river bed. This was done from a platform which was suspended out from the completed dam, the contour of the bottom being determined by sounding with iron rods. The new section was then floated out into position in the rushing torrent, and to prevent its being carried away, a sliding shield, built of massive timbers, was moved forward along the outer face of the dam to act as a kind of temporary breakwater. The new section was brought forward into the lee of this shield, drawn into place by steel cables, and loaded down with rock. A glance at the accompanying views of the unwatered bottom of the rapids and of the launching of a new section shows how extraordinarily difficult an undertaking this was.

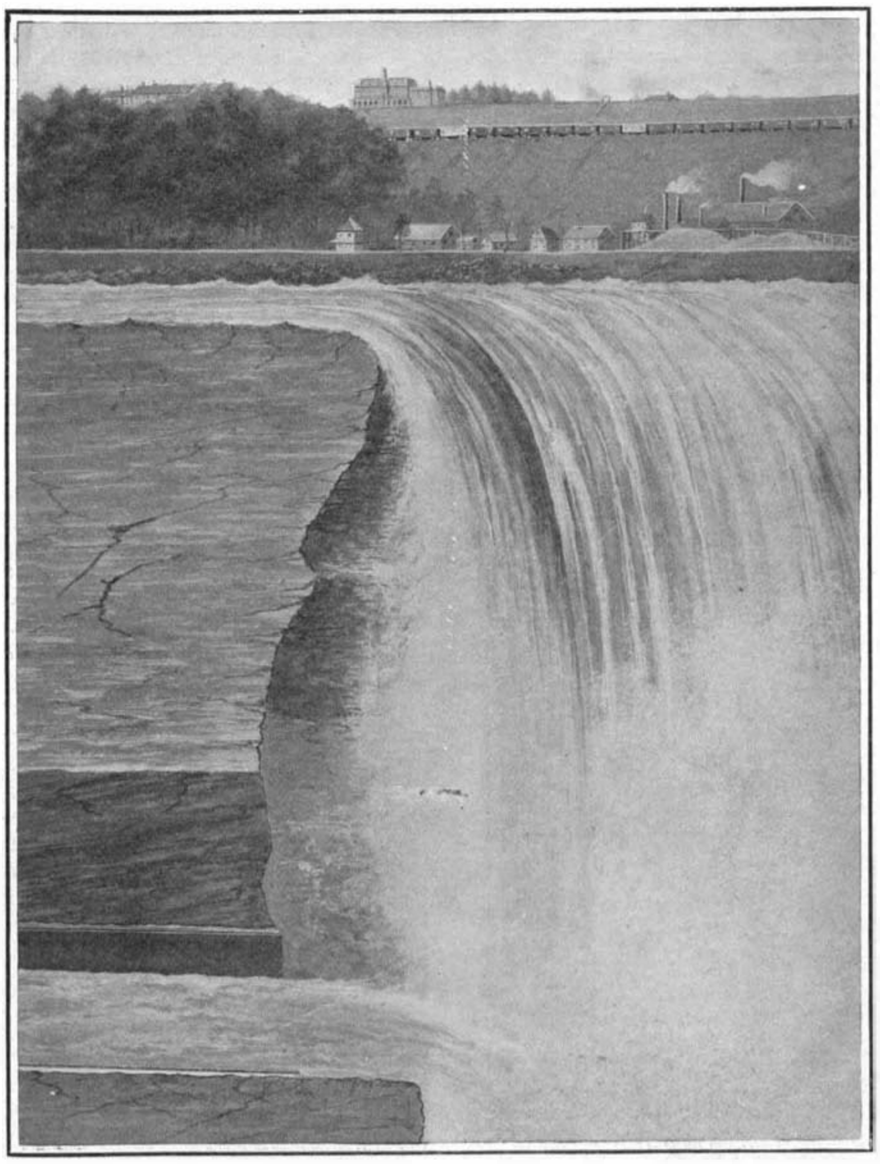
When the cofferdam was completed and the river bottom laid dry, a concrete gathering dam, 33 feet in width and 26 to 33 feet in depth, was built out from the shore, the inshore end being located just below the intake of the wheel pit, and the dam extending out diagonally into the rapids for a distance of 700 feet. The crest of the dam is somewhat lower than the surface of the water, for which it will act as a weir or spillway. The crest of the dam at the inshore end is built at a lower level than the rest of the structure, this being done in order to insure that there shall be a steady and somewhat swift current sweeping past the outer row of submerged arches through which the water will flow into the tubes leading to the wheel pit. The effect of this current will be to carry floating ice and general debris clear of the intakes. It is exceedingly important that the water that enters the penstock, as the large tubes leading down to the turbines are called, should be kept clear of floating debris; for if this should pass through it would not only cause rapid wear and possibly the wrecking of the water turbines, but it would set up serious friction and greatly impair their efficiency. In order to prevent this, the intakes, of which there are two, consist of two parallel walls of heavy concrete carried upon submerged arches. The artificial current created in the forebay by the lowering of the inshore end of the gathering dam, as above described, causes the ice and drifting debris to be swept safely clear of the submerged arches on which the wall is carried. After passing through the two parallel rows of submerged arches, the outer one of which is practically a continuation of the shore line of the river, the water flows through a screen, which effectually catches any of the finer debris. Opening into the inner forebay on the inshore side of the rack are eleven steel penstocks 10½ feet in diameter, which conduct the water to the bottom of the wheel pit.

The Wheel Pit.—The wheel pit is a huge excavation 27 feet in width, 421 feet in length and 138 feet in depth, which has been blasted out of the solid rock in the unprecedented time of eight months. Two branch tailraces each 26 feet in diameter extend parallel with the wheel pit and below the floor level, one on each side, and converge into one huge tail-race tunnel which has been excavated in a straight line, for a distance of 2,000 feet, to the Falls. Founded directly upon the solid rock at the bottom of the wheel pit are eleven massive turbines of the type shown on our front-page engraving. Each of these has a capacity of 13,000 horse-power at three-quarters gate. Although the charter of the company is for 125,000 horse-power, the generators under overload conditions would have a maximum capacity of 165,000 horse-power. They are of the vertical type and the power is transmitted from each one by a massive vertical hollow shaft 115 feet in length, which extends up through the wheel pit, and is supported at three intermediate points by solid masonry bearings. Each shaft carries at the top, in the great generating station at ground level, an electric generator of 9,375 kilowatts capacity. The turbines discharge into the two branch tailraces, five of them to one side, and six to the other. This is a new and excellent feature in this plant, for by the use of two separate branch tunnels it becomes possible to close down one-half of the station for repairs while the other half is running. Thus to all intents and purposes the Electrical Development Company has two stations, absolutely independent of each other, at command. A valuable advantage of this arrangement is that frequent examinations can be made of the turbines, shafting, and generators, and any trouble may be detected in its early stages. A further advantage is that the turbines will be at all times accessible, and will not be continually more or less flooded, as they are in other plants.

The Tailrace Tunnel.—The two branches of the tailrace merge at the downstream end of the wheel pit in one large tunnel, which is carried in a straight line and with a fall of 20 feet in its total length of 2,000 feet, through to the cliff over which descend the waters of the Horseshoe Falls. This is the most daring piece of engineering in the whole work, or, indeed, in the whole range of power development as carried out by the various Niagara companies. Had this tunnel been carried around beneath the shore line to discharge, like that of the Canadian Niagara Power Company's plant, through the side of the gorge, the tunnel must have been built on a curve and its length would have been considerably greater. A remarkable feature of its construction is the fact that it was built from the lower end toward the wheel pit. This was done from motives of economy; for to have commenced at the wheel pit end would have necessitated hoisting the excavated material to the surface, through an average height of 135 feet. By building it from the lower end, it was possible to dispose of the material by dumping it out through the face of the cliff, where it was speedily washed away by the rush of the falling waters.

As a preliminary to driving the tunnel proper, a shaft was sunk on shore near the edge of the Falls, and a working tunnel was driven parallel with the Falls to the point of exit of the big tunnel. After the working tunnel had been carried to within a short distance of the line of the main tunnel, the engineers drove a short cross drift out through the face of the cliff, in order to investigate conditions. When the final shot was fired the mass of falling spray and broken water was driven by its own velocity and the pressure of the wind into the working tunnel so fast that the workmen barely escaped with their lives, and the water came in such volume that the pumps were not able to keep it down.

After great labor and danger, the outlet was reached by traveling along the debris at the foot of the cliff behind the Falls, and the obstructing debris was removed by successive blasts of dynamite, thus draining the tunnel. In the whole of this work, which was carried on without interruption until its completion, remarkably quick tunnel excavation was done. In the first drift of the main tunnel, whose section was 13 feet high by 27 feet greatest diameter, the work was carried along at the rate of 50 feet per week, and the main drive, including the yellow-pine timbering, was excavated at a rate as high as 68 feet per week. The diameter of the excavation was 30 feet. The tunnel is lined throughout with 24 inches of concrete, which is worked in between the pine timbers, the latter being left imbedded in the concrete. The finished diameter of the tunnel, when the latter had received its final concrete coat, was 25 feet.



Showing the outlet of the tailrace tunnel for discharging the water behind the falls.

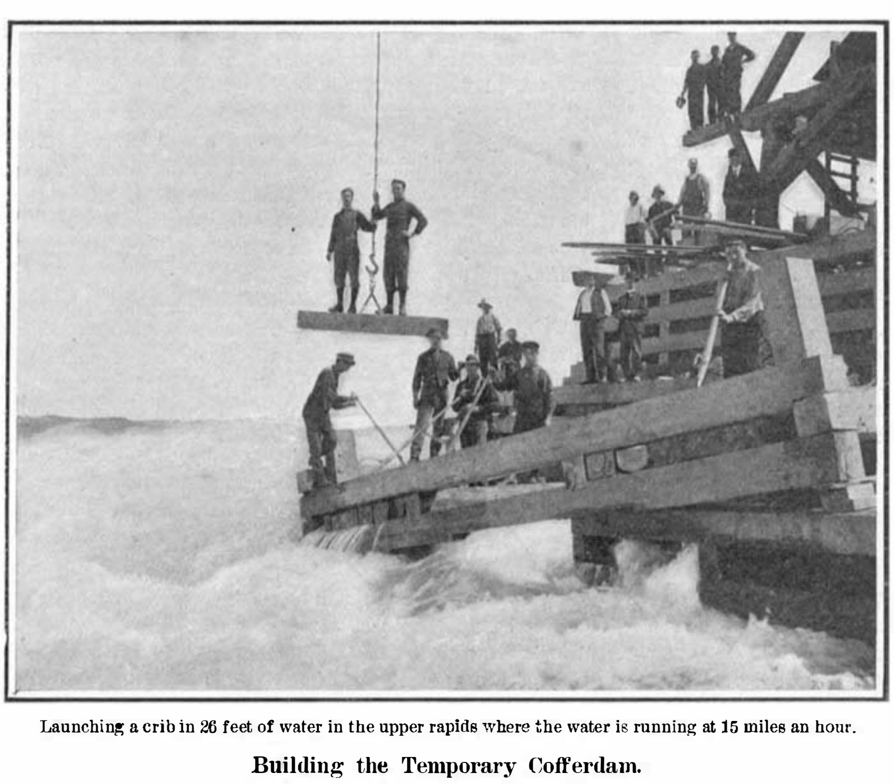
Section Through the Niagara Falls.

The Turbines and Power Station.—The eleven turbines are the largest ever constructed. Time was when we had to go abroad to secure hydraulic machinery of the largest size, and, indeed, the water wheels of the first installation of any magnitude at Niagara Falls were built in Switzerland. Of late years, however, American manufacturers have taken up the design and construction of large turbines so successfully that it is no longer necessary to send abroad to secure them. The turbines under consideration were designed and built at the works of the I. P. Morris Company, of Philadelphia, to whom we are indebted for our illustration. To the right is seen the lower portion of the huge vertical penstock, 10½ feet in diameter, which opens into two annular passageways that lead entirely around the axis of the turbine. They deliver the water to the two water wheels, through which it passes into a central chamber to finally pass out through the draft tube into the tailrace tunnel. The speed of the wheels is regulated by two cylindrical, vertically-sliding gates, one at each wheel, which are operated by an electrically-controlled governor in the generating station above.

The Generating Station.—In the design of the generating station which, in its completed condition, will contain eleven 12,500-horse-power generators, the company have endeavored to put up a building which, architecturally, will be in keeping both with the magnitude and dignity of the plant and with the beauty of Victoria Park, in which it is located. The building, which will be 500 feet long, 70 feet wide, and 40 feet high, will be in the style of the Italian renaissance. The front façade will show a lofty center bay, two end bays, and two loggias, each with an imposing colonnade. The surrounding grounds will be laid out suitably to the general landscape effect of Victoria Park, and it is believed that so far from being an eyesore the building will be a decided addition to the scenic attractions of this justly-famed resort. We are indebted to Mr. Beverly R. Value, chief engineer of the Electrical Development Company, for facilities and information given during the preparation of this article.

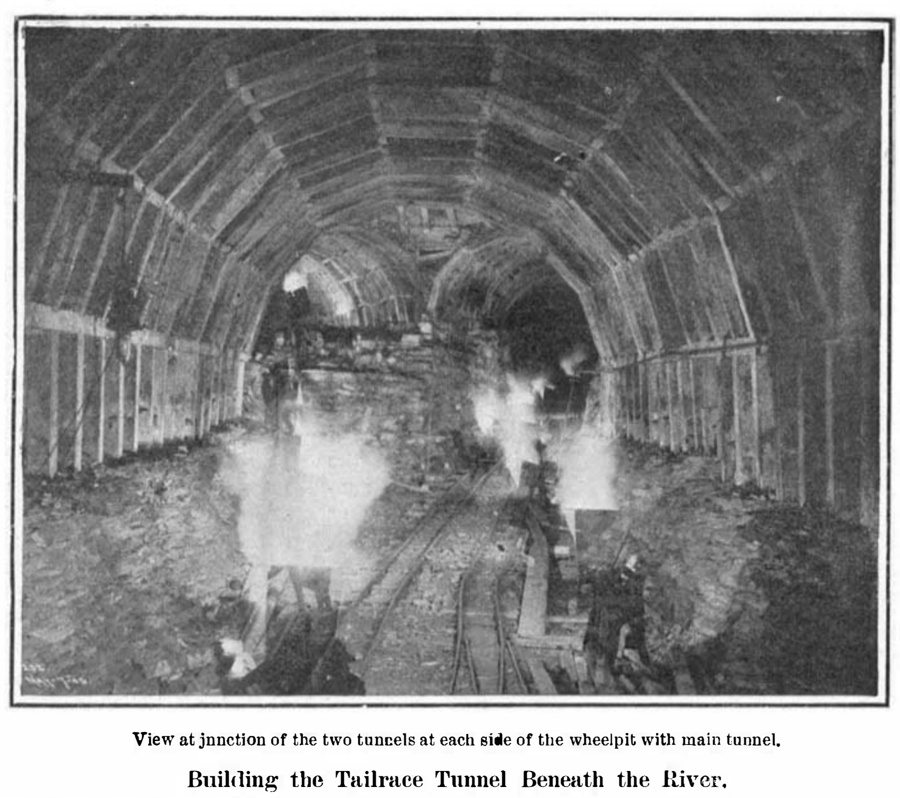
The hydraulic portion of the work was designed by Mr. Hugh L. Cooper and executed under the direction of Mr. Beverly R. Value.

A time-recording camera which will prove of great utility in timing automobile races, where exactitude is such a great requisite, has been devised by two English inventors. The feature of the apparatus is that a photograph of the car is obtained when passing a given spot at a given time, recording the actual time to the fraction of a second. The shutter speeds give a range of exposures from 1-25 of a second to 1-1,000 of a second, while at the same time and with the same movement a photograph is taken of a watch, thus giving the exact time. A special case is provided for the watch, and in an opening above the latter a card is inserted giving the date, which can be signed by the officer responsible for the time test. Underneath the dial is a numbering apparatus. The case is so made that after the official has placed the watch in the case, it can be sealed up, and it is impossible to tamper with the watch without breaking and destroying the seal. The record thus procured can be referred to at any future time.



Launching a crib in 26 feet of water in the upper rapids where the water is running at 15 miles an hour.

Building the Temporary Cofferdam.



View at junction of the two tunnels at each side of the wheelpit with main tunnel.

Building the Tailrace Tunnel Beneath the River.

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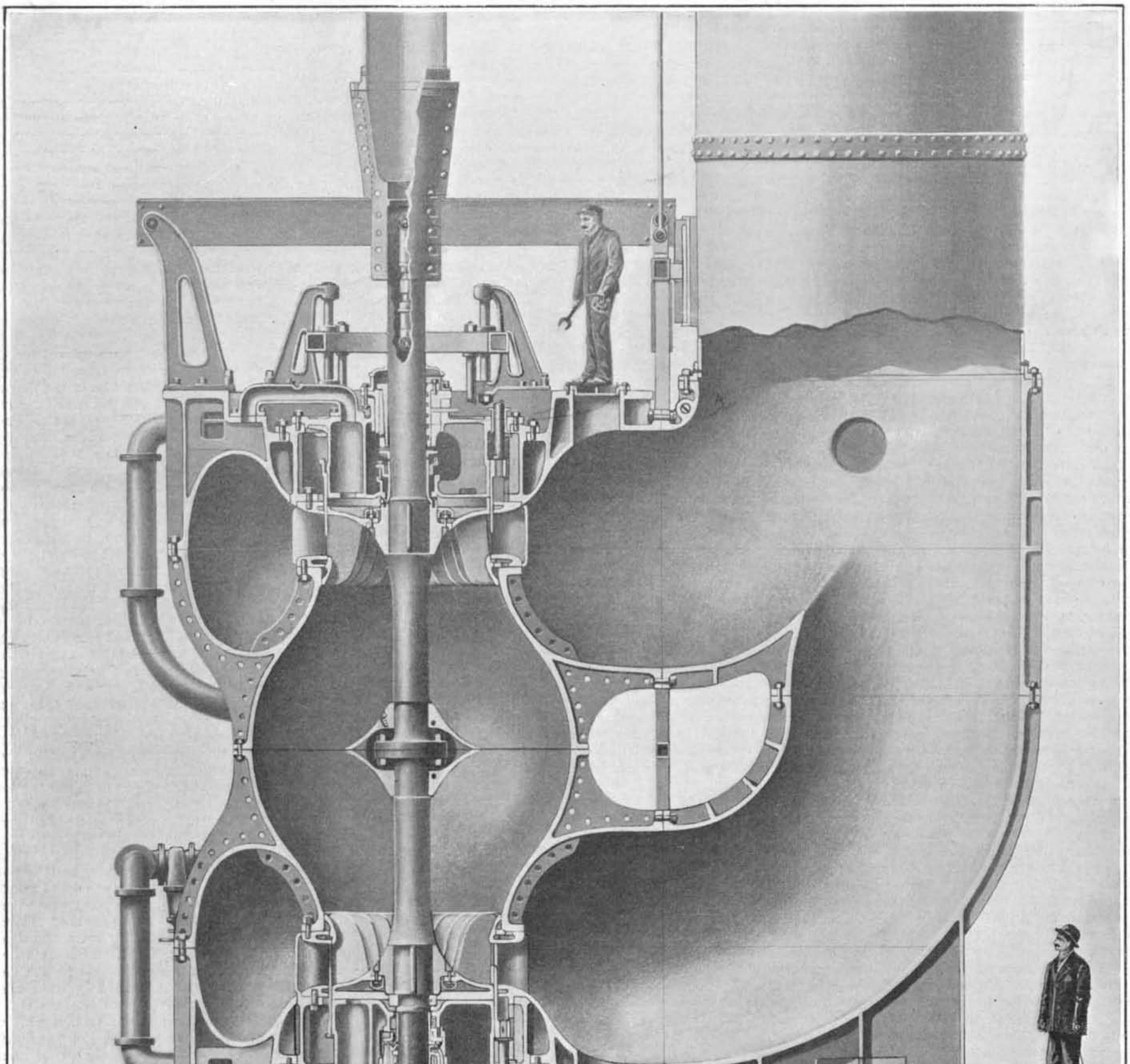

Sectional View of One of the 13,000-Horse-Power Turbines at the 125,000-Horse-Power Plant of the Electrical Development Company.

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