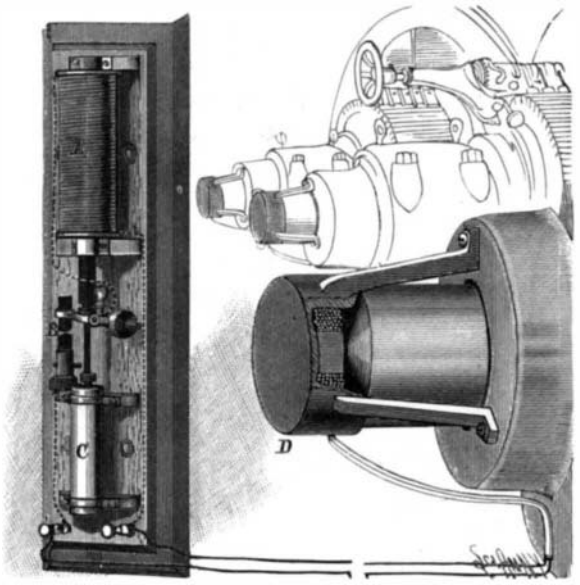
NIAGARA FALLS POWER PLANT.

The two preceding articles on Niagara as an industrial center, published in our issues of May 27 and June 17, dealt respectively with the general topographical and physical features of the Falls, and the many remarkable bridges which span the Niagara gorge. We now take up the subject of the industrial development of the water power. In its present stage this great work has been almost exclusively carried out by two companies, whose methods of utilizing the great hydraulic head presented by the Falls are so different, and include such elaborate and highly interesting plant, as to defy any adequate illustration or description in a single chapter. The present article will be devoted to the larger of the two plants, which is known as the Niagara Falls Power Plant and is situated on the American side at a distance of about a mile above the Falls.

The total fall available for power purposes between the river above the upper rapids and below the falls is 216 feet. This has been utilized on two different plans. The Niagara Falls Power Company has placed its turbines at the bottom of a huge wheel pit, 180 feet in depth, and excavated a great tunnel 7,000 feet in length, which acts as a tailrace to carry the water from the bottom of the pit to an outlet below the Falls. The available head in this case is 136 feet, measured from the surface of the company's feeder canal to the center of the turbines. The other company, known as the Niagara Falls Hydraulic Power and Manufacturing Company, conducts the water through the town of Niagara by an open canal, to a basin at the edge of the gorge below the falls, from which it is carried by large penstocks down to the turbines which are located in a power house at the base of the cliff, and a few feet above the level of the lower river. The available head in this case is over 200 feet.

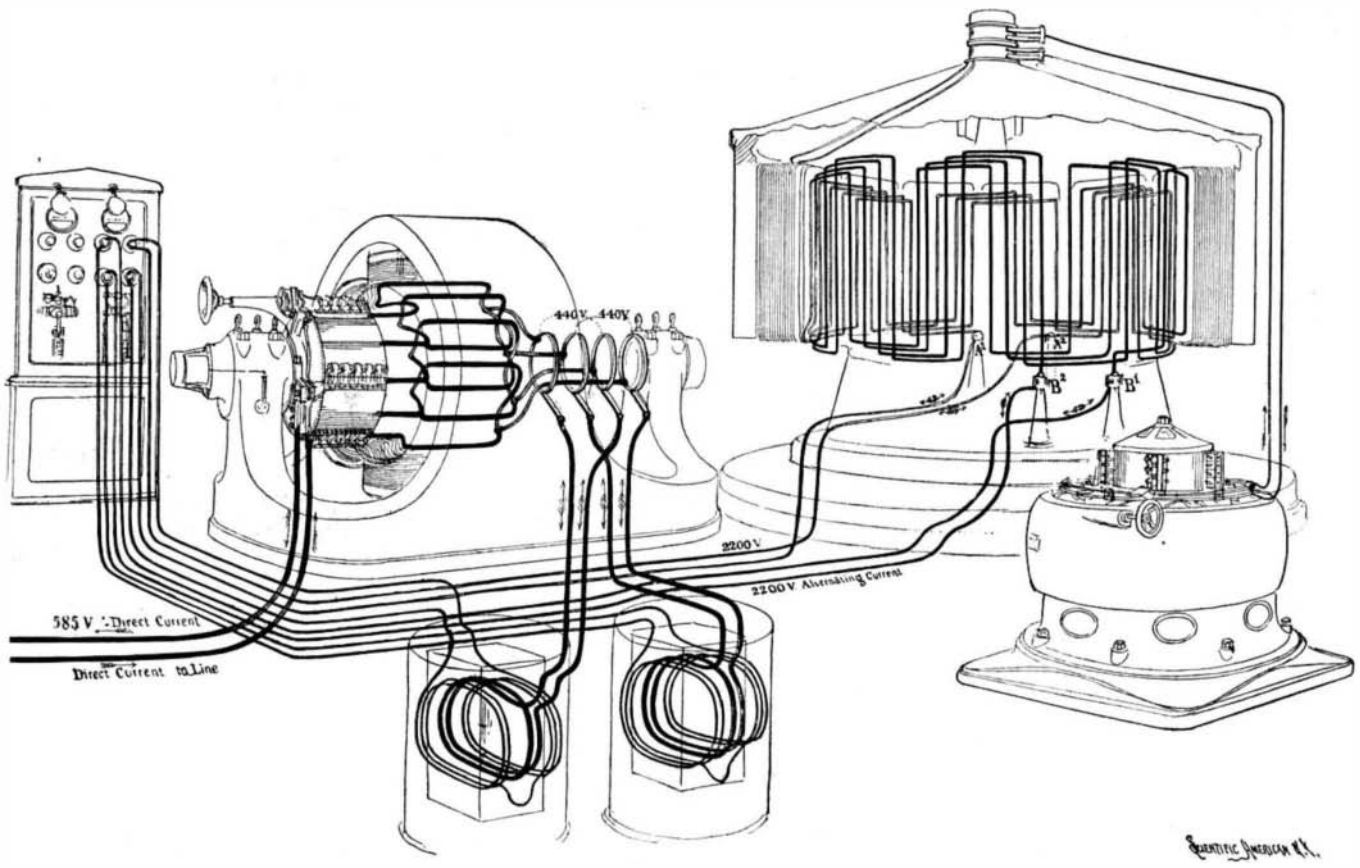
The water is led from the upper river to the power house of the Niagara Falls Power Company by a short canal which is 12 feet deep and is of sufficient capacity to supply water for the development of 100,000 horse power. The scheme as completed calls for a power house extending along each side of the canal, each containing generators capable of a total output of 50,000 horse power. At present only one power house has been built, as shown in our front page engraving, with designed capacity of 50,000 horse power, of which 40,000 horse power is already installed. Below the floor of the house has been excavated a great rectangular wheelpit 20 feet in width, 330 feet in length and 178 feet deep. Leading from the canal to the bottom of the pit are eight steel penstocks, each nearly 8 feet in diameter, which deliver water under a 136-foot head to eight 5,000 horse power turbines, which were designed by Messrs. Faesch & Piccard of Geneva, Switzerland, and built by the I. P. Morris Company, of Philadelphia. These designs were chosen by the company from a number of competitive plans sent in by the most prominent hydraulic engineers of the world. Each wheel is made up of two Fourneyron vertical turbines, one inverted above the other, with a view to getting rid of excessive weight upon the bearings. Weight is neutralized by admitting the water from the penstock through the disk of the upper guide wheels, so that it may exert a vertical thrust upon the disk of the upper turbine wheel. When running at 250 revolutions per minute, each turbine develops 5,000 horse power. As will be seen from the front page engraving, the wheel-pit extends beneath the floor of the power house for its full length. From each turbine there rises a vertical shaft, which for the greater part of its length consists of a steel tube 38 inches in diameter with a shell ¾ inch in thickness. The upper portion of the shaft is of solid steel and is 11 inches in diameter, and at the top of this is carried the massive revolving field of a 5,000 horse power generator. The turbines are built upon a bottom platform of massive steel girders placed at a depth of 146 feet below the surface of the canal water; and three sets of girders which span the wheel-pit at regular intervals serve to carry steadying bearings for the vertical shaft.



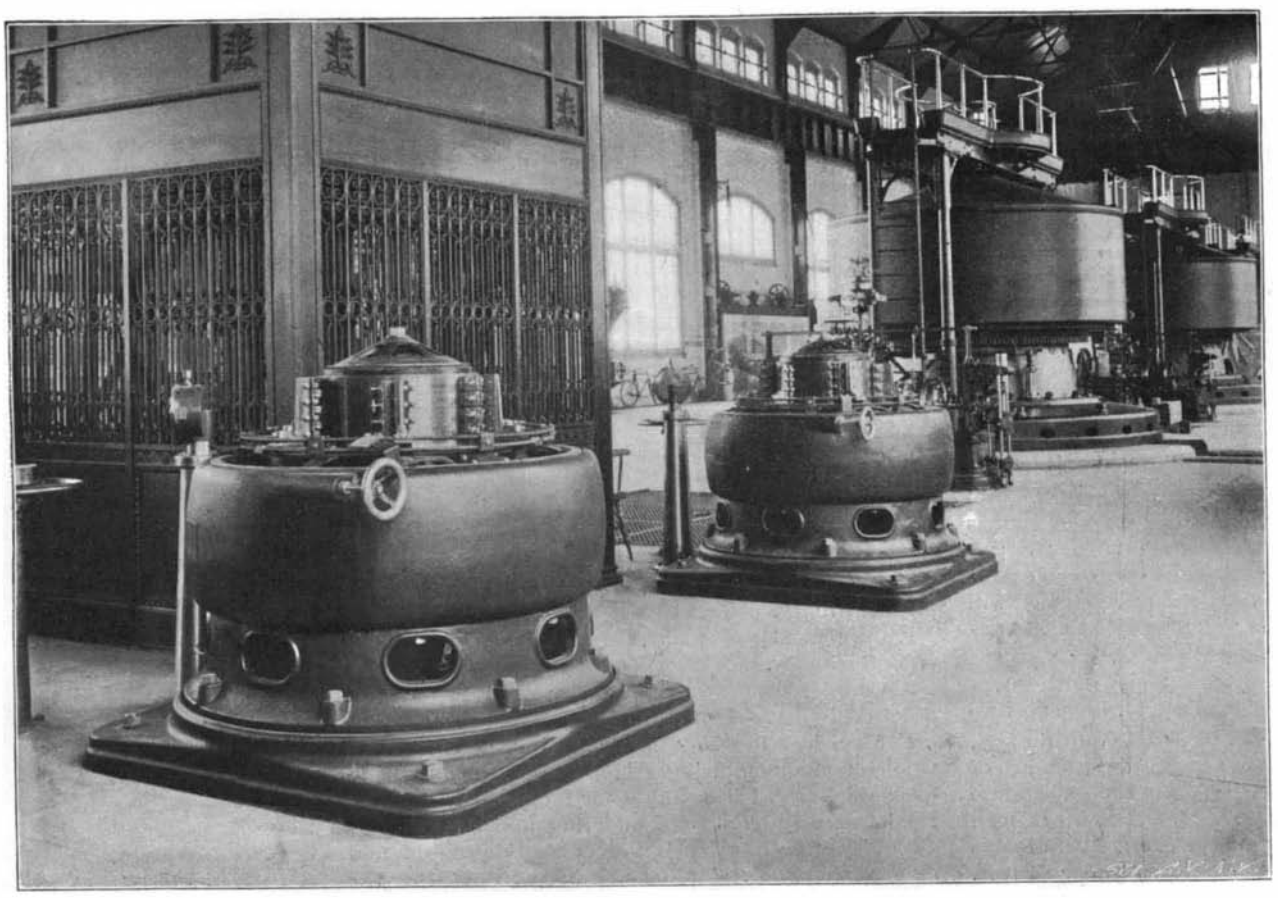
4.—Automatic Attachment for Securing Even Wear on Commutators and Journals.

The great generators, of which there are eight, are placed vertically over the turbines, and rest partly upon the floor of the power house. The armature is stationary and is carried upon a massive conical casting, which is bolted to the arched roof of the wheel-pit, the top of which is level with the power house floor. The rotating field-ring is attached to the main shaft by means of an umbrella-shaped disk, and rotates in a horizontal plane around the armature. The field-ring is a solid ring of nickel steel, 11 feet 7⅛ inches in outside diameter. It carries on its interior face 12 field poles, each with its winding weighing 2,800 pounds. The weight of each generator is 85 tons, the revolving field alone weighing about 40 tons.

Two systems are in use for governing the turbines. The first three are controlled by Faesch & Piccard hydraulic governors which act directly through a walking-beam upon the gates. The other five turbines are controlled by electrical governors, which are so arranged that when the voltage falls, a magnetically-operated clutch closes and serves to raise the gate. The pole-pieces of the field are supplied with 220-volt current supplied by the two generators shown in the foreground of Fig. 6. The current is led to the rotating field by way of collecting-rings at the top of the rotating disk, as shown in the diagram of the wiring, Fig. 5. These two exciters serve all of the main generators.



5.—Diagram of Wiring of Main Generators and Static and Rotary Transformers.



6.—Generators for Exciting Fields of Main 5,000 Horse Power Generators.

NIAGARA FALLS POWER PLANT—III.

We draw particular attention to the large photographic view of the interior of the power house as something quite unique in its way, for here we see represented the generation not only of the largest aggregate of electrical horse power, but the largest aggregate of any kind of horse power, now being developed under one roof and in one room anywhere in the world. The nearest approach to it is the engine room of the steamship "Campania," where 30,000 horse power are given out on the propeller shafts. It is true the great traction companies in New York are building and planning stations whose total output will be 70,000 to 100,000 horse power, but just now the splendid power house here represented has the greatest capacity of them all. The point of view of the photograph is the visitors' gallery, and one receives a vivid impression of the compactness and general

convenience of electrical generating machinery when he bears in mind that each of those swiftly rotating machines, any one of which could be placed within the walls of an ordinary cottage living room, is generating the enormous total of 5,000 horse power. Around the roof of each rotating field is arranged a series of hoods which serves to catch the air and cause a draught of cold air to pass through the generator. The hazy effect caused by the swift rotation of these hoods is noticeable in the illustration.

The enormous two-phase 2,200-volt currents from the

ALESSANDRO VOLTA.
From an engraving by Morghen.

generators are led to a special switchboard, operated entirely by compressed air, on which a panel containing an ammeter, wattmeter, and voltmeter for each phase and a direct-current ammeter in the exciter circuit, is provided for each main generator. On the opposite side of the canal from the power house is a smaller building, which contains the transformers, a covered passageway between the buildings serving to carry the mains. It is impossible within the limits of this article to describe in detail the various transformations of the current which are made to suit the needs of the various users. The diagram, Fig. 5, showing the wiring of the main generators, and also of the static and rotary transformers in which the current for the Niagara Falls railways is converted to direct current, will be of interest. The 2,200-volt two-phase current from the main generator is transformed by a static transformer in each phase to 440-volt current, and then led to a rotary transformer, where it is changed to 550-volt direct current for use on the local street railways. Of these the Niagara Falls and Suspension Bridge Company takes 250 horse power and the Buffalo and Niagara Falls Electric Railway 350 horse power. Perhaps the most interesting transmission is that of 6,000 horse power to Buffalo, twenty-six miles distant. The current for this purpose is stepped up from 2,200-volt two-phase to 11,000-volt three-phase in two huge static transformers located in the transformer building. These have been so arranged that by a change of connections the pressure may at any time be raised to 22,000 volts if it should be deemed advisable.

The company owns a continuous tract of land which includes two miles of river water front, and embraces over a thousand acres. Located upon this and other adjacent property are a large number of electro-chemical establishments which have been attracted to the locality. The names of some of these concerns and the horse power they are receiving from the Niagara Falls Power Company are as follows: Union Carbide Company, 6,000 horse power; Pittsburg Reduction Company, 3,600 horse power; Carborundum Company, 1,100 horse power; Mathieson Alkali Company, 2,000 horse power; Niagara Electro-Chemical Company (sodium), 650 horse power; Oldbury Electro-Chemical Company, 500 horse power; Buffalo and Niagara Falls Electric Light and Power Company, 800 horse power. Altogether the company is supplying over 22,000 horse power, and it is now under contract to supply 20,000 additional horse power for various purposes. Two additional 5,000 horse power wheels are now being installed, so that before long the present power house will have reached its designed capacity of 50,000 horse power.

In addition to its sale of electrical power the company supplies 7,200 hydraulic horse power to the Niagara Falls Paper Company, whose large establishment is located near the power house. The water received from the power company is utilized by the paper company in turbines located in its own wheel-pit, which is connected with the main tunnel tailrace by a branch tailrace 7 feet in diameter.

The visitor to this splendid plant is impressed with the great care that is taken to keep everything up to the highest state of efficiency, a care that extends to the smallest details. We present a cut of an attachment designed by the chief electrician, Mr. P. M. Lincoln, for securing an even wear on the commutators and also on the journals of the generators, converters, etc. It consists of an electro-magnet, *D*, which is held by means of three legs bolted to the frame of the generator, outside one end of the armature shaft, and a current interrupter which may be placed in any convenient corner of the building. The object of the device is to give the shaft a continuous reciprocating motion in the direction of its axis so as to prevent irregular wear in the brushes and journals. When the magnet, *D*, is excited the shaft is drawn outward, and when it is demagnetized the shaft returns by the attraction of the field on the armature. When the coil, *A*, of the interrupter is excited it lifts its core, trips a small weighted lever, and breaks the contact at the carbon points, *B*, when the coil is demagnetized and the core and arm drop, the fall being retarded by a dashpot, *C*. The device is giving good results on the machines to which it has been attached.

It will be remembered that when the Niagara Falls Power Plant was first set in motion, there was a confident prediction by the press that before many years the energy of the Falls would be transmitted electrically to cities that were 100 miles or more distant. The statement was not generally indorsed by expert opinion, and it is significant that the tendency to-day is for the manufacturers to locate at the Falls rather than for the power of the Falls to be carried long distances to the consumer. Although the current, in the present state of the art, could probably be transmitted for 100 miles with a loss in transmission of less than 20 per cent, it would cost so much more to the consumer as to render the erection of works at Niagara a more profitable alternative.

ALESSANDRO VOLTA.

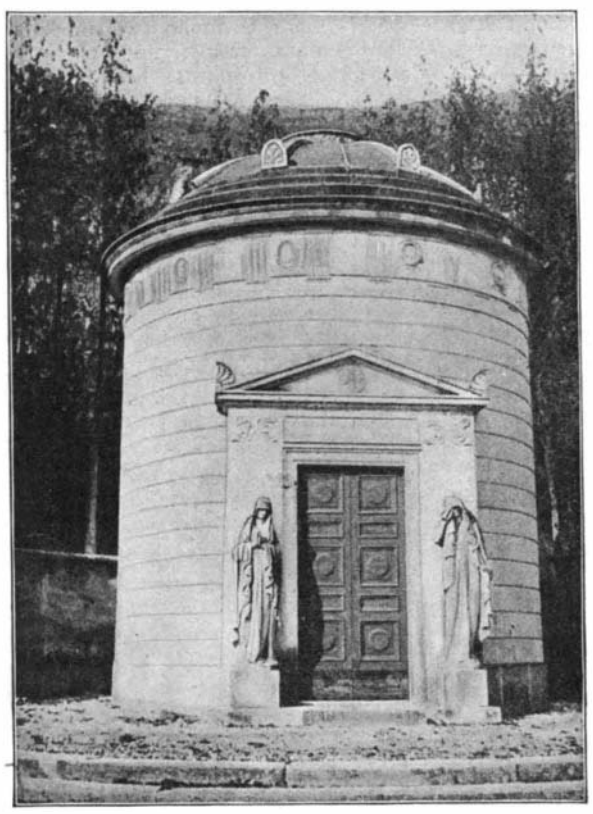
The hundredth anniversary of the invention of the electric battery by Volta was celebrated by an International Electrical Exposition at Como, which was opened with due ceremony in the presence of the King of Italy, on the 20th of May, and certainly no more fitting tribute could have been paid by the people of his native place to its most illustrious citizen.

The Volta Electrical Exhibition at Como, Italy, including the many relics of Alessandro Volta, was entirely destroyed by fire on July 8, the cause being a defective electric wire. The fire broke out in the marine gallery, and spread with marvelous rapidity, owing to the combustible nature of the buildings and their contents. Many visitors were in the buildings, and they fled in a panic. Two gasometers exploded, adding to the disaster. No lives were lost, but many exhibits and scientific records, which cannot be replaced, were burnt.

The Volta relics were contained in a receptacle built of solid masonry, but, notwithstanding this fact, they were all destroyed with the exception of some of the personal effects of Volta, including the Senatorial sword presented to him by Napoleon, and his decorations. Fortunately, we are enabled to present engravings of a number of the interesting exhibits. The illustrations were published originally in our esteemed Italian contemporary, L'Illustrazione Italiana.

Volta was born at Como, on February 18, 1745, in the house that was occupied by the Volta family for 326 years. His father was Filippo Volta, who wasted his patrimony by imprudence and prodigality, and his mother was Countess Maddalena Inzaghi. He had three brothers and three sisters; all of the former were connected with the church, and two of his sisters were nuns, but the third married Count Reina. The first two years of his life Alessandro spent in the house of his nurse. He developed so slowly, intellectually as well as physically, never speaking a word, that his parents feared that he might be a mute, until one day, when he was four years old, he uttered an emphatic "No." Afterward his progress was rapid, and even in childhood he manifested a passion for observing natural phenomena and investigating their cause, and this propensity very nearly cost him his life, for one day, when endeavoring to find something, which he supposed to be gold, in a fountain, he fell in and was in danger of drowning.

In 1758 he entered the School of Rhetoric, where he remained for three years. While there he showed a most unusual aptitude for writing poetry. When still a youth he wrote a poem of eight hundred verses on the Seasons, in Latin, which has recently been translated and published by one of his descendants, Zanino

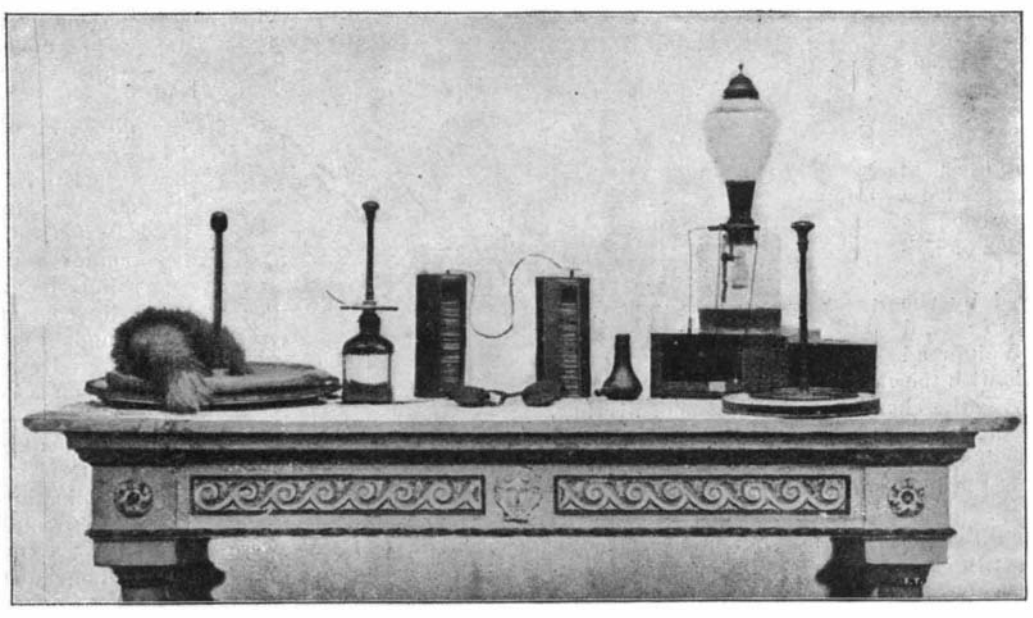


TOMB OF ALESSANDRO VOLTA IN THE CEMETERY AT CAMNAGO.

Volta. His study of philosophy began in the College of the Jesuits, where he, however, remained only one year, and was continued in the Bensi Seminary. He devoted much time to physical and natural sciences and wrote more poetry. About this time he wrote an ode, in French, on the ascent of Mont Blanc, and sent it to De Saussure. When eighteen he corresponded on scientific subjects with the Abbé Nollet, who encouraged him to publish a paper on the causes of electrical phenomena, in which he referred to the unity of physical forces, foreseen by him as well as Spallanzani and other physicists and naturalists of that time. At twenty-four he published and dedicated to Beccaria, the great Piedmont physicist, a Latin memoir, which was followed by another in 1771 on an electrical apparatus of his invention, and this was dedicated to Spallanzani.

In 1774 he was made regent of the schools of Como; an interesting account of this period has been published by Zanino Volta. The following year he invented the electrophorus, which caused a great stir in the electrical world, in other countries as well as Italy, and brought him many honors from numerous academies, leading to his appointment as professor of experimental physics in the gymnasium of Como. One of his innovations in former customs worthy of mention in connection with his work as a professor is the writing of theses in Italian instead of Latin; this he caused to be done because he thought that physical truths which were to be demonstrated by experiments, during which it was necessary to refer to apparatus and the manipulation of the same, could be more clearly set forth in the language of the students.

Investigations pursued by Volta at the hot springs of Pietra Mala and di Velleia led to his discovery of the



VOLTA'S APPARATUS AT THE INSTITUTO LOMBARDO DI SCIENZE, IN MILAN.

SCIENTIFIC AMERICAN

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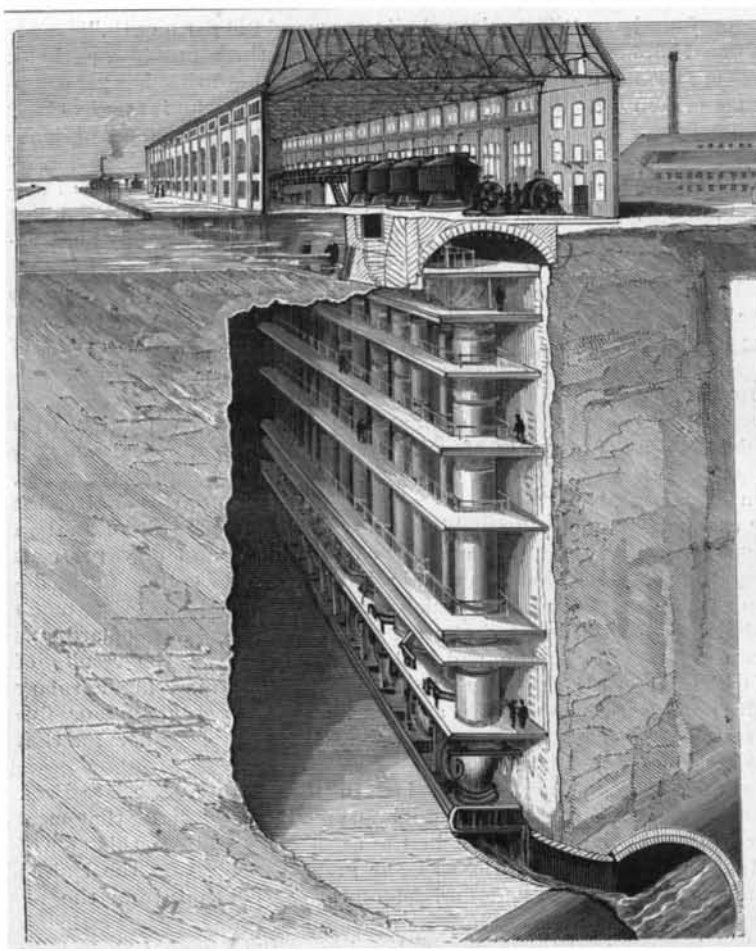
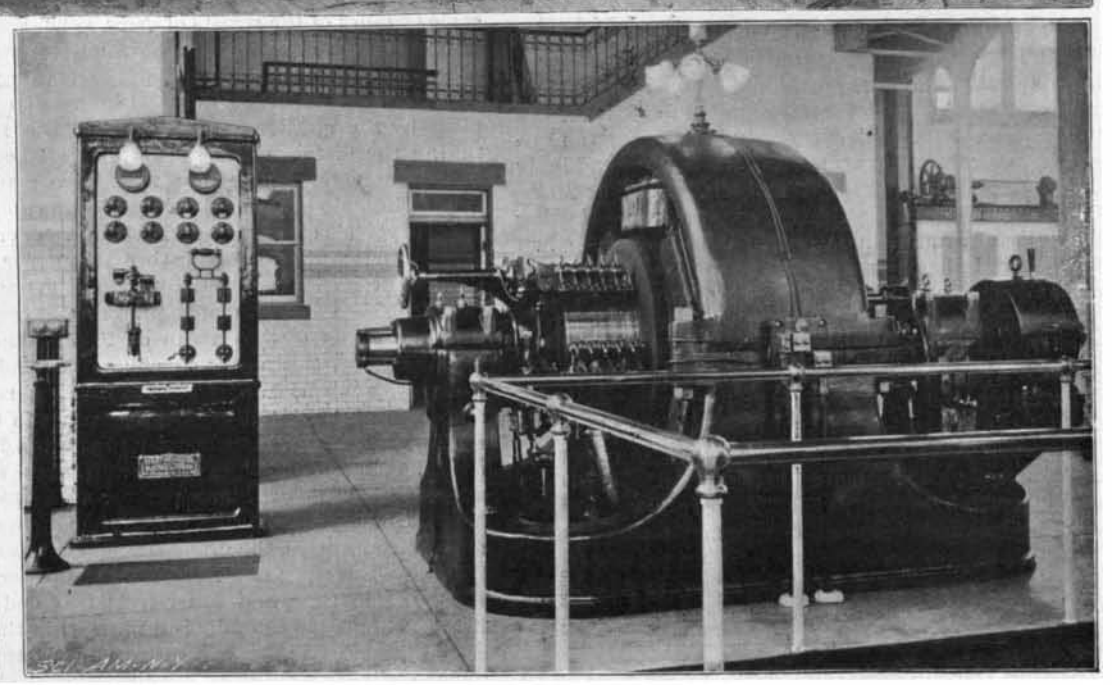


1.—Sectional View of Power House, Wheelpit and Tailrace Tunnel.



2.—Rotary Transformer for Local Railway Supply.

3.—The 50,000 H. P. Power House, with Eight 5,000 H. P. Generators Installed.

NIAGARA FALLS POWER PLANT—III.—[See page 56.]