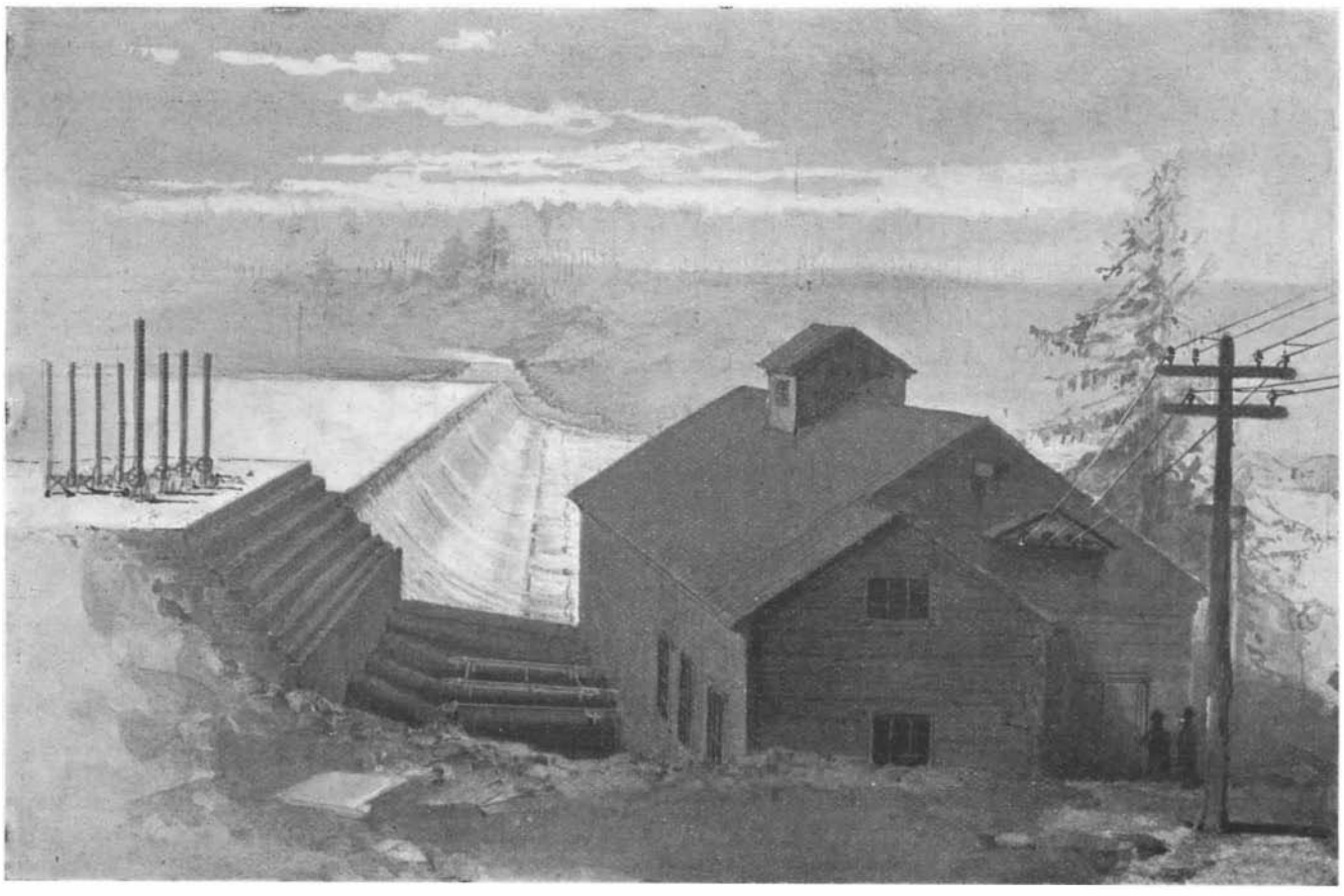
THE HARTFORD ELECTRIC LIGHT AND POWER PLANT.

With the completion of the new plant of the Hartford Electric Light Company and the leasing of the old plant of the Hartford Electric Light and Power Company, the citizens of Hartford are able to boast that they use more electric light and power than any other city in the United States and that they have one of the best electrical systems on the continent.

The original dam on the Farmington River was built in 1889. The site was 10·8 miles distant from Hartford, and at that time the success of long distance power transmission was somewhat problematical. The dam, 18 feet in height, was accordingly built of wood, with a vertical face and wooden abutments. When it was decided to enlarge the electrical system of the city last year, 5 feet were added to the height of the dam, bringing it up to 23 feet, and the wooden abutments were replaced by a solid construction of granite. The water is led through four pairs of 36 inch horizontal turbines by means of large steel flumes 8 feet in diameter, which pass through the abutment and inclose the turbines, as shown in the accompanying engraving. The turbines, which are of the McCormick and Rodney Hunt type, are arranged in pairs upon a common shaft, the water entering at the ends of the casing and discharging centrally through a draught tube. The total capacity is 1,600 horse power. The turbines are controlled by Lombard governors, which compress air into a receiver for use in shutting down the gates, should the load be suddenly taken off during operation. If the turbines should commence to race, the governor automatically releases the compressed air and shuts down the gates in a few seconds' time. Two pairs of turbines are belted to each generator, the generator pulley being double crowned for this purpose. There are two 600 kilowatt 22 pole generators made by the Westinghouse Electric and Manufacturing Company. They are run at 325 revolutions per minute and the frequency of the current is 60 cycles per second.



THE FARMINGTON RIVER DAM AND POWER HOUSE.

The current at 500 volts is raised in transformers to 10,000 volts for transmission to the city, 10·8 miles distant. It is brought in over six No. 0 copper wires whose combined cross section is about one-fourth of a square inch. It was decided to use six wires in place of three in the three-phase transmission (two being connected in multiple on each phase), because by this arrangement the lines used in the former plant could be utilized with better economy. At a distance of a little over half a mile from the Pearl Street station, in Hartford, the wires are carried underground and connected to three No. 0000 cables which run direct to the station. The loss of power in transmission is less than 10 per cent for the 10·8 miles. By reference to the engraving of the power station at Farmington, it will be seen that the power is transmitted from the turbines to the generators by belting, the distance between the respective shafts being 50 feet. As a striking illustration of the relative economy of electric as compared with belt transmission, it may be mentioned that the loss in this 50 feet is 10 per cent, or equal to the loss on the whole 10·8 miles of electrical transmission The lines are protected from lightning by banks of Wurts arresters and choke coils. The former are mounted in racks, one rack being placed in each phase of the circuit both at Farmington River and the Pearl Street station.

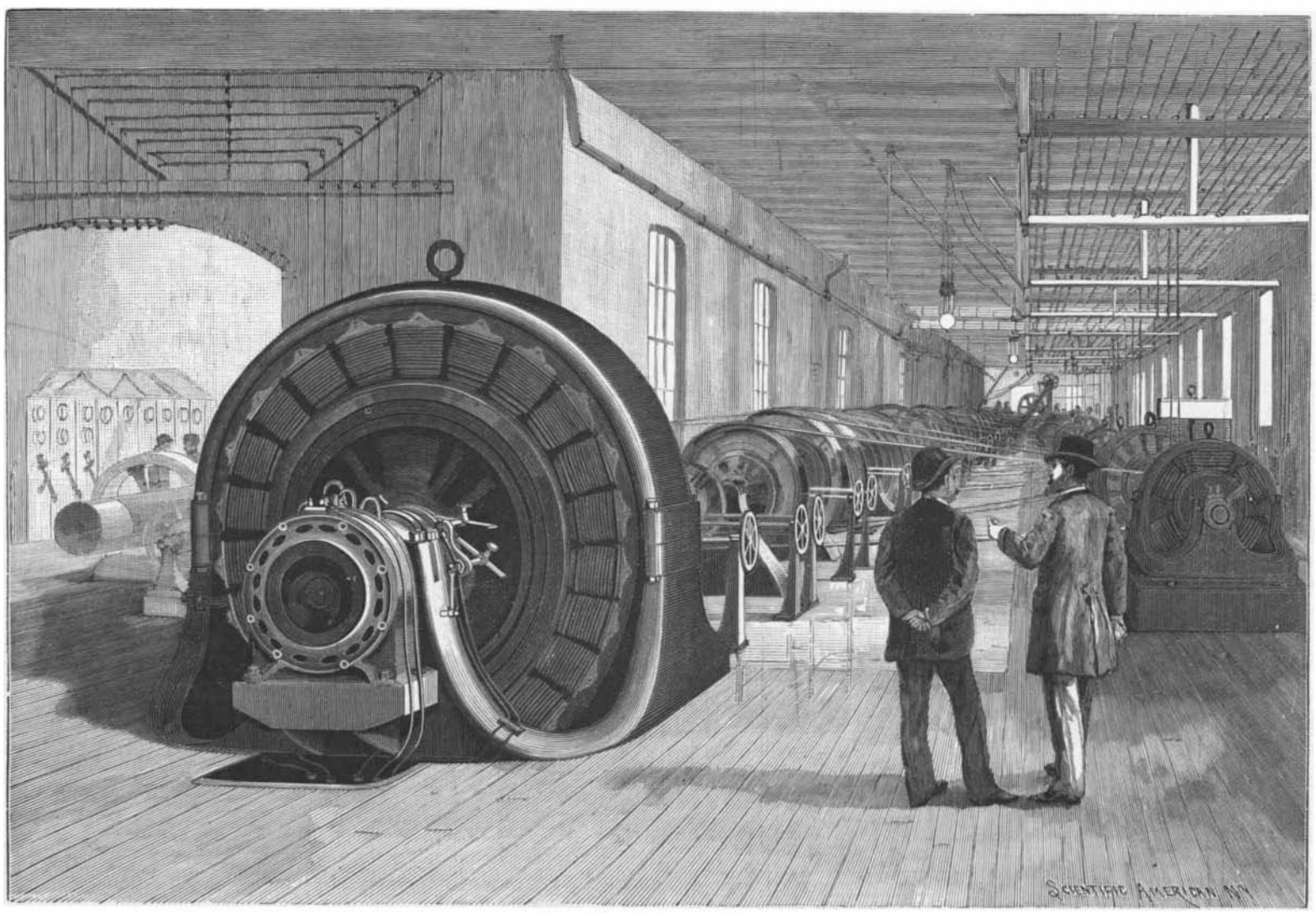
At Pearl Street station the 10,000 volt three-phase current, which was used for the long distance transmission as being best adapted for the work, is reduced to two-phase, 2,400 volt current. Here the electric energy is used in three different ways :

1. It supplies current to the alternating current lighting and power system of the city.

2. It supplies current to the rotary transformers at the State Street station.

3. The current that is not used for the above purposes operates a 600 kilowatt motor at the Pearl Street station.

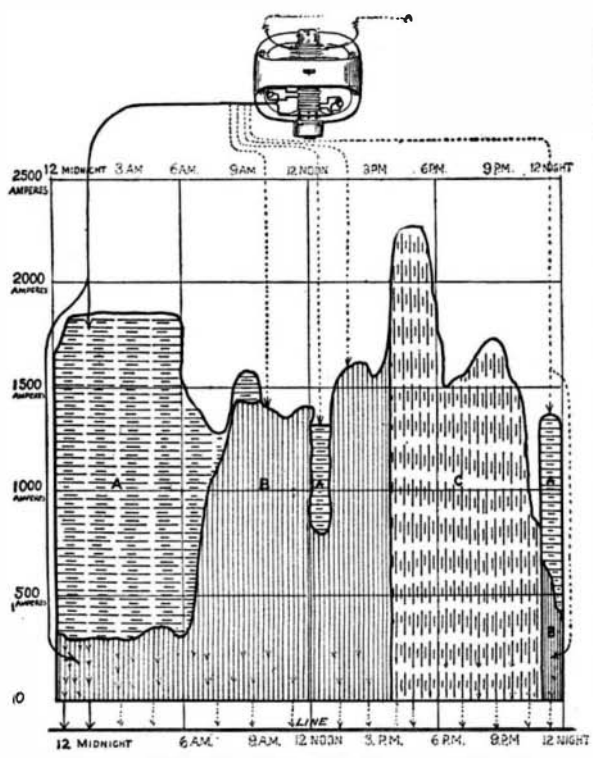
In the alternating current distribution at Pearl Street mentioned above the lighting circuits are run at 1,200 volts, on the single-phase system, and the light and



THE PEARL STREET STATION.

THE HARTFORD ELECTRIC LIGHT AND POWER PLANT.

power circuits at 2,400 volts on the two-phase system. Under the present system the current that is not derived from the Farmington power house is furnished by the engines and generators at Pearl Street, which were formerly the property of the Hartford Electric Light and Power Company. This plant consists of a 1,600 horse power Cooper-Corliss compound condensing engine belted to one end of a shaft at the other end of which is a 600 kilowatt Westinghouse generator. This line of shafting serves also to operate the series-arc dynamos and two 200 kilowatt generators that supply current to one of the suburban street railways.



STATE STREET STATION LOAD DIAGRAM.

The 600 kilowatt generator may operate either as a motor or a generator. It is at all times connected with the switchboard, so that when the water power is not equal to the demands of the alternating system (as often occurs during the hours of maximum load) the motor at once becomes a generator driven by the engine and supplies current in multiple with the Farmington power house generators. In the summer time the plant at the river can only be run for 12 hours out of the 24, and during this period the steam power plant acts as an auxiliary. Moreover, in case of a breakdown of the water power, the same plant would be available to furnish the city's needs.

The presence of the 600 kilowatt motor in the station also allows the voltage to be varied on the alternating system without reference to the power station. The voltage may be made to vary through a wide range by varying the field excitation of the motor, and this is done by introducing a lagging current into the transmission line. An induction motor serves to start the 600 kilowatt motor, the former being thrown out of the circuit as soon as the correct speed is obtained. As the motor is built to work at a 2,400 volt pressure, no special transformers are required when it is operated as a generator.

The State Street station, of which we present an interior view, is said to contain the largest storage battery in the United States. At the far end of the room will be noticed the large marble switchboard, which is 8 feet in height, and when completed will measure 50 feet in length. To the left are the two rotary transformers and behind the switchboard are four stepdown static transformers. The 2,400 volt current which is delivered from Pearl Street station is received by the rotaries and their accompanying transformers, which change it from alternating two-phase and deliver it as 240 volt direct current to the three-wire system.

The current received from Pearl Street station is controlled and recorded on the panel to the left. Upon another panel are the switches and meters which receive the current from the rotary transformers. They are provided with automatic circuit breakers, which prevent the pressure from rising above a certain point. The tall metal frames standing up above the switchboard at the center contain vertical screws, by means of which "end cells" in the storage battery can be cut in or out of the circuit, according to the variation of the demand. On each side of this regulator are the discharge panels. To the right again are the switches which control the underground feeder circuits.

The storage battery, manufactured by the Electric Storage Battery Company, of Philadelphia, contains 130 cells, 65 on each side. The cells are made of oak and are lined with lead, and each cell contains 31 negative and 30 positive plates. The negative plates are of the chloride type, the positive plates being the Manchester type of Planté plate. The capacity of the battery is a discharge of 1,700 amperes on each side for five hours. The total weight of the cells is 300 tons, and each cell measures 2 feet by 5 feet by 4 feet high. When the battery was erected it took ten car loads, or 180,000 pounds, of sulphuric acid to charge it. The switchboard connections are arranged so that the battery is at all times connected with the distributing bus bars, whether it is charging or discharging, or when the battery and rotary are supplying current in multiple to the lines. As a result of the connection of the alternating to the direct current system through the rotary transformer, the battery is able to provide for fluctuations in either of the systems.

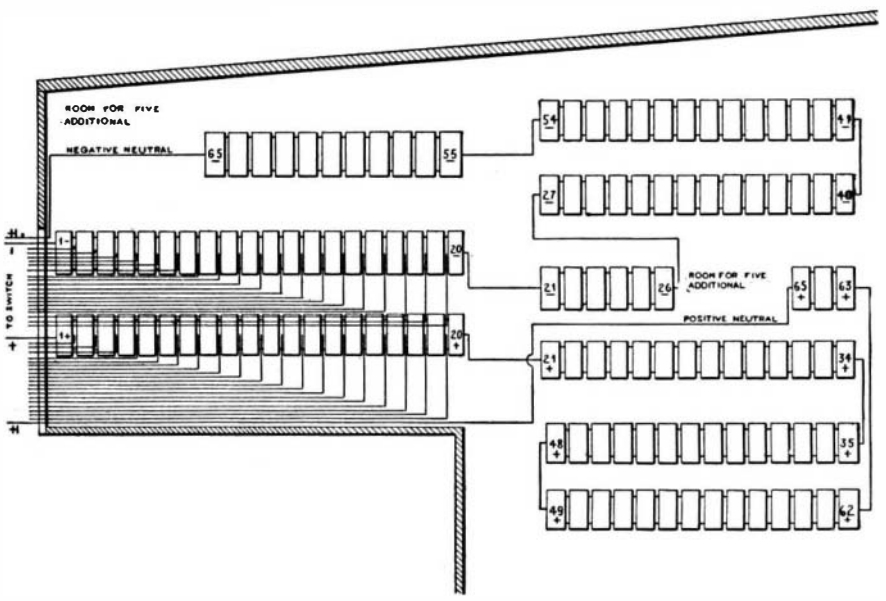


DIAGRAM OF STATE STREET BATTERIES.

The accompanying load diagram will assist the reader in understanding the part played by the storage battery in the Hartford system. The figures on the vertical scale show the amperes and the horizontal scale the time for 24 hours on December 12, 1896. The battery has a capacity of 500 horse power for five hours. It is capable of running 1,000 incandescent lamps for 34 hours or 34,000 lights for one hour. The shaded space marked A shows the current that was discharged into the battery from the wire through the rotary transformer. The space marked B shows the current that was sent direct from the transformers to the lines, and that marked C indicates the current sent into the lines from the battery. It will be seen that from 12 P. M. to 6 A. M. the consumption was about 350 amperes. Between 6 A. M. and 8:30 A. M. it rises rapidly to over 1,500 amperes. At about 8 A. M. the current from the Farmington River station, which has been passing into the battery, temporarily assists the transformer current, as shown by the horizontally shaded portion of the diagram at the top of B, at this hour. The demand then drops slightly until near noon, when it falls suddenly to 750 amperes. This is caused by the large number of lights and motors that are shut off for the dinner hour. The surplus current meanwhile flows into battery. From 1 P. M. to 3:30 P. M. the whole of the Farmington current goes to the lines. From 3:30 P. M. to 11 P. M. the lines draw all of their current from the battery, and at 11 P. M. the charging of the battery again commences, and the current for the lines is drawn from the transformers. By 3:30 P. M. the battery will be fully charged and the 1,000 horse power from Farmington River can be utilized at Pearl Street station. With the battery at State Street fully charged, the Farmington current running the Pearl Street generator and the Pearl Street engine also running, the total horse power available would be about 3,000.

We are indebted to Mr. William Lispenard Robb, the electrical expert of the company, and Mr. R. W. Rollins, superintendent of the works, for courtesies extended during the preparation of this article.

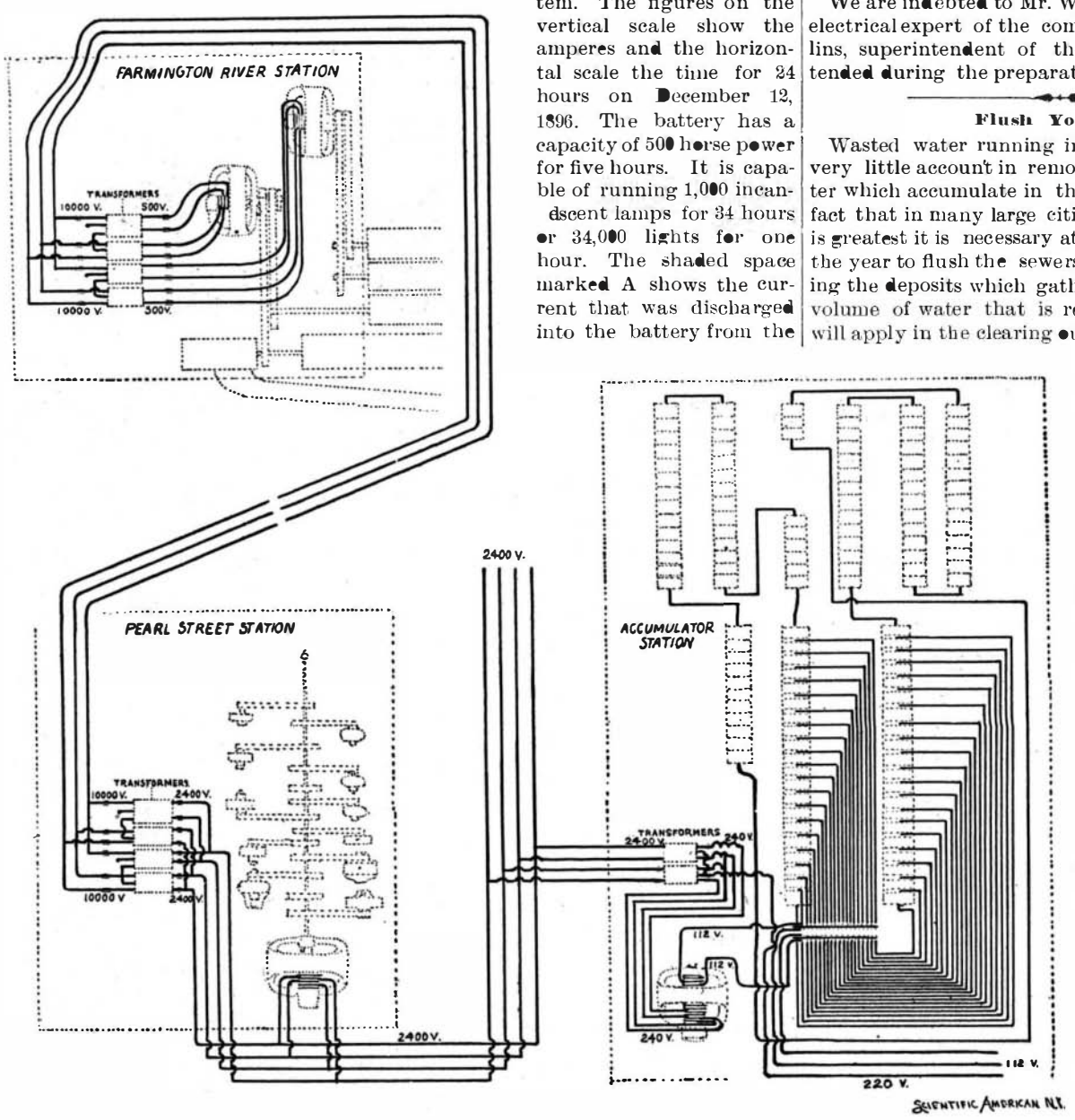


DIAGRAM OF THE HARTFORD ELECTRIC LIGHT AND POWER PLANT.

Flush Your Pipes.

Wasted water running into drains and sewers is of very little account in removing deposits of solid matter which accumulate in them. This is proved by the fact that in many large cities where the consumption is greatest it is necessary at frequent intervals during the year to flush the sewers for the purpose of removing the deposits which gather there. It is weight and volume of water that is required, and the same rule will apply in the clearing out of a drain or waste pipe. In the ordinary closet a stream of water pours through the valve into the arm of the bowl, then encircles the bowl, feebly drops into the trunk of the closet, then into the trap and down the soil pipe. The internal circumference of the soil pipe is a little over twelve inches. The stream of water flattened out will not exceed four inches; consequently, but one-third the inside circumference of the soil pipe is ever washed by the water. A pail of water, thrown into the bowl of a water closet, an operation taking only a few seconds of time and a few gallons of water, will have a flushing effect more complete than if the closet valve were kept open for a whole day.—Water and Gas Review.

MR. R. T. GUNTHER has gone to Lake Urumiya, on the Persian frontier, with a view of studying the fauna of the lake.

SCIENTIFIC AMERICAN

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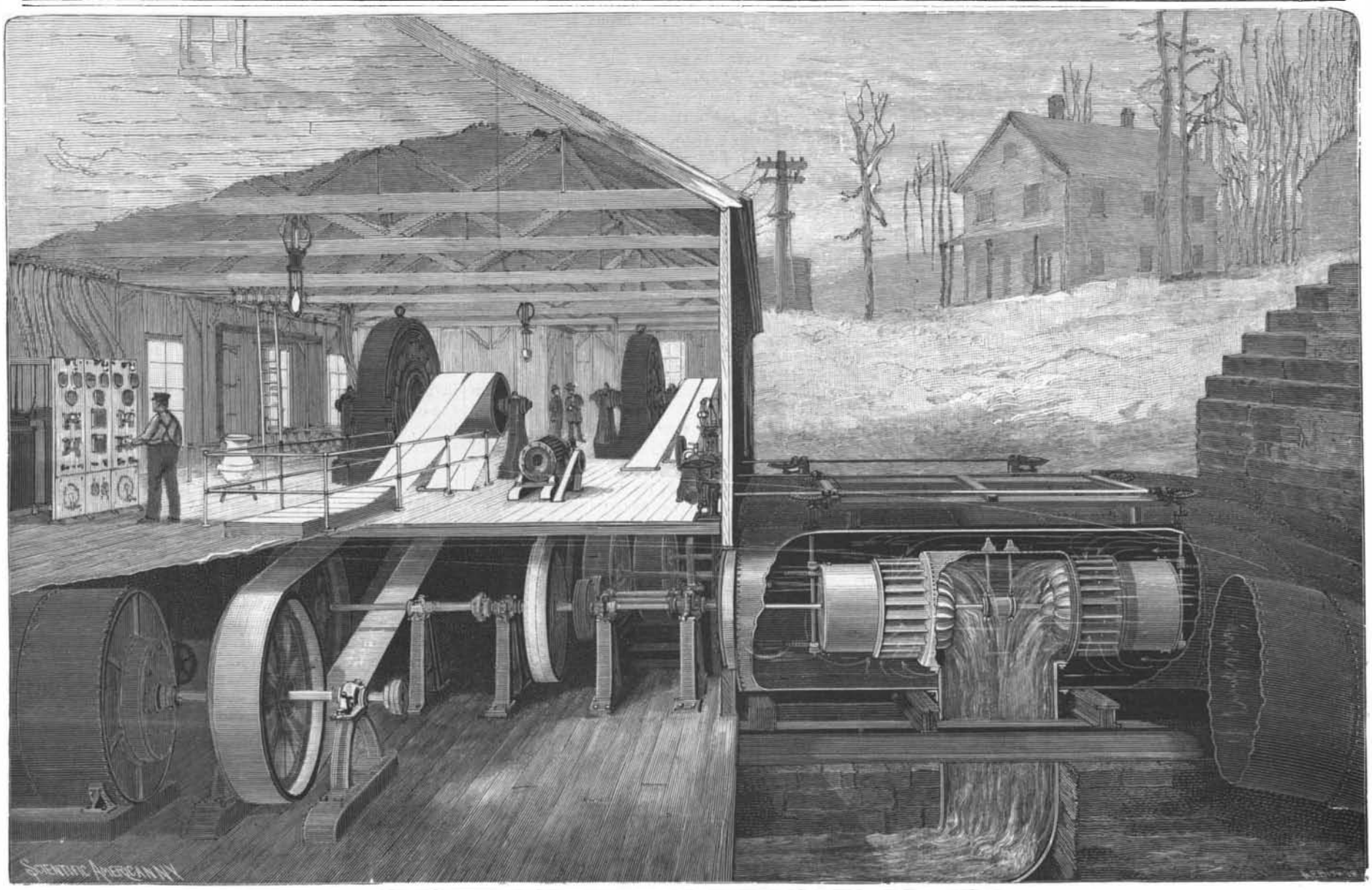
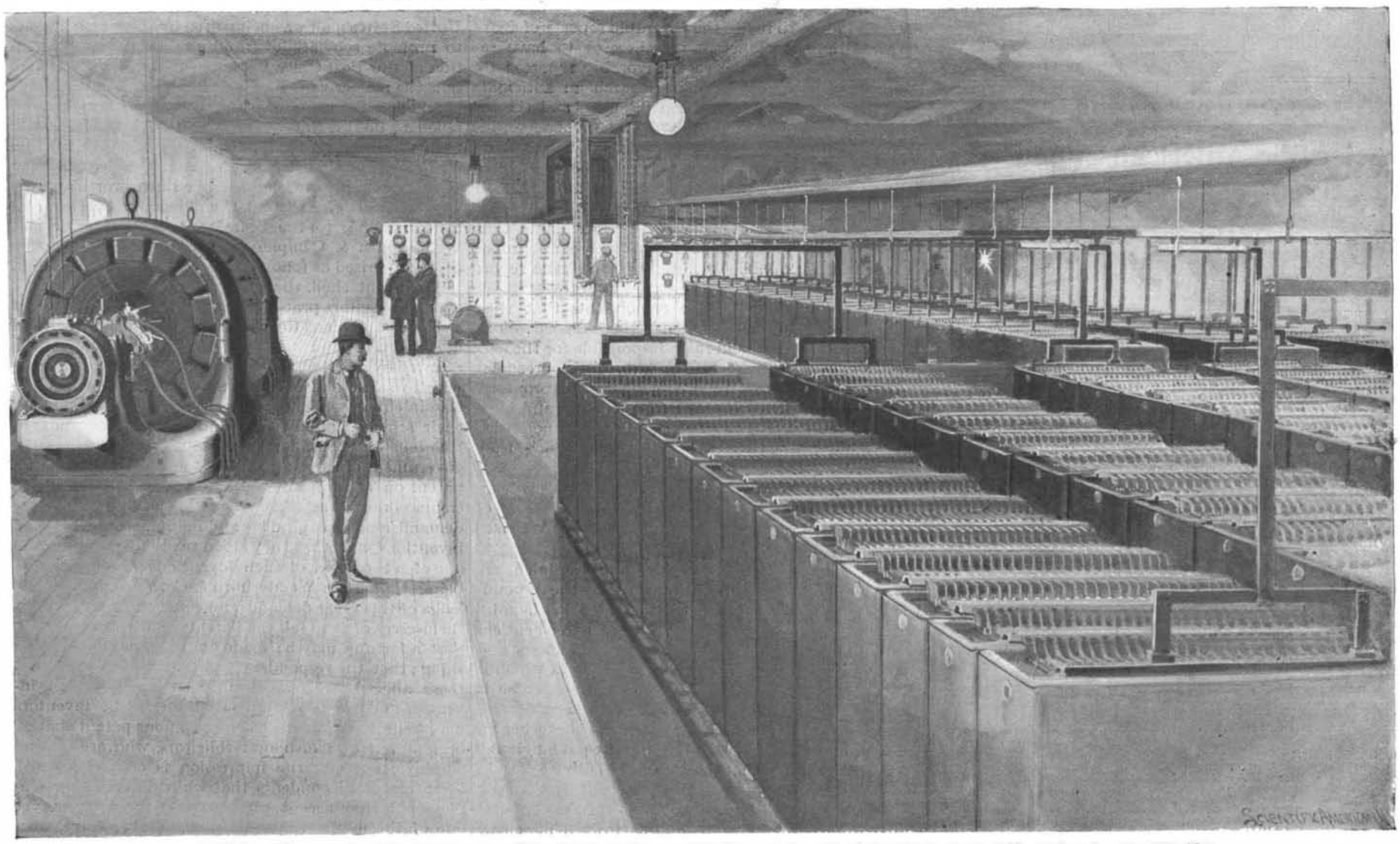


THE TURBINES AND GENERATORS AT FARMINGTON RIVER POWER HOUSE.



STATE STREET STATION, SHOWING THE ROTARY TRANSFORMERS, THE SWITCHBOARD, AND THE STORAGE BATTERIES.

THE HARTFORD ELECTRIC LIGHT AND POWER PLANT.—[See page 255.]