A 70,000 HORSE POWER CENTRAL STATION.

There is now in active operation in New York a power station which will ultimately contain by far the largest aggregation of horse power ever gathered at a single station. About half of the total number of units, which will have a combined horse power of about 70,000, has been installed, and the others have been ordered and are now being built by the Edward P. Allis Company, of Milwaukee, Wis.

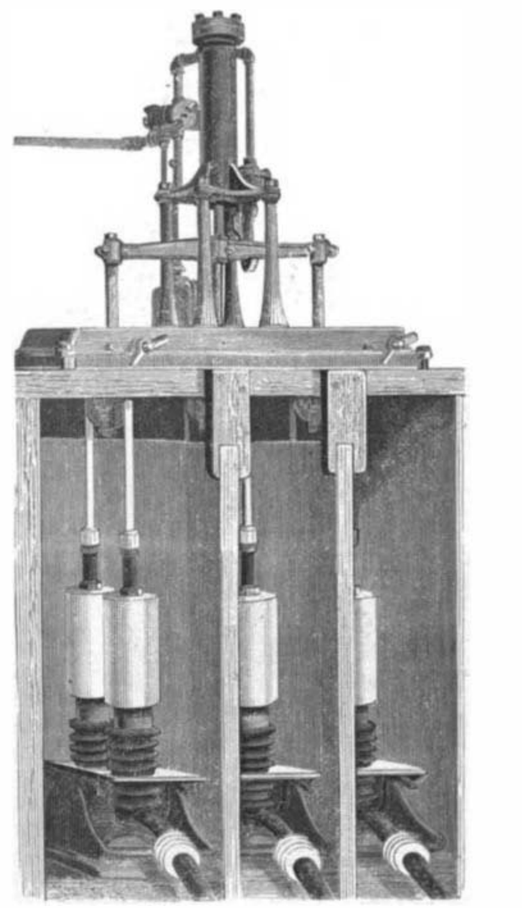
It is scarcely necessary to say that the construction of a power station of such unprecedented proportions is not prompted by any mere desire to eclipse all existing plants, but has been determined by strict economic considerations. The station was designed for the purpose of supplying electric current for the 220 miles of track of the Metropolitan Railway Company, which are to be operated by the underground trolley system. A few years ago such a scheme would have been impossible to carry out, as the low-tension currents in use at that time would have required the construction of several independent stations scattered throughout the city. The introduction of the alternating current, however, made it possible to generate the whole of the required current at one mammoth central station, transmit it at high voltage to substations located at convenient points on the system, and there reduce it to 500-volt direct current for the operation of the trolley cars.

The power station, of which we give both an exterior and an interior view on the front page, is located between Ninety-fifth and Ninety-sixth Streets on the East River. It is a very imposing structure and measures 279 feet on Ninety-fifth Street, and over 200 feet on First Avenue. It is divided into an engine and a boiler room by a brick wall partition, the engine room being 111 feet in width, and the boiler room 84 feet. In preparing the foundation of the power house, 7,854 piles were driven over the whole area to an average depth of 35 feet, and above this was laid a bed of concrete 5 feet in thickness, the concrete beneath the big stack being 20 feet in thickness. The boiler room has three floors on which are located 48 boilers of the Babcock & Wilcox type. Each boiler has 2665·5 square feet of heating surface and the steam pressure is 160 pounds. Through the center of the boiler room and adjoining the partition wall rises the huge smokestack, 353 feet in height, which is one of the largest structures of the kind in the world. It was described in detail in an illustrated article on the power house given in the SCIENTIFIC AMERICAN of November 12, 1898. Above the boilers are two unusually large coal bins with a combined capacity of 10,000 tons. The coal is brought alongside the power station dock in barges, where it is unloaded by a mechanical coal-handling system which carries it by conveyers to the coal bins.

Our engraving of the engines represents the main floor of the building, beneath which are a basement and a sub-basement. The steam pipe, feed water heaters, condensers and air and circulating pumps are located in the basement, while in the sub-basement are the pipes for the condenser water, and the electric cable conduits. In the engine room will eventually be located eleven Allis, vertical, cross-compound, condensing direct-connected engines which will have a capacity at 50 per cent overload of 6,600 horse power each, making a total capacity for the whole engine house of about 70,000 horse power. Each engine stands upon a massive brick foundation measuring 28 × 43 feet on the base, and rising to a height of 29 feet above the concrete floor. It took 450,000 bricks to build each pier, making a total of nearly 5,000,000 bricks for the foundation of the eleven engines. The engines are set up in two parallel rows which extend the full length of the engine room, one row containing five units and the other six. Our front page illustration shows the two engines which stand at the head of each line, near the western end of the power house. The high pressure cylinder is 46 inches in diameter, the low pressure 86 inches, and the common stroke is 60 inches. The engines are run at 175 revolutions, at which the piston speed is 750 feet per minute. With a view to reducing the clearances to a minimum, the valves are placed in the heads of the cylinders. They are driven by the Reynolds-Corliss gear with separate wrist-plates for steam and exhaust valves. The steam cylinders are not jacketed, but a large reheating cylindrical reservoir, which will be noticed in the farther engine in our illustration, is placed between the high and low pressure cylinders. All the wearing surface of the engines are of very liberal proportions. Thus the bearings of the engines are 34 inches in diameter by 66 inches in length, and the cross-heads and crank-pins measure 14 × 14 inches. The fly-wheel, which is 28 feet in diameter, is of steel. It was cast in ten sections and weighs 150 tons. Each section consists of an arm and rim. The arms are bolted to the hubs, and the rim segments are connected by links of steel, 5 inches deep by 10 inches wide. After the wheel was erected, the rim, which is 29 inches deep by 10 inches wide, was widened by building up on each side of it eight circles of 1⅛-inch steel plates, which were riveted on by means of 3-inch steel rivets. The engine shaft is of fluid compressed steel. The outside diameter is 37 inches at the fly-wheels, 34 inches at the journals, and 30 inches at the cranks, and it measures 27 feet 4 inches in length. A 16-inch hole extends through the whole length of the shaft. The fly-wheel, cranks, and the generator spider were forced on the shaft by hydraulic pressure after the parts had been assembled at the power-house, the pressure used being 5½ tons to the square inch.

The condensing water for the surface condensers is drawn from the adjoining East River. It should be mentioned that each engine is provided with an independent air and circulating pump and with a Worthington condenser. Each air pump discharges into its own hot well in the basement, and each hot well connects with two equalizing tanks. From these tanks the boiler feed-water is taken. On its way to the pump the water from the equalizing tanks is drawn through the primary feed water heaters, which are warmed by the exhaust steam of the main engines. After passing the pumps the water goes through the secondary heaters, which are of the Goubert type, and from them it passes to the boilers. The secondary heaters are heated by the exhaust steam from the auxiliary engines of the power house.

Mounted on the crank-shaft and adjoining the fly-wheel of each engine is a three-phase generator, with a normal capacity of 3,500 kilowatts at a speed of 75 revolutions per minute. Current at a pressure of 6,600 volts is transmitted from the generator to the substations to which we have already referred. The generators are of the revolving field type with an external stationary armature. The field ring carries 40 poles and the field coils are supplied with current from two 160-kilowatt and one 75-kilowatt generators. The step-down transformers at the substations are rated at 350 kilowatts and the rotary converters at 990 kilowatts with a pressure of 550 volts. The rotary converters are of the revolving armature type. We present an illustration of the pneumatic oil switch for breaking the circuit on the main line, which, as we have said, carries an alternating current of 6,600 volts. The lower part of the switch containing the contact points is carried within a case, which is walled in with brickwork. Above the case is a vertical pneumatic cylinder whose valves can be operated from the electrician's desk. The piston rod carries a crosshead, to which are attached three vertical insulated rods. Each rod supports two copper contacts which enter the brass cylinders through insulated stuffing boxes (as shown in the engraving), and engage split spring copper sockets, into which they slide. The cylinders are filled with oil. By admitting air below the pneumatic piston, the copper contacts are raised clear of the sockets and the 6,600-volt circuit is broken.



PNEUMATIC OIL SWITCH.
Metropolitan Street Railway Company Power Station.

As may be judged from the first page engraving, the interior view of the engine room is very impressive. Fifty feet above the floor a 30-ton, electric, traveling crane spans the entire room, and the admirably designed steel truss roof at its loftiest point rises 90 feet above the floor. The figures on the two platforms and on the floor serve as a scale to indicate the massive proportions of these engines, which weigh complete, with generator, 700 tons and have a clear vertical height of 38 feet above the floor, or of 65 feet measured from the base of the brick foundations. The plans of the station were prepared under Mr. F. S. Pearson, the consulting engineer of the M. S. Railway Company; and we are indebted to Mr. M. G. Starrett, the chief engineer of the company, and Mr. J. D. Lamden, the chief engineer of the station, for courtesies extended during the preparation of this article.

Carbonic Oxide Absorbed by Plants.

In his presidential address, delivered before the British Association, Mr. Horace Brown gives an account of the experiments which he has carried out in order to determine the conditions under which the carbonic oxide of the atmosphere is absorbed by the leaves of plants. He finds that the surface of the leaves absorbs the carbonic oxide at about one-half the rate at which the same gas would be absorbed by an equal surface kept constantly wet with a solution of caustic alkali. He considers that the gas penetrates only by the mouths or pores of the leaf, these occupying a relatively small proportion of the surface. He makes some calculations as to the rate of speed with which the carbonic oxide passes through the pores, and finds that in the case of the plant under consideration, a variety of the catalpa, the gas must pass at the rate of 150 inches per minute. To imitate the action which takes place in the leaf of the plant, he has carried out a series of experiments, using a recipient containing an alkaline solution and provided with openings of various diameters. In this way the speed of penetration of the carbonic oxide is found to increase very rapidly, as the diameter of the aperture is lessened, and for minute openings this speed is necessarily very great. Mr. Brown has also made determinations to find out what proportion of the solar energy is utilized for the vital processes of the plant. This proportion is much greater in diffused light than when the leaf is exposed to the direct light of the sun. In the former case he estimates that 95 per cent of the energy absorbed may be utilized; of this, 2·7 per cent represents the work of assimilation and the remainder is used for evaporation of the water contained in the leaf. In the second case, that of exposure to direct sunlight, only 28 per cent of the energy was utilized, and for the work of assimilation but ½ per cent. Among other calculations, he estimated that 6·5 per cent of the total energy of solar radiation consists of rays which are capable of being absorbed by the chlorophyl of the leaf.

New Photographic Developer.

A new developer has lately appeared which is said to give very good results, and to be equal to hydroquinone, if not superior. The body, which has received the name of audriol (Audriol), is a derivative of hydroquinone, and seems to have all the good properties of this body, without its defects. It requires but a small quantity of alkali, and the potassium carbonate may thus be replaced by sodium carbonate, which is less corrosive, while the use of caustic alkali becomes unnecessary. In spite of the small quantity of alkali used, the image comes up more quickly than in the case of hydrochinon. It is also to be remarked that low temperatures within ordinary limits have little or no influence in retarding the development of the image as a whole or the details. The principal quality of audriol is its great developing power, which is not equaled by hydroquinone, even with the use of caustic soda. It has the valuable quality of working up to the end of the development without fogging the plate, which renders it superior to most of the other developers in this respect. The image appears normally in about twenty seconds, and comes up uniformly; after about four minutes it has gained the desired intensity in the high lights as well as in the details.

These latter came up regularly as the development proceeds; in this way the final result is a plate which presents a harmonious appearance, rather soft than hard in quality. Bromide of potassium is an excellent retarder for this developer, but a greater proportion should be used than for hydroquinone. It is thus apparent that audriol may be used in short exposures, and thus be of value for exposures made in the studio by dim light, for rapid instantaneous work, cinematograph films and X ray exposures.

The Scientific American in South America.

We notice the following in our esteemed contemporary The Wheel: "A traveler for an export house returns from South America and says that in Brazil and several other South American countries the trade papers he saw most frequently were The Wheel and the SCIENTIFIC AMERICAN."

THE manufacture of "khaki" cloth has been greatly increased by the war in South Africa, and over 15,000 people are now engaged in making cloth for the soldiers. The word "khaki" is of Hindoo origin, and means dust or clay colored. It is made entirely of cotton and is exceedingly durable. It was probably first used by the English regiments in India, and was also worn by them in the Egyptian campaigns. The color is not attractive, but it is very satisfactory for service in warm countries.

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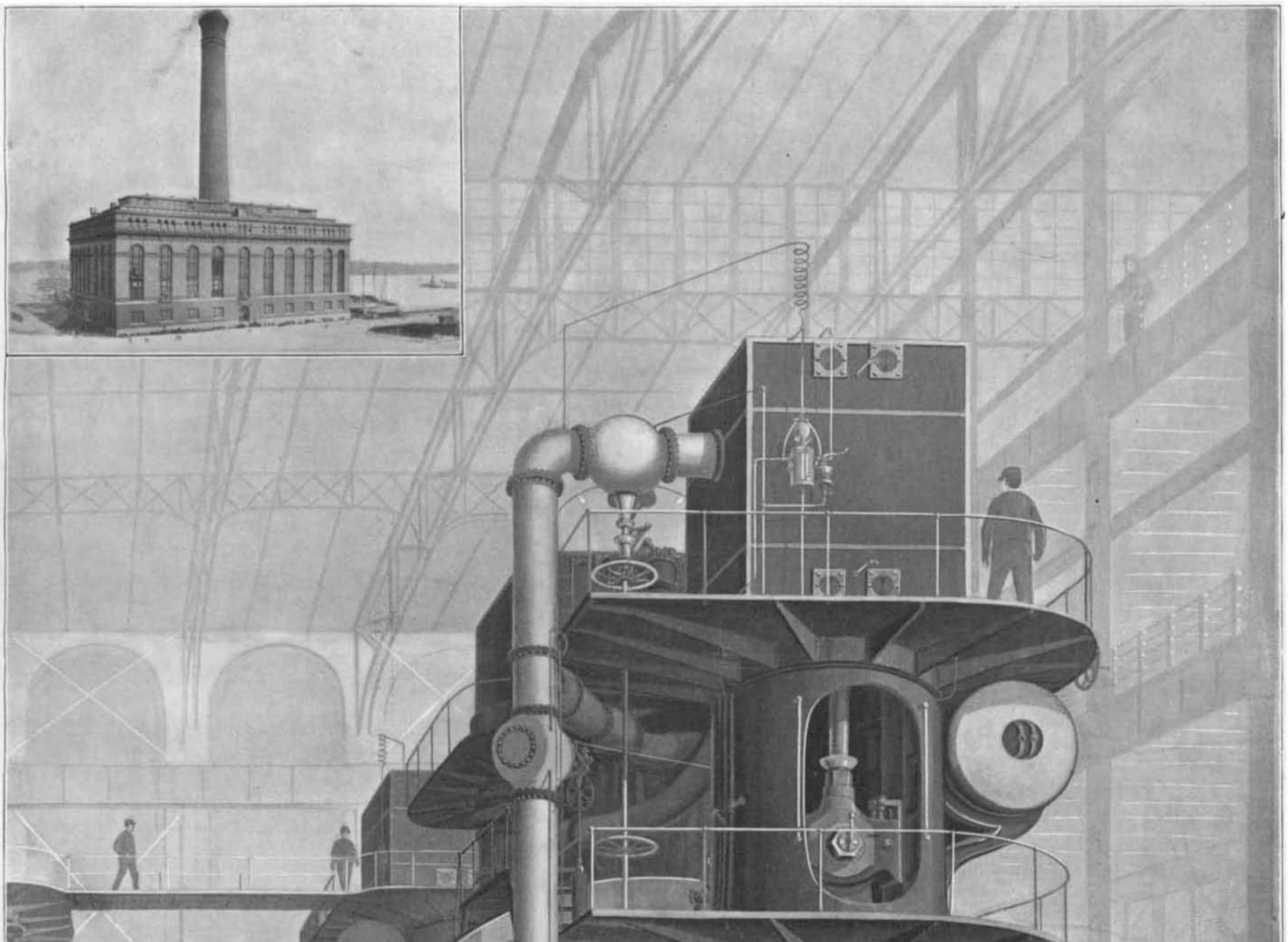

THE 70,000 HORSE POWER STATION OF THE METROPOLITAN STREET RAILWAY COMPANY, NEW YORK.—[See page 26.]