constructed that flaps open outward on either side and on the ground, thereby protecting the ambulance staff while engaged in their work behind. The area thus protected is about 9 feet in width by 7 feet in height.

This first-aid vehicle, in the severe tests to which it was submitted, was driven over rough ground, and brought within close range of the firing line. The backways were opened out to cover the stretcher party at work behind. A severe fusillade was then poured upon the vehicle from rifles at ranges varying from 20 to 100 yards, but without penetrating the armor. Of course, the vehicle is not constructed with the object of resisting heavy gun fire, and a single shell from a large-caliber weapon would absolutely wreck it.

The car carries two ambulance men, one of whom also performs the offices of engineer and driver. The apparatus proved very serviceable and easy to handle upon the battlefield. Notwithstanding the rugged nature of the ground, a speed varying from three to six miles an hour was attained. Owing to its wedge-like shape, the bullets that struck it were deflected, without causing the slightest damage. One drawback which it possesses is that it can only be used with gasoline as fuel. As this volatile spirit is not easily procurable upon the battlefield, the engine is to be adapted to the consumption of cruder oils.

In addition to ambulance work pure and simple, it proved its efficiency for other phases of work in connection with first aid, by the haulage of the necessary auxiliary attachments for the sterilizing of water, etc. Also, while the work of tending the wounded was in progress, the engine, owing to its peculiar construction, was instantaneously detached from the driving gear, and by pulley and belting supplied the necessary energy for driving a portable ice-making plant designed for service in tropical climate. When the tests in the firing line were completed, the ambulance car returned to safety, hauling a supplementary ambulance wagon containing thirty wounded men—a task which was easily accomplished, owing to the great power of the motor.

As this was a first attempt to prove the efficiency and utility of such an automobile for this class of work, several defects presented themselves. These, however, were of an easily surmountable nature, and have been since remedied. The car, however, established complete success, and is to be submitted to further trials. Another important advantage it provides is that owing to the arrangement for disengaging the motor and driving mechanism, the car can be utilized as a stationary engine for generating electricity for illuminating the hospital tent in camp, or other purposes for which power is required.

ELECTRICAL EQUIPMENT OF THE NEW YORK CENTRAL RAILROAD.

Judged from the standpoint of its magnitude and the far-reaching results which must follow, the electrical equipment of the New York Central system, which is now under way, is the most important event that has happened in the application of electrical traction to steam railroads. It is true that the electrical equipment of limited sections of steam railroads is nothing new; as witness the work done on various roads both here and in England—to say nothing of the Valtellina electric line in Italy; but the novelty of the New York Central work lies in the great magnitude upon which it is being carried out; the elaborate and carefully systematized experimental work now being done near Schenectady; and the important bearing which all of this will have upon the great question of the electric operation of long-distance railroads between such points as New York and Chicago, or New York and Pittsburg, or Washington. There is no body of men in the world that is so extremely practical or so reasonably conservative as your railroad engineer; and the fact that the New York Central engineers, whether in the department of civil, electrical, or steam engineering, are willing to admit that the ultimate outcome of the present work that is being done at the New York terminus, and on the suburban lines of the New York Central system, will, quite possibly, lead to the ultimate application of electric traction to the whole of their fourteen thousand miles of track, may be taken by laymen in general as a pretty sure guarantee that this stupendous change will actually be made within the present decade.

The changes involved in this work include the electrifying of the New York terminal for a distance of 34 miles on the main line from the Grand Central station, and for 24 miles on the Harlem Division as far as White Plains. The express service will be separated from the local service, the express trains being hauled as far as the points named by electric locomotives, and the local trains being operated on the multiple-control system as used on the Elevated and Subway lines. This separation of the service will involve the four-tracking of these roads, and indeed on some portions there will be as many as eight tracks. The express trains will be run on the regular schedule demanded by the company's through express service to distant points; but the suburban service will be vastly improved by shortening the trains and running them at more frequent intervals, the proposed schedule calling for a train every two minutes. The well-known ability of the electric motor to start a train rapidly and quickly carry it to full speed will result in a great acceleration in the average speed of this local service; and there can be no doubt that the increased frequency, higher speed, and general all-round convenience of the new service will result in a great upbuilding of the most distant suburban districts. Two years from the present time will probably see the electrical service in full swing, although there may be some finishing work to be done in the terminal station and yards. In rebuilding the line, the platforms are to be raised to the level of the floor of the cars, all grade crossings are to be eliminated, and much of the heavy curvature of the line is to be reduced or cut out entirely.

The scheme for hauling the heaviest express trains by electric locomotives is an entirely new one. There is absolutely no precedent to go upon. It was for this reason that the New York Central determined to equip a section of their main line with apparatus that should correspond to that with which the suburban lines are to be equipped. For this purpose a stretch of six miles of the east-bound local tracks of the New York Central was selected, a few miles beyond the city of Schenectady, and this has been equipped with the standard third-rail construction. The track is practically straight and is ballasted so as to permit of a maximum speed of 70 to 80 miles per hour being obtained. Power is furnished by a 2,000-kilowatt, three-phase, 25-cycle, Curtis turbo-generator, delivering 11,000 volts to the line. The generator is located in the new power house of the General Electric Company at Schenectady. The current is carried by a high-tension transmission line to a sub-station at Wyatts located at the center of the six-mile stretch of track. Here the 11,000-volt, alternating current is stepped down and converted to 600-volt direct current, at which pressure it is delivered to the third rail, from which it is taken by the contact shoes of the locomotive.

For the past three months an experimental electric locomotive has been hauling trains of various weights over this track, and careful records have been made of the results obtained under widely different conditions of load, and under every possible condition of the weather. The locomotive is one of fifty which will be used in hauling express trains, the heaviest of which will reach 875 tons in weight. The maximum speed contemplated is from 60 to 65 miles per hour. By using the multiple-unit system of control, two or more locomotives can be coupled together and operated from the leading cab as a single unit. A single electric locomotive will be able to maintain the schedule with a 450-ton train, and two locomotives will be coupled together for the heavier train.

The locomotive is carried on four driving axles and two radial pony trucks. On each driving axle is mounted, without intermediate gearing, the armature of an electric motor having a normal rating of 550 horse-power. The normal rated capacity of the locomotive is 2,200 horse-power, although at starting it can develop 3,000 horse-power or more. An interesting feature is that in the new locomotive the armature is mounted rigidly upon the axle, thus reducing the bearings to those of the pony trucks and the main journals, all of which are outside of the driving wheels. The motor has two poles, whose faces are flat and vertical, to permit a large vertical movement between armature and poles as the latter move up and down with the riding of the frames upon the springs. The main frame is of cast steel. The pole pieces are carried by heavy steel transoms, bolted to the side frames, which form part of the magnetic circuit, besides acting as cross braces for the truck. This construction, besides being strong and simple in design, greatly facilitates repairs and renewals, as an armature with its wheels and axle may be removed by lowering the complete element, without disturbing the wheels or any other part of the locomotive, and a new element inserted in its place. In addition to the four pairs of driving wheels, there is a pony truck of the radial type at each end of the locomotive.

In spite of the fact that the armatures are attached rigidly to the axles, the dead weight on the axle is not materially greater than is customary with steam locomotives; and in addition, there is no unbalanced weight to produce the hammer blow of the steam locomotive, which has proved so disastrous to track and roadbed. The superstructure consists of a central cab for the operator, containing master controllers, engineer's valves, and the necessary switches and valves for operating, sanding, whistling, and bell-ringing devices. This apparatus is furnished in duplicate, one set on each side of the cab, and it is arranged so as to conform in a general way to the position of the similar controls in the cab of a steam locomotive. The operator has an unobstructed view both in front and rear from the windows of the cab. A central corridor, extending through the cab, is provided with end doors through which there is access from the locomotive to the train. On each side of this corridor are arranged the contactors, rheostats, and reversers. They are carried in boxes of sheet steel, and are sheathed on the inside with fireproof insulating material. The control system permits of three running connections, namely, four motors in series, two groups of two in parallel series, and all four motors in parallel.

The accompanying comparative table of one of the new electric locomotives and the new compound steam locomotive recently designed for the same service will be of great interest. The compound, which was exhibited at St. Louis, was illustrated in our issue of July 30, 1904, and reference is made to that article for illustrations and full particulars of this fine engine. This engine is the latest and most powerful express locomotive on this road, exceeding the celebrated Atlantic type of simple engines that are used at present in handling the express service. In this engine we see the limit of size, weight, and power to which an express steam engine can be carried; and yet it will be seen that on every point of comparison, the electric locomotive is more efficient. The new type is 25 feet shorter; weighs 67 tons less; has 14 tons more adhesive weight, and has 10¼ tons less weight concentrated on each pair of wheels, and is therefore proportionately easy on the track; has 1,200 more horse-power available for starting a train; and indeed on a basis of horse-power per ton weight of locomotive is 300 per cent more efficient. The total absence of reciprocating parts renders the electric locomotive even easier on the track than the balanced compound steam locomotive.

COMPARISON OF N. Y. C. R.R. ELECTRIC AND STEAM LOCOMOTIVES.

	Electric	Steam
Total length	37 feet	62 feet, 2¾ inches*
Total weight	95 tons	162 tons*
Weight on drivers	69 tons	55 tons
Maximum horse-power	3,000	1,800
Horse-power per ton weight	31.5	11.1

* Including tender.

The tests already made indicate what may be expected of a locomotive running in regular service. With an eight-car train weighing 336 tons, exclusive of locomotive, a maximum speed of 63 miles per hour was reached, and 72 miles per hour with a four-car train weighing 170 tons.

In the starting tests a speed of 30 miles per hour was reached in 60 seconds with an eight-car train weighing, including the locomotive, 431 tons, corresponding to an acceleration of one-half mile per hour per second. During certain periods of the acceleration the increase in speed amounted to 0.6 mile per hour per second, calling for a tractive effort of approximately 27,000 pounds developed at the rim of the locomotive drivers. This value was somewhat exceeded with the four-car train, where a momentary input of 4,200 amperes developed a tractive effort of 31,000 pounds at the drivers, with a coefficient of traction of 22.5 per cent of weight on drivers. The average rate of acceleration with the four-car trains, weighing including the locomotive 265 tons, was 30 miles in 37½ seconds, or 0.8 mile per hour per second, calling for an average tractive effort of 22,000 pounds.

The maximum input recorded, 4,200 amperes at 460 volts, or 1,935 kilowatts, gives an output of the motors of 2,200 horse-power available at the wheel. With 4,200 amperes and a maintained potential of 600 volts there would have been an input of the locomotive of 2,520 kilowatts, corresponding to 2,870 horse-power output of the motors. This output is secured without in any way exceeding the safe commutation limit of the motors and with a coefficient of traction of only 22.5 per cent of the weight on the drivers, thus placing this electric locomotive in advance of any steam locomotive yet built. No service capacity temperature runs have been made as yet, and the preliminary tests have not shown any appreciable warming of the motors sufficiently to take thermometer readings.

Throughout both the starting and running tests the electric locomotive shows its remarkable steadiness in running, a distinct contrast in this respect to the steam locomotive, especially should the latter be forced to perform the work here shown to be accomplished by the electric locomotive.

The elimination of gear and bearing losses permits of a very high efficiency of the locomotive. Reference to the motor characteristics shows a maximum efficiency of approximately 93 per cent, this value being fully 4 per cent better than is possible with motors of the geared type. This gain is especially noticeable at the high speeds, the efficiency curve remaining above 90 per cent even at the free running speed of the locomotive alone, in contrast to the 85 per cent or less which would be a good showing for a locomotive provided with geared motors. The simple construction and high efficiency made possible with this design of gearless motor, together with the minimum cost of repairs attending such a construction, makes the direct-current gearless-motor type of locomotive a distinct forward step in electric-locomotive construction.

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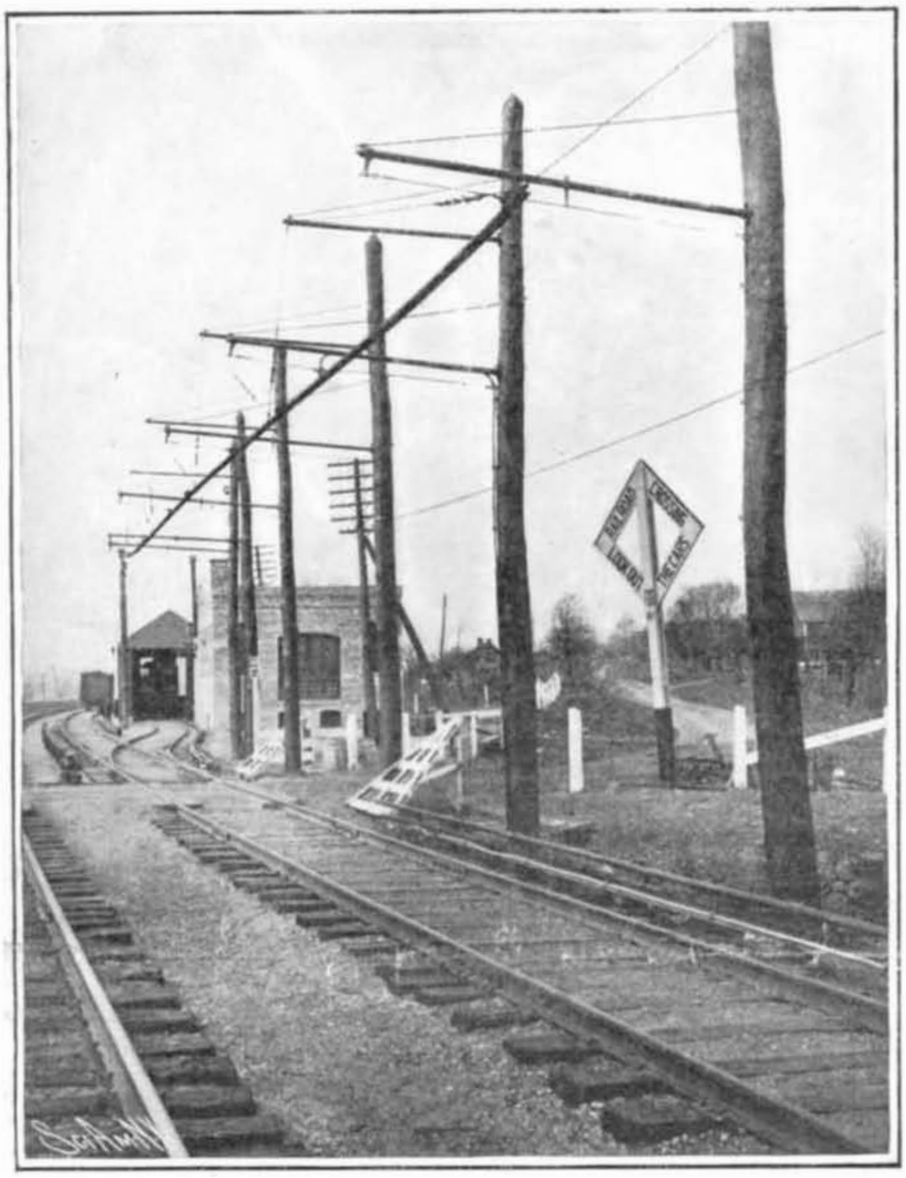
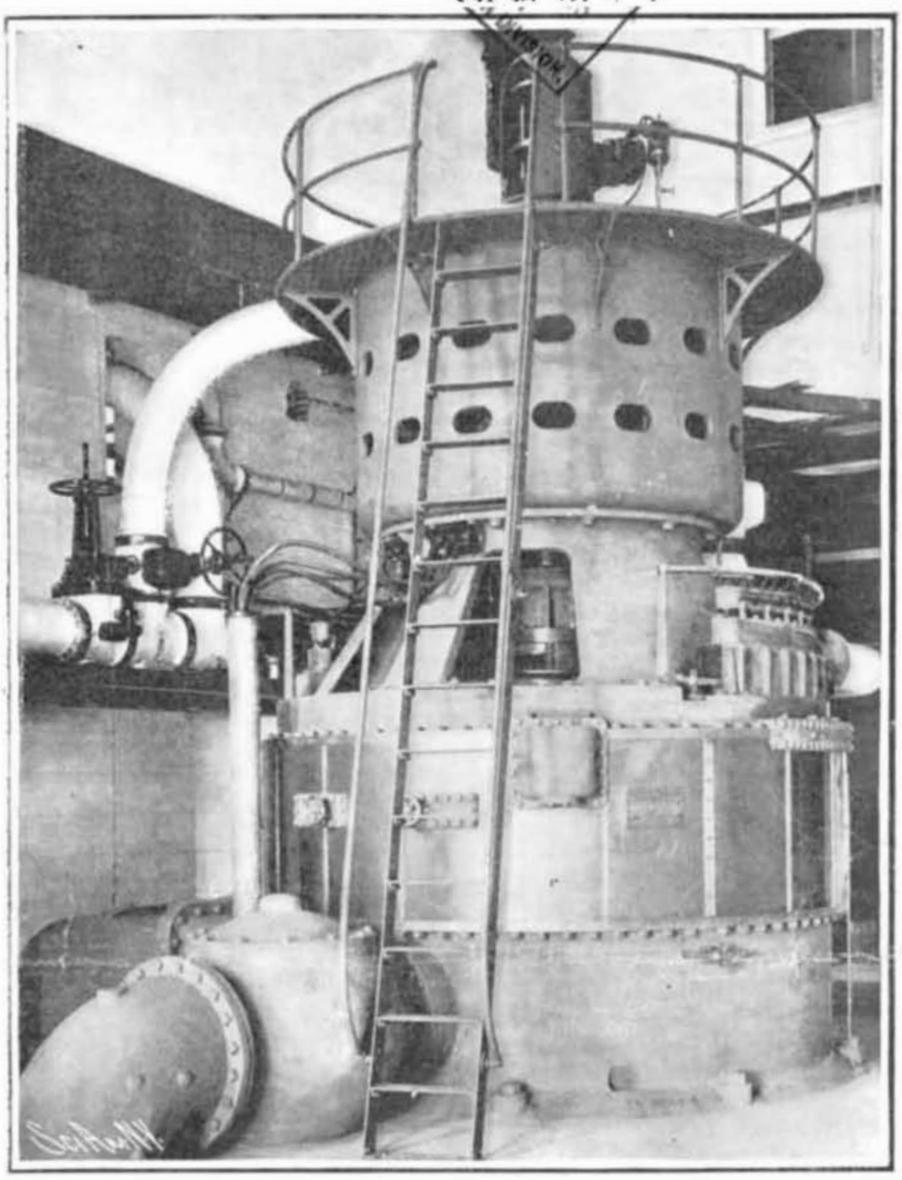
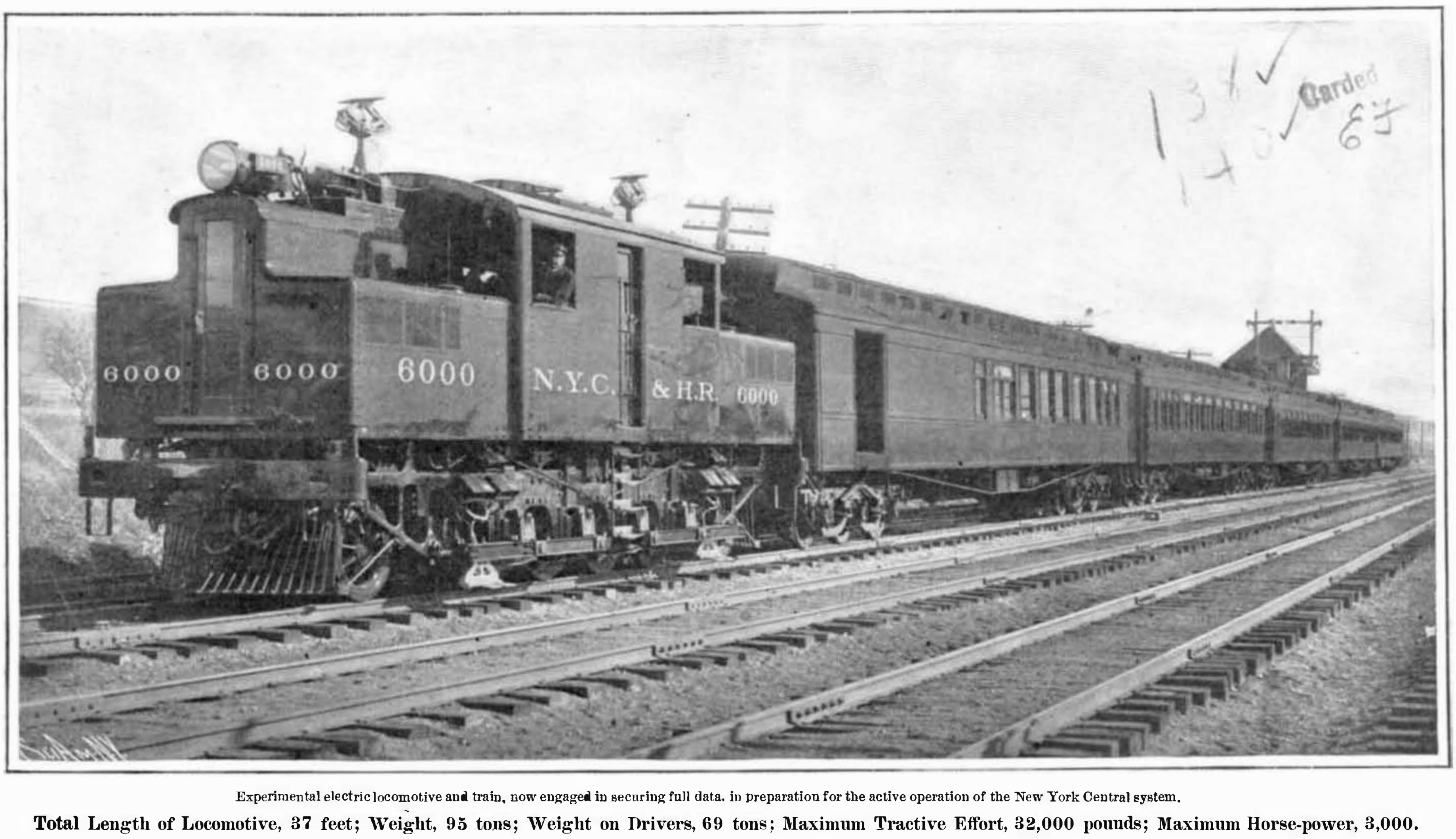


Experimental Track, Showing Third Rail; Overhead Conductor at Crossing; and the Substation.



The 2,000-Kilowatt Curtis Generator for Supplying 11,000-Volt Current to the Substation, Where it is Transformed to 600-Volt Current for the Third Rail.



Experimental electric locomotive and train, now engaged in securing full data, in preparation for the active operation of the New York Central system.

Total Length of Locomotive, 37 feet; Weight, 95 tons; Weight on Drivers, 69 tons; Maximum Tractive Effort, 32,000 pounds; Maximum Horse-power, 3,000.

ELECTRICAL EQUIPMENT OF THE NEW YORK CENTRAL RAILROAD.—[See page 142.]