The NEW YORK CENTRAL ELECTRIFICATION

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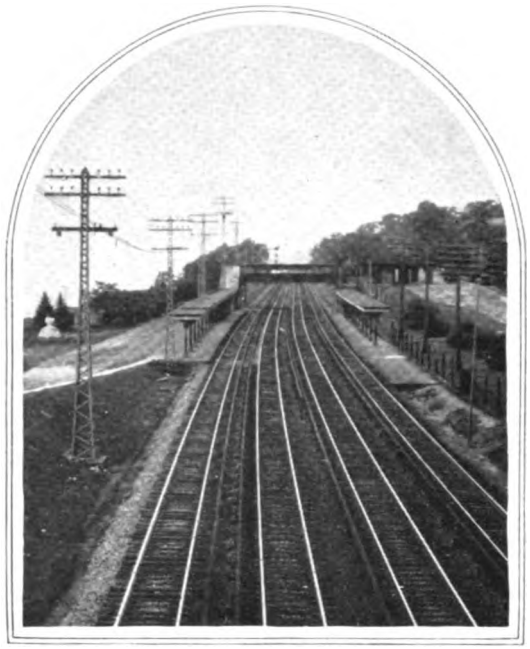
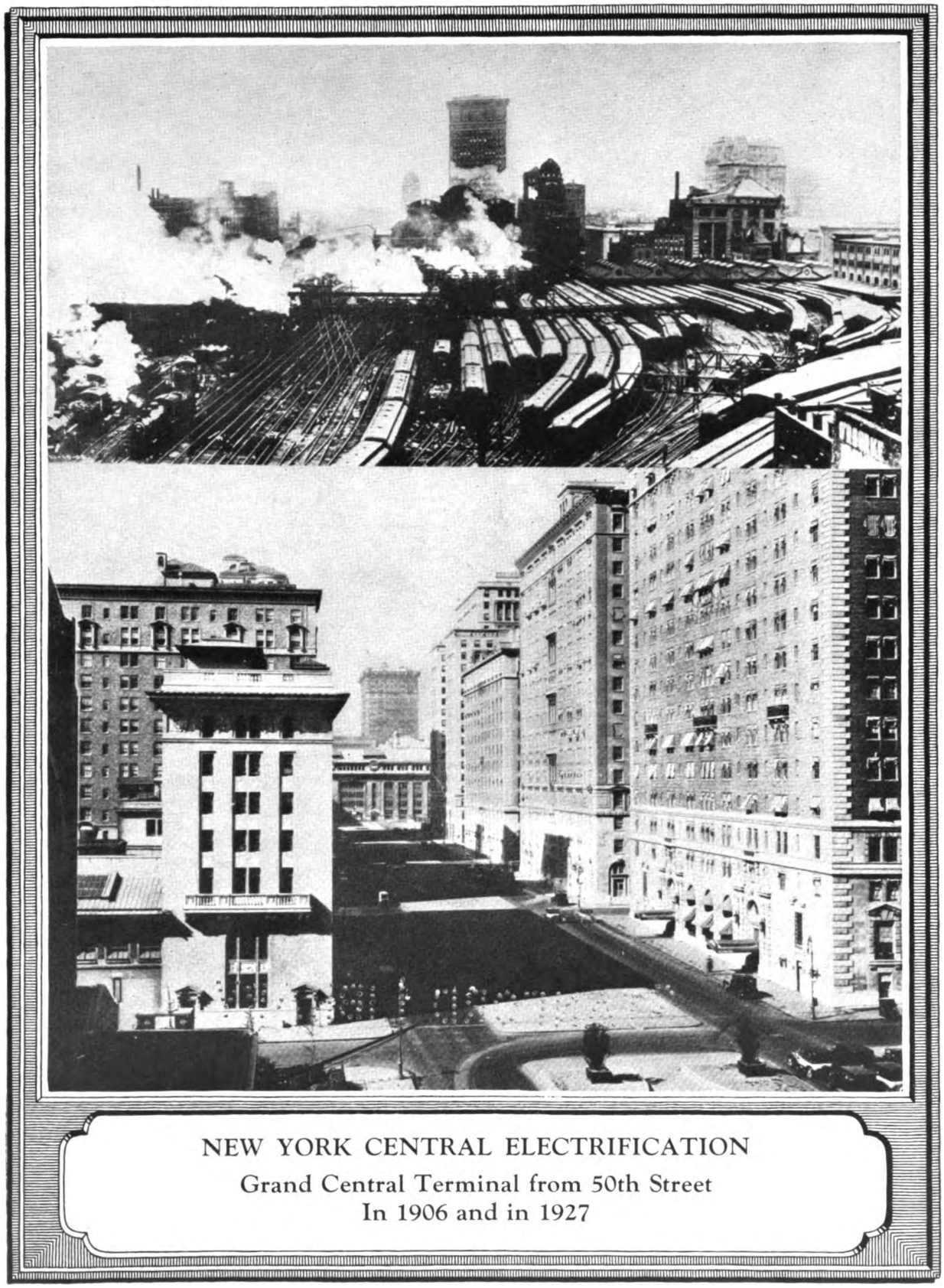


GENERAL ELECTRIC COMPANY
SCHENECTADY, NEW YORK

January, 1929 GEA-902



NEW YORK CENTRAL ELECTRIFICATION

Grand Central Terminal from 50th Street
In 1906 and in 1927

THE NEW YORK CENTRAL ELECTRIFICATION

THE New York Central system has very appropriately been called "The Greatest Highway in the World." Its immense terminals at New York and Boston handle a huge passenger and freight business to and from all parts of the globe. Leaving the eastern seaboard, the lines of this system reach into twelve states and two Canadian provinces. In these twelve states, is located approximately one-half the population of the whole United States. Sixty-four per cent of the manufactured products of the country is produced in these states, and a large part of all the bituminous coal. Some of the principal northern and midwestern cities reached are Montreal and Ottawa, Buffalo, Detroit, Cleveland, Toledo, Chicago, St. Louis, and Cincinnati.

The main line of the New York Central Railroad has an almost complete freedom from difficult grades. It is practically a water-level route, the only helper section being the short grade just west of Albany. Including leased and allied lines such as Boston & Albany, Michigan Central, Big Four, Pittsburgh and Lake Erie, and other roads, the New York Central system comprises a total of more than 16,400 miles of main tracks.

The earlier section of what is now the New York Central system was the Mohawk & Hudson Railroad, operating between Albany and Schenectady. This company was incorporated in 1826 and began operation in 1831. Shortly afterwards, a line was built from Schenectady to Utica, and later to Rochester and Niagara Falls. It was not until 1853, however, that the ten railroad corporations operating in this district were incorporated in what is now known as the New York Central Railroad Company.

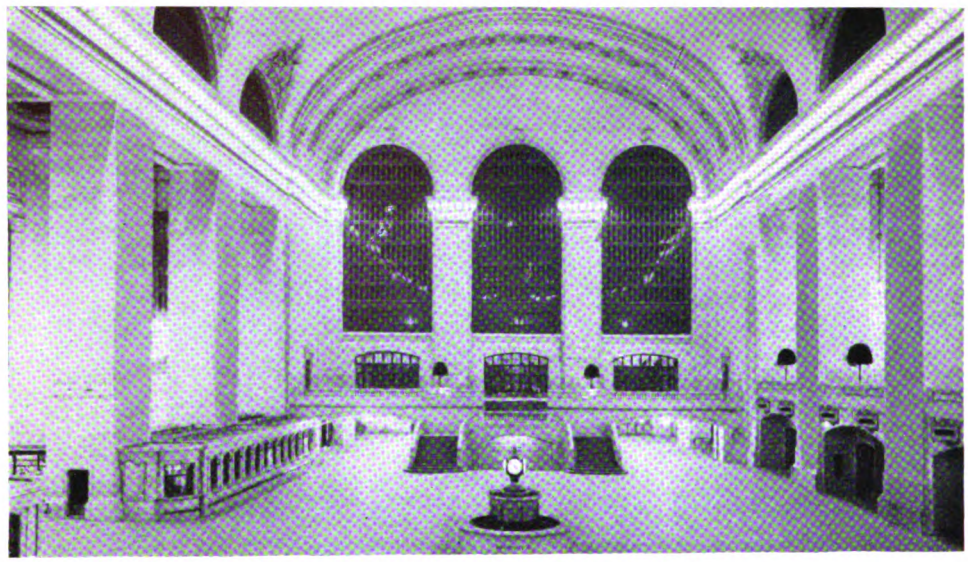
The New York Central Railroad includes over 700 miles of four-track road, about 800 miles of three-track, and about 2200 miles of double-track line. Over the remarkable piece of roadway between New York and Chicago, the Twentieth Century Limited is operated in each direction daily, frequently running in three to six sections. The trip between these cities is made in twenty hours, and the trains are practically always on time. Numerous other finely equipped, high-speed trains are operated between Chicago and New York, handling an immense through traffic between these two cities.

ELECTRIFICATION

The electrification of the suburban zone of the New York Central Railroad around New York City was, when initiated, the most extensive electrification project ever attempted. Extensions of the electrified lines and additions to equipment from time to time still allow this Company to retain its position as one of the foremost exponents of heavy electric railroading.

The normal week-day passenger traffic movement in and out of the Grand Central Terminal, including both New York Central and New Haven trains, averages each day about 475 trains aggregating some 4000 cars. The maximum total movement reported for a single day is 800 trains aggregating 6200 cars. The number of passengers handled in both directions by all trains totals about 134,000 per day normal and as high as 166,075 maximum.

In addition to the extensive electrical operation around New York City, notable electrification work has been done on other parts of the system. The Michigan Central



The Main Concourse of the Grand Central Terminal

Railroad operates about 26 miles of track in the Detroit River tunnel and terminal, using twelve electric locomotives handling traffic between Detroit and Windsor, Ontario. The West Shore Railroad between Utica and Syracuse, a distance of 48 miles, was electrified in 1907, using multiple-unit cars for handling interurban passenger traffic. Practically all of this line is double-tracked. The most recent electrification is that of the new Cleveland Terminal by the Cleveland Union Terminals Company. It is expected that this project, which includes about 17 miles of line, will be completed in 1929.

ELECTRIC DIVISION

A study of the possibilities of electrification on the New York Terminal was begun by New York Central officials in 1899. In the meantime, legislation at Albany was enacted directing the abandonment of steam locomotives in the Park Avenue tunnel south of the Harlem River not later than July 1, 1908. Plans for electrification of this terminal, however, were so well advanced that contracts were placed for locomotives, substations, and other equipment in the fall of 1903, and the first electric locomotive was formally tested on the experimental tracks at Schenectady in November, 1904. The first scheduled multiple-unit trains began service in December, 1906, and electric-locomotive trains in February, 1907. The complete change of passenger-train motive power, extending as far as High Bridge on the Hudson Division and Wakefield on the Harlem Division, was completed in July, 1907, a full year in advance of the date specified by legislative enactment.

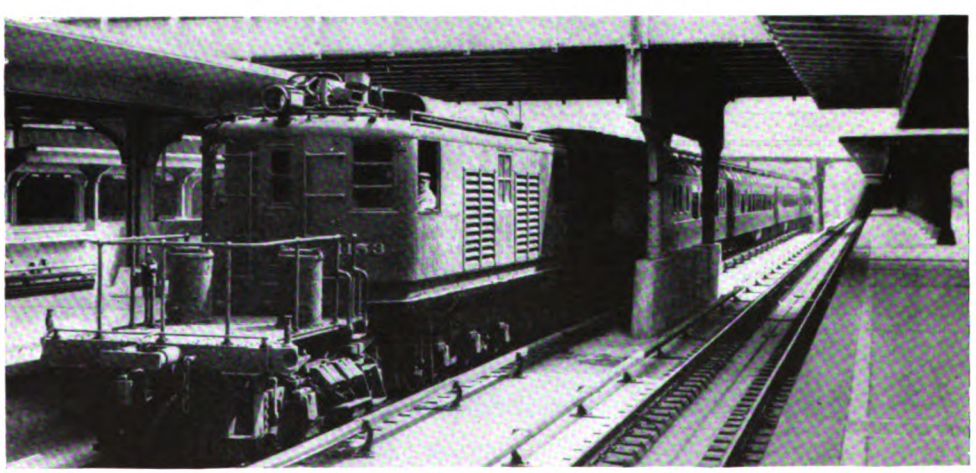
The initial studies by the company officials were made with a view to eliminating the undesirable conditions in the Park Avenue tunnel and, from the start, the program was built up around the movement of trains by electric power, accompanied by an almost complete application of electric power to other purposes around the terminal.

Briefly, the program included the complete reconstruction of the Grand Central Terminal district with a new station arranged for two-level operation; the construction of new streets over the depressed electrified tracks; the installation of two complete power plants with necessary substations; transmission and distribution; and the substitution of electric for steam locomotives on the main-line trains and of electric motor cars for the steam-drawn suburban trains. The problem was further complicated by the fact that the New York, New Haven & Hartford Railroad is a joint user of the tracks from Woodlawn for the handling of its trains to and from the Grand Central Terminal.

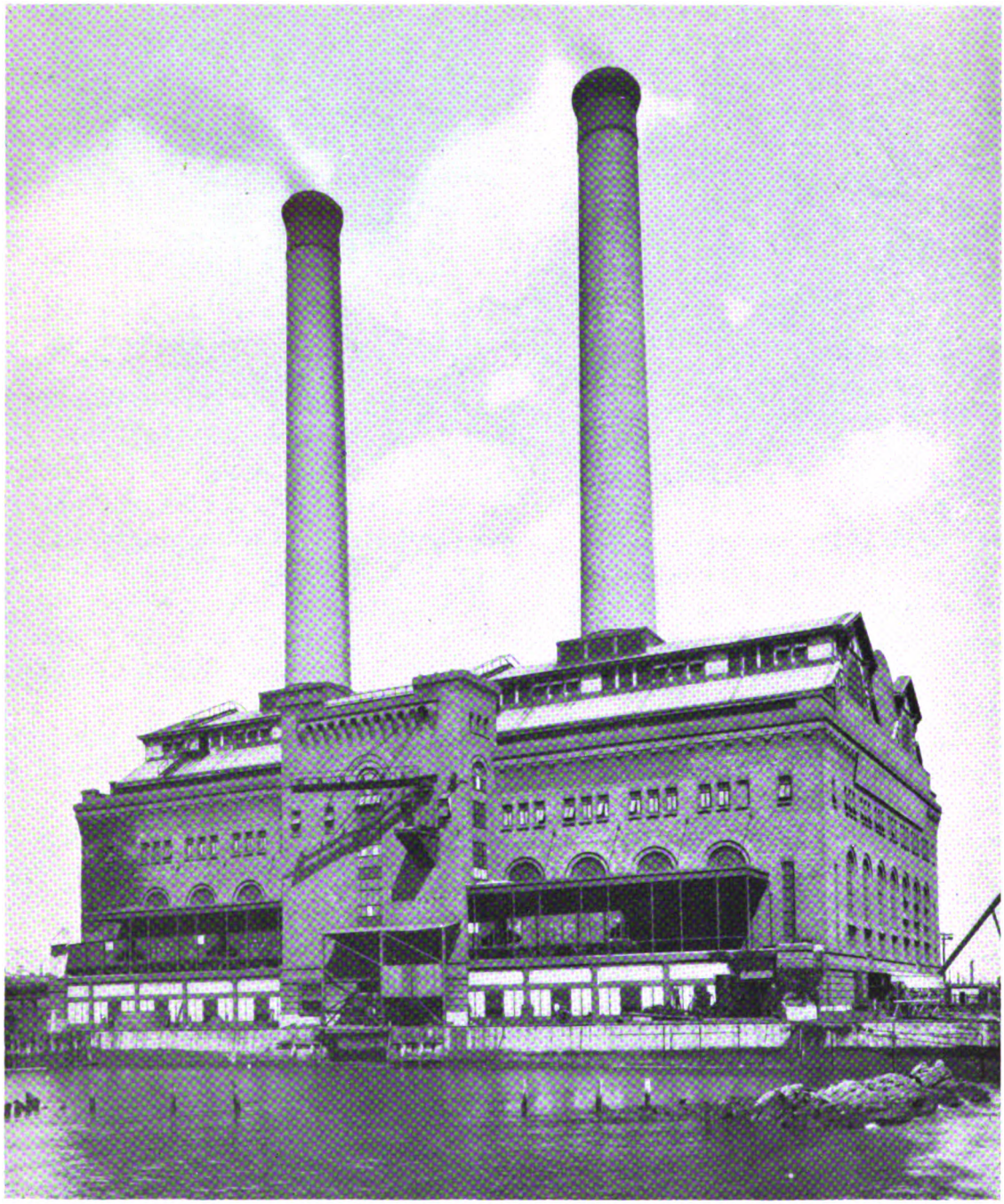
The initial electric zone included about 15 miles of route and 77 miles of single track. As now operated, the electric zone includes 63.73 miles of route and 360.23 miles of single track. The first electric locomotives, known as the class "S" locomotives, were delivered during the years 1906 to 1909 and included a total of 47 units. Each is equipped with four gearless motors, and at each end a four-wheel guiding truck. Some of these locomotives have been in operation for over 20 years and have run more than 600,000 miles each. These earlier locomotives are now being given their first general overhauling in connection with modernization of equipment and adaptation to switching service.

In the selection of the proper system for electrifying the Grand Central Terminal, the officials of the Railroad Company proceeded with great caution, bearing in mind the imperative necessity of uninterrupted operation. The following commission of experts was appointed to study the situation and make recommendations: W. J. Wilgus, Bion J. Arnold, Frank J. Sprague, George Gibbs, Arthur M. Waitt (later succeeded by John F. Deems). E. B. Katte, later Chief Engineer of Electric Traction, sat with the Commission as Secretary.

It was finally recommended that 660 volts, direct current, be used with a protected third rail. In this decision, the question of reliability had considerable weight, and the fact that this method of power distribution had been thoroughly tried out was regarded as of great importance. Furthermore, restricted clearances forbade the use of overhead wires, and legal obstacles prohibited the use of overhead trolley wires carrying high voltages within the limits of the City of New York.



The Twentieth Century Limited in the Grand Central Terminal

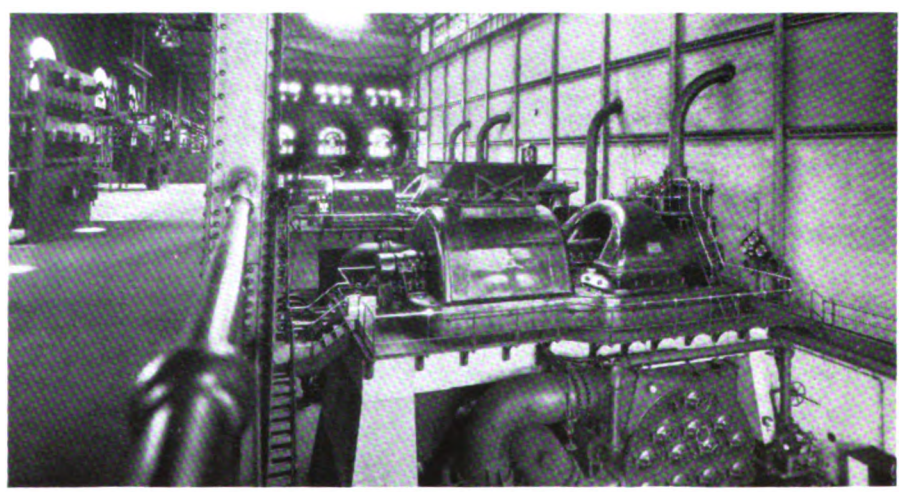


The Port Morris Power Plant

The Glenwood Power Station and Substation

POWER STATIONS

As a precaution against possibility of failure of power at the generating source, duplicate stations were located at Glenwood, near Yonkers, and at Port Morris. The initial equipment of each station included sixteen 625-horsepower boilers with superheaters and mechanical stokers, and four 5000-kilowatt steam turbine-generators. Provision was made for an ultimate increase in total capacity to 30,000 kilowatts. It is an interesting commentary on the progress of the art to note that, after nearly twenty years of service, these 5000-kilowatt units are being replaced by 20,000-kilowatt units which require no more space than was originally provided for units of one-fourth the capacity. Not only is the new equipment a great improvement as regards space occupied, but it is much more efficient and enables the company to produce electric power at a much lower cost. At the present time, the modern units handle all of the load, the older turbines being held in reserve. The equipment of both the power stations at the present time is given in the accompanying tables. The power-station units are designed for generating



Interior of the Port Morris Power Plant

110th Street Automatic Substation, Controlled from Mott Haven Substation

three-phase, 11,000-volt, 25-cycle current, which is transmitted without change to the several substations.

At the Port Morris station, which is now considered the main generating plant, bituminous coal is used entirely. Provision is made for transferring the coal directly from the cars to overhead bins, a storage capacity of 3500 tons being available. At the Glenwood Station, which is located nearer to the residential section, the off-peak load is carried on coal-burning boilers, and the peak load on boilers burning fuel oil.

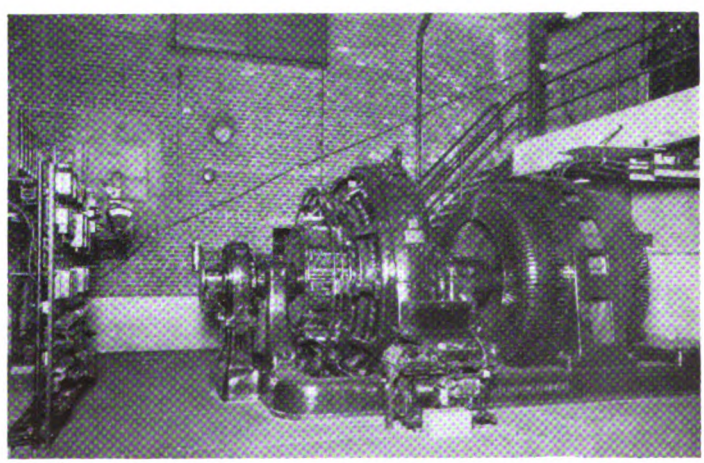
PRESENT BOILER EQUIPMENT

The present boiler equipment of the Port Morris plant consists of sixteen 625-horsepower and four 673-horsepower boilers, all equipped with underfeed stokers for burning bituminous coal. The Glenwood plant also has sixteen 625-horsepower and four 673-horsepower boilers, of which four are equipped with underfeed stokers for burning bituminous coal, six with chain grates for burning anthracite, and ten for burning fuel oil.

TRANSMISSION AND DISTRIBUTION SYSTEM

Under the present conditions of operation, power is transmitted at 11,000 volts to the nine original substations, all of which are equipped with synchronous converters and are manually operated. Additions have been made to the equipment from time to time so that these original stations now contain a total of 66,500 kilowatts.

During the last three or four years, it has been found necessary to increase the substation capacity because of additional traffic. This has been done by the addition of new substations of the automatic type, located approximately midway between the older stations.



Interior of 110th Street Substation

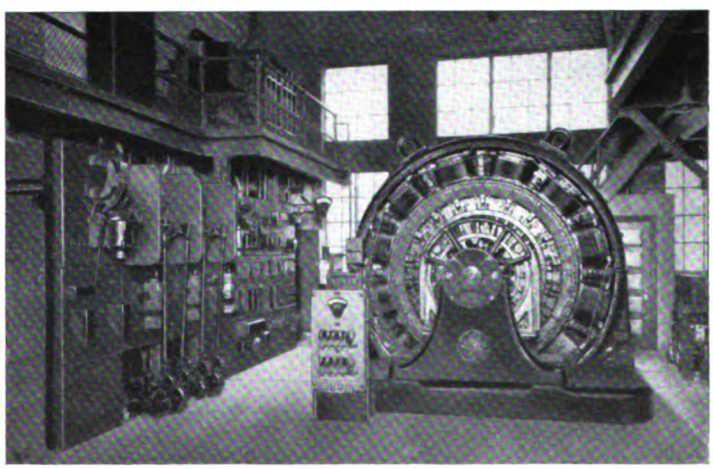
TRANSMISSION LINES

The 11,000-volt, high-tension lines are carried in ducts throughout the congested districts, and on steel poles located on the right-of-way, in the outside sections. Low-tension power is fed from the substations to the third rails by underground feeders. The third rails act as the main d-c. feeders and are connected together at intervals through circuit breakers located in circuit-breaker houses. The Yonkers Branch, recently placed in service, is fed from Kingsbridge and Glenwood substations. Three new substations are planned for supplying power to the West Side tracks when the electrification of tracks in this district is completed.

Automatic Substation at Wakefield

THIRD RAIL

The contact conductor is known as the Wilgus-Sprague under-running third rail and was first used by the New York Central. It is particularly designed to safeguard employees and others from accidental contact. It is also arranged so that the contact surface is not exposed to sleet or snow. This insures freedom from tie-ups in bad weather. The rail itself is of the bullhead type weighing 70 pounds per yard. The contact surface is located 2¾ inches above the top of the running rail and the center line 2 feet 4¼ inches from the gauge line of the nearest running rail. This rail is used at all points except where intricate switch layouts prohibit the use of a continuous conductor near the level of the track. At such points, a rigid overhead conductor is used. Gaps are left in the third rail opposite substations to facilitate sectionalization and the isolation of any defective portion of the contact line. Flexible ribbon bonds are soldered to the side of the third rail. The track bonds are 16.8 inches long, pin-expanded into 1-inch holes drilled in the track rail. On the main line, both rails are double-bonded; but in the yards, only one of each pair of rails is bonded.



Interior of Scarsdale Substation, Controlled from Tuckahoe Substation

Substation No. 1B at 43rd Street. 2000-kw. Synchronous Converters

Synchronous Converters at Substation No. 5, Irvington

POWER STATION EQUIPMENT

	No. Units	Kw.	
Port Morris	2	5,000	11,000 volt, 25 cycle, 3 phase
	3	20,000	11,000 volt, 25 cycle, 3 phase
Glenwood	4	5,000	11,000 volt, 25 cycle, 3 phase
	1	20,000	11,000 volt, 25 cycle, 3 phase

SUBSTATION EQUIPMENT

Substation	No. Units	Capacity	Total Kw.	
No. 1. 50th Street	4	1,500		
	1	2,000	14,500	
	1	2,500		
	1	4,000		
No. 2. Mott Haven	3	1,500		
	1	2,000	10,500	
	1	4,000		
No. 2a. 110th Stret	2	2,000	4,000	automatic
No. 3. Kingsbridge	3	1,000	5,500	
	1	2,500		
No. 4. Glenwood	3	1,000	5,500	
	1	2,500		
No. 4a. Hastings	1	2,500	2,500	automatic
No. 5. Irvington	2	2,000	6,500	
	1	2,500		
No. 5a. Phillipse Manor	1	2,500	2,500	automatic
No. 6. Ossining	3	1,000	8,000	
	2	2,500		
No. 6a. Harmon	2	2,500	5,000	automatic
No. 7. Bronx Park	3	1,000	5,000	
	1	2,000		
No. 7a. Wakefield	1	2,000	2,000	automatic
No. 8. Tuckahoe	3	1,000	5,500	
	1	2,500		
No. 8a. Scarsdale	1	2,500	2,500	automatic
No. 9. White Plains	3	1,000	5,500	
		2,500		
		Total	85,000 Kw.	

Manually controlled 66,500 Kw.
Automatically controlled 18,500 Kw.

Traction Substations Total 85,000 Kw.

SUBSTATIONS FOR LIGHTING AND POWER

Substation	No. Units	Capacity	Total Kw.
No. 1a. 50th Street	4	1,500	6,000
No. 1b. 43rd Street	4	2,000	8,000
			14,000

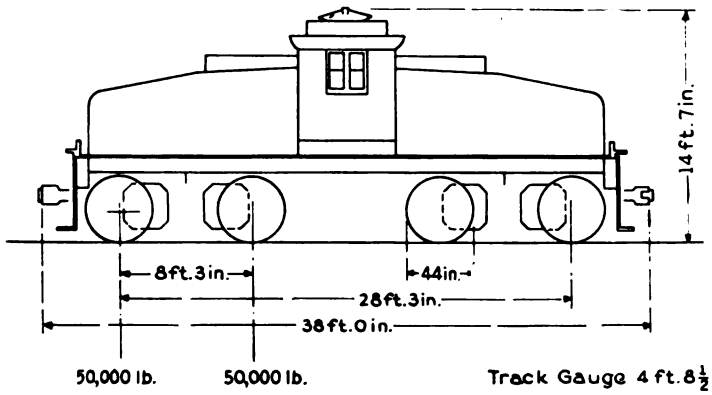
600 VOLT DIRECT CURRENT

100 TON ELECTRIC LOCOMOTIVE

B-B 200/200 4GE286A 600V.

NEW YORK CENTRAL RAILROAD

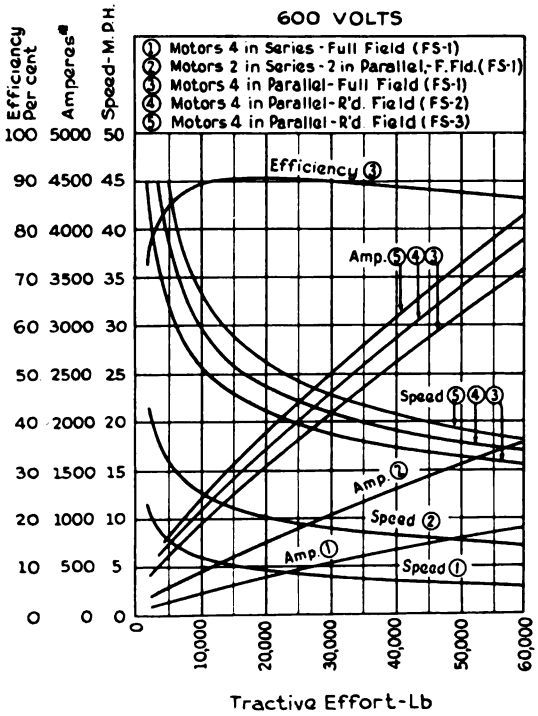
SWITCHING SERVICE



Track Gauge 4 ft. 8½ in.

LOCOMOTIVE CHARACTERISTICS

600 VOLTS



LOCOMOTIVE DATA

Weights-Lb.	
Total (Excluding Sand)	200,000
On Drivers	200,000
Per Driving Axle	50,000
Cab, Platform and Trucks	126,045
Traction Motors (Including gearing)	36,100
Other Equipment	37,855
Traction Motors	
Number	4
Type	GE-286-A
Rated Voltage	600/1200
Method of Drive	Single Cushion Gear
Gear Ratio	72/17 = 4.235
Ventilation	Forced

Locomotive Ratings	One Hour Blown 120°C. Rise by Res. Full Field (FS-1)	Continuous Blown 120°C. Rise by Res. Full Field (FS-1)	Continuous Blown 120°C. Rise by Res. Fd. Field (FS-3)
Tractive Effort-Lb.	34,100	25,260	18,820
Coef. Adhesion	17.05%	12.63%	9.41%
Speed M.P.H.	16.3	19.75	26.85
Horse Power	1665	1330	1350
Amperes*	2300	1840	1840
Tractive Effort at 25% Coef. Adhesion		50,000 lb.	
Maximum Safe Speed		40 M.P.H.	

Control	Type PCL (S.U.) 3 Speeds F.F. 6 Speeds R.F.
Current Collector,	Third Rail Shoe and Overhead 3rd Rail Collector
Braking	Air
Train Heating Equipment,	None

First Locomotive Built	1926
Total Number in Service	7
Years Placed in Service	1926
Road Engine Numbers (Class Q)	1250-1256 Incl

*Note:- Current values shown do not include auxiliaries.

Locomotive Data, Class Q, 100 Ton

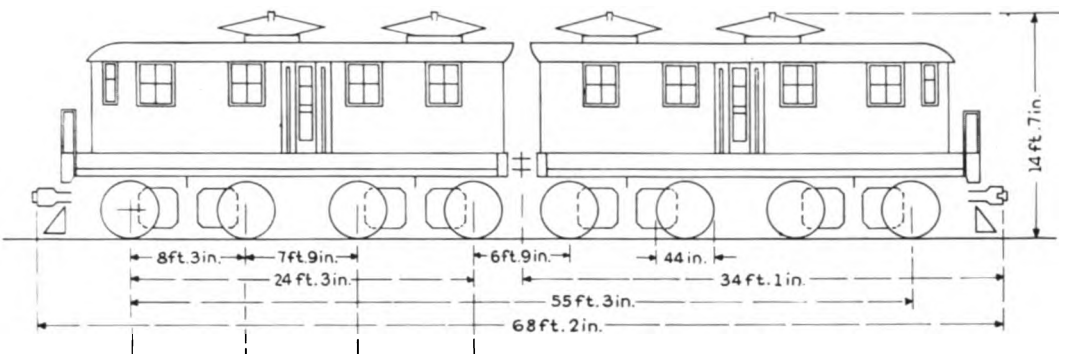
600 VOLT DIRECT CURRENT

176 TON ELECTRIC LOCOMOTIVE

B-B+B-B 351/351 8GE286A 600V.

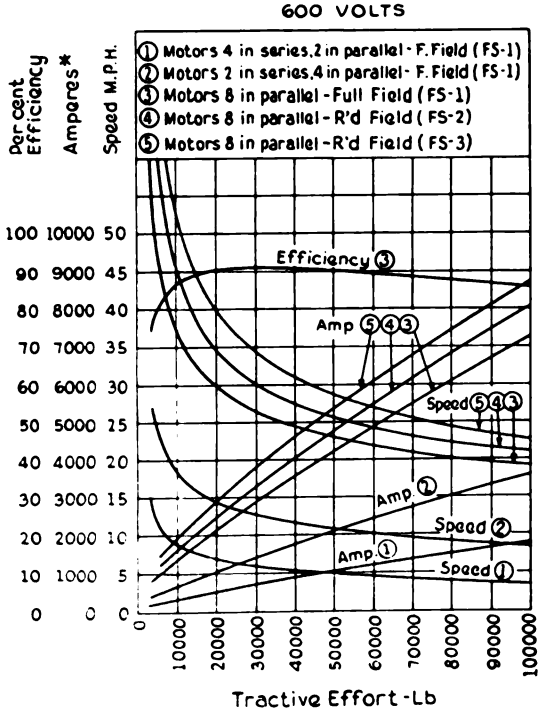
NEW YORK CENTRAL RAILROAD

FREIGHT SERVICE



Track Gauge 4 ft. 8½ in.

LOCOMOTIVE CHARACTERISTICS
600 VOLTS



LOCOMOTIVE DATA

Weights-Lb.	
Total (Excluding Sand)	351,400
On Drivers	351,400
Per Driving Axle	43,925
Cab, Platform and Trucks	197,940
Traction Motors (Including gearing)	72,200
Other Equipment	81,260
Traction Motors	
Number	8
Type	GE-286-A
Rated Voltage	600/1200
Method of Drive	Single Cushion Gear
Gear Ratio	69/20 = 3.45
Ventilation	Forced

Locomotive Ratings	One Hour Blown 120°C. Rise by Res. Full Field (FS-1)	Continuous Blown 120°C. Rise by Res. Full Field (FS-1)	Rd. Field (FS-3)
Tractive Effort-Lb.	55,800	41,200	28,640
Coef. Adhesion	16.0%	11.8%	8.2%
Speed M.P.H.	22.3	24.2	35.1
Horse Power	3,320	2,660	2,680
Amperes*	4,600	3,680	3,680
Tractive Effort at 25% Coef. Adhesion		87,850 lb.	
Maximum Safe Speed		60 M.P.H.	

Control	Type PCL (S.U.) 3 Speeds F.F. 6 Speeds R.F.
Current Collector, Third Rail Shoe and Overhead 3rd Rail Collector	
Braking	Air
Train Heating Equipment	None

First Locomotive Built	1926
Total Number in Service	2
Years Placed in Service	1926
Road Engine Numbers (Class R)	1200 - 1201

*Note.- Current values shown do not include auxiliaries.

Locomotive Data, Class R, 176 Ton

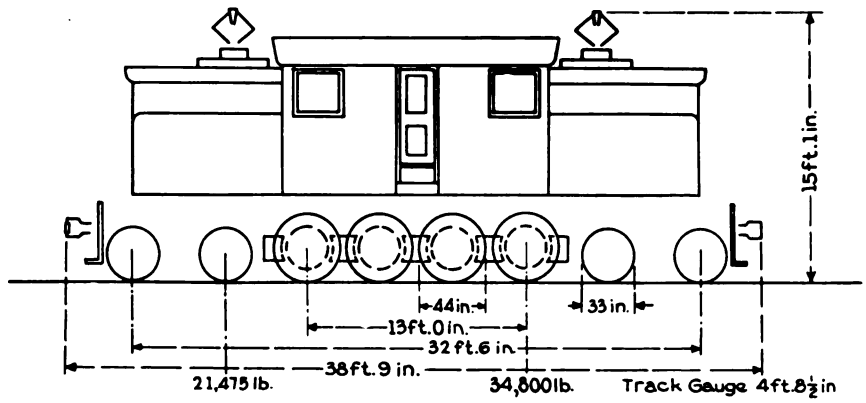
600 VOLT DIRECT CURRENT

113 TON ELECTRIC LOCOMOTIVE

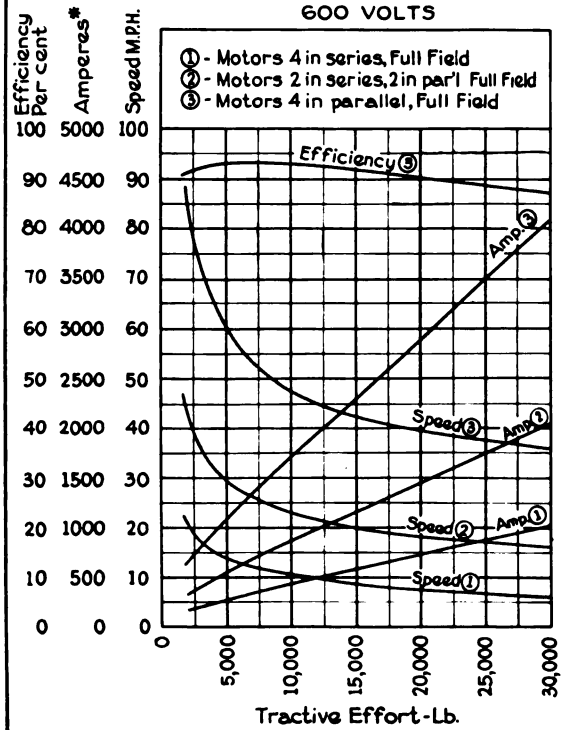
2-D-2 225/139 4GE84A 600V.

NEW YORK CENTRAL RAILROAD

PASSENGER SERVICE



LOCOMOTIVE CHARACTERISTICS
600 VOLTS



LOCOMOTIVE DATA

Weights-Lb.	
Total	225,100
On Drivers	139,200
Per Driving Axle	34,800
Cab, Platform and Trucks	168,800
Traction Motors	40,760
Other Equipment	15,540
Traction Motors	
Number	4
Type	GE 84A
Rated Voltage	600
Method of Drive	Direct
Gear Ratio	Gearless
Ventilation	Natural

Locomotive Ratings	One Hour-Unblown 75° C. Rise by Therm. Full Fld (FS-1)	Continuous-Unblown 120° C. Rise by Res. Full Fld (FS-1)
Tractive Effort	15,200 lb.	4,870 lb.
Coef. Adhesion	10.92%	3.5%
Speed	41.8 M.P.H.	61.0 M.P.H.
Horse Power	1695	792
Amperes*	2300	1060
Tractive Effort at 25% Coef. Adhesion		34,800 lb.
Maximum Safe Speed		60 M.P.H.

Control	Type M-(M.U.)-3 Speeds F.F.
Current Collector, Third Rail Shoe and Slider Pantograph	
Braking	Air
Train Heating Equipment	None

First Locomotive Built	1904
Total Number In Service	35-N.Y.C.R.R.
Years Placed in Service	35-1906
Road Engine Numbers (Classes S1 & S-2)	1100 to 1134 incl.

*Note:- Current values shown do not include auxiliaries.

Locomotive Data, Classes S-1 and S-2, 113 Ton

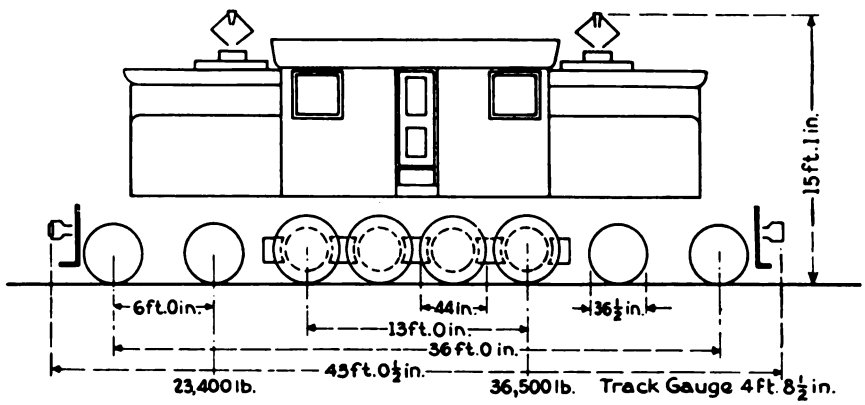
600 VOLT DIRECT CURRENT

120 TON ELECTRIC LOCOMOTIVE

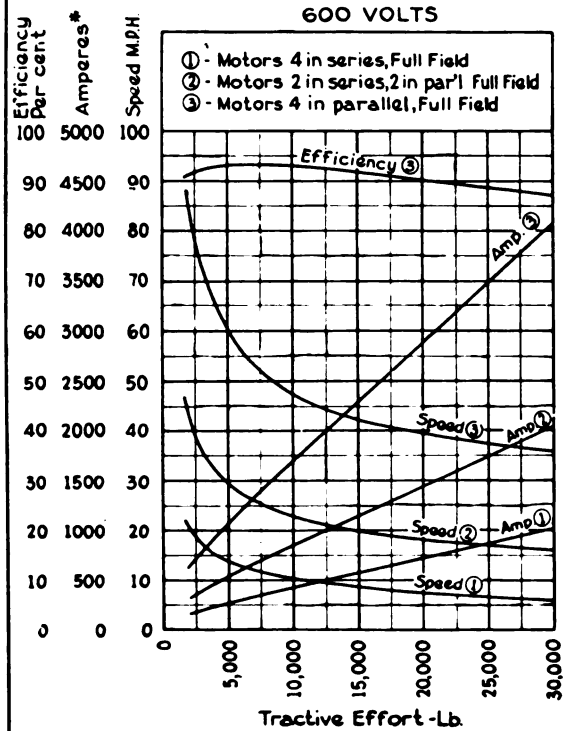
2-D-2 240/146 4GE84A 600V.

NEW YORK CENTRAL RAILROAD

PASSENGER SERVICE



LOCOMOTIVE CHARACTERISTICS
600 VOLTS



LOCOMOTIVE DATA

Weights-Lb.	
Total (excluding heater fuel & water)	239,600
On Drivers	146,000
Per Driving Axle	36,500
Cab, Platform and Trucks	177,260
Traction Motors	40,760
Other Equipment	21,580
Traction Motors	
Number	4
Type	GE 84A
Rated Voltage	600
Method of Drive	Direct
Gear Ratio	Gearless
Ventilation	Natural

Locomotive Ratings	One Hour-Unblown 75° C. Rise by Therm. Full Fld (FS-1)	Continuous-Unblown 120°C. Rise by Res. Full Fld (FS-1)
Tractive Effort	15,200 lb.	4,870 lb.
Coef Adhesion	10.4%	3.34%
Speed	41.8 M.P.H.	61.0 M.P.H.
Horse Power	1695	792
Amperes*	2300	1060
Tractive Effort at 25% Coef. Adhesion		36,500 lb.
Maximum Safe Speed		60 M.P.H.

Control — Type M-(M.U.)-3 Speeds F.F.
Current Collector, Third Rail Shoe and Slider Pantograph
Braking — Air
Train Heating Equipment, Oil Fired Boiler, Capacity 2000 lb. per hr.

First Locomotive Built	1908
Total Number in Service	12-N.Y.C.R.R.
Years Placed in Service	12-1909
Road Engine Numbers (Class S-3)	1135 to 1146 inclusive

*Note:-Current values shown do not include auxiliaries.

Locomotive Data, Class S-3, 120 Ton

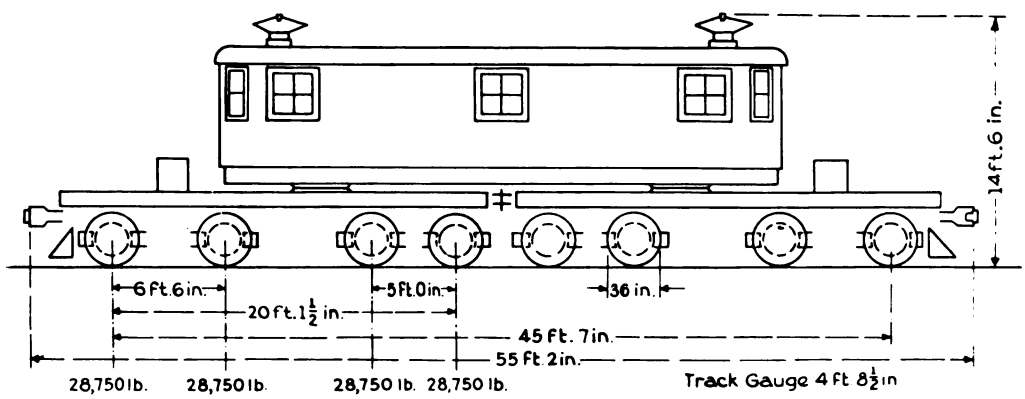
600 VOLT DIRECT CURRENT

115 TON ELECTRIC LOCOMOTIVE

B-B+B-B 230/230 8GE92A 600V.

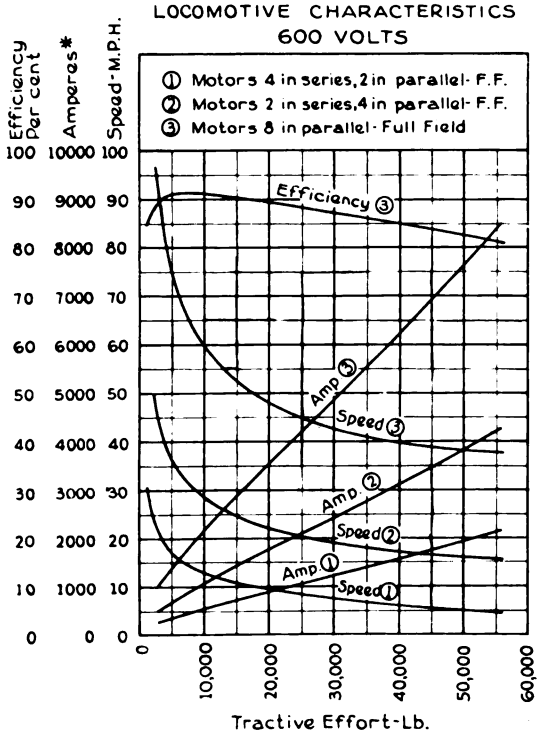
NEW YORK CENTRAL RAILROAD

PASSENGER SERVICE



LOCOMOTIVE CHARACTERISTICS

600 VOLTS



LOCOMOTIVE DATA

Weights-Lb.	
Total (excluding sand, fuel and water)	230,000
On Drivers	230,000
Per Driving Axle	28,750
Cab, Platform and Trucks	147,000
Traction Motors	40,950
Other Equipment	42,050
Traction Motors	
Number	8
Type	GE92A
Rated Voltage	600
Method of Drive	Direct
Gear Ratio	–

Ventilation, Forced-3000 cu. ft. per min. per motor

Locomotive Ratings	One Hour-Blown 120°C Rise by Res Full Fld (FS-1)	Continuous-Blown 120°C Rise by Res Full Fld (FS-1)
Tractive Effort	20,350 lb.	11,500 lb
Coef. Adhesion	8.85%	5.0%
Speed	4.76 M.P.H.	57.2 M.P.H.
Horse Power	2584	1756
Amperes*	3600	2400
Tractive Effort at 25% Coef. Adhesion		57,500 lb.
Maximum Safe Speed		75 M.P.H.

Control — Type M-(S.U.)-3 Speeds Full Field
Current Collector, Third Rail Shoes and Overhead Rail Collectors
Braking — Air
Train Heating Equipment, Oil fired boiler, capacity 2000 lb. per hr.

First Locomotive Built	1913
Total Number in Service	10 N.Y.C.
Years Placed in Service	10-1913
Road Engine Numbers (Class T-1)	1147 to 1156 inclusive

*Note - Current values shown do not include auxiliaries

Locomotive Data, Class T-1, 115 Ton

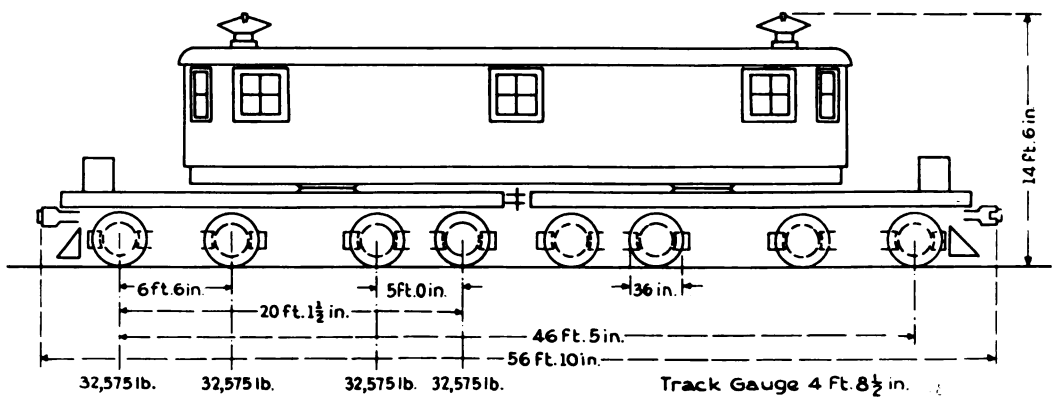
600 VOLT DIRECT CURRENT

130 TON ELECTRIC LOCOMOTIVE

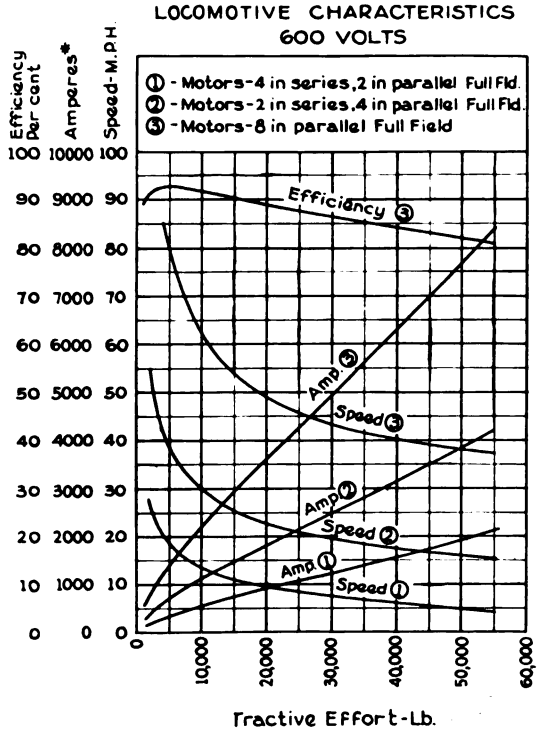
B-B+B-B 261/261 8GE91A 600V.

NEW YORK CENTRAL RAILROAD

PASSENGER SERVICE



LOCOMOTIVE CHARACTERISTICS
600 VOLTS



LOCOMOTIVE DATA

Weights-Lb.	
Total (excluding sand, Fuel and water)	260,600
On Drivers	260,600
Per Driving Axle	32,575
Cab, Platform and Trucks	164,000
Traction Motors	53,000
Other Equipment	43,600
Traction Motors	
Number	8
Type	GE 91A
Rated Voltage	600
Method of Drive	Direct
Gear Ratio	Gearless
Ventilation, Forced-3000 cu. ft. per min. per motor	

Locomotive Ratings	One Hour-Blown 120°C. Rise by Res. Full Fld (FS-1)	Continuous-Blown 120°C. Rise by Res. Full Fld (FS-1)
Tractive Effort	18,500 lb.	12,500 lb.
Coef. Adhesion	7.1%	4.8%
Speed	50.1 M.P.H.	57.1 M.P.H.
Horse Power	2475	1905
Amperes*	3440	2600
Tractive Effort at 25% Coef. Adhesion		65,150 lb.
Maximum Safe Speed		75 M.P.H.

Control	Type M-(S.U.) 3 Speeds F.F.
Current Collector	Third Rail Shoes and Overhead Rail Collectors
Braking	Air
Train Heating Equipment, Oil fired boiler, Capacity 2000 lb. per hr.	

First Locomotive Built	1913
Total Number in Service	16-N.Y.C.
Years Placed in Service	6-1914 - 9-1917 - 1-1918
Road Engine Numbers-(Class T-2)	1157 to 1172 inclusive

*Note:-Current values shown do not include auxiliaries

Locomotive Data, Class T-2, 130 Ton

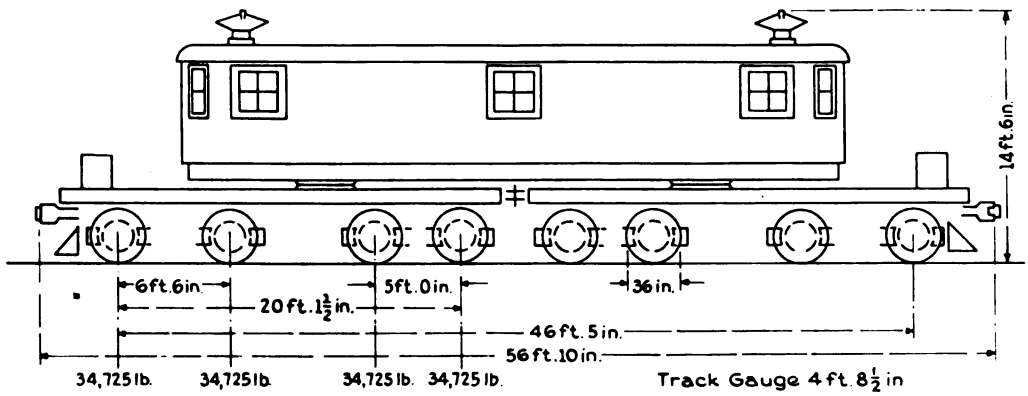
600 VOLT DIRECT CURRENT

139 TON ELECTRIC LOCOMOTIVE

B-B+B-B 278/278 8GE91A 600V.

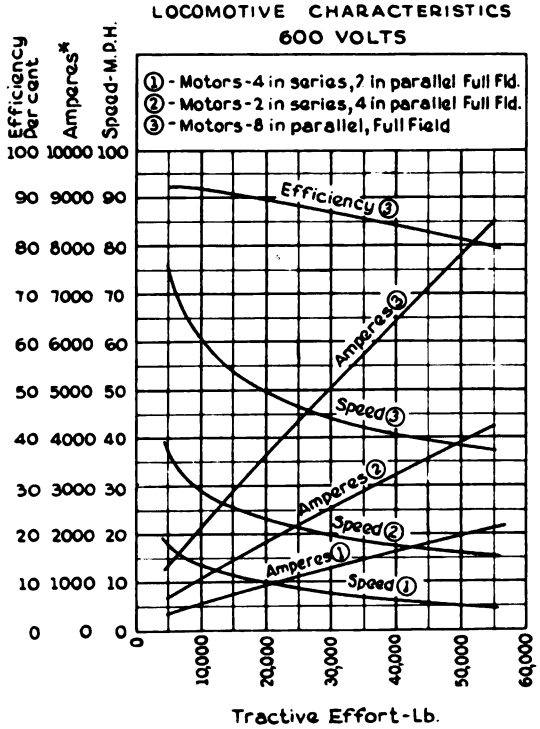
NEW YORK CENTRAL RAILROAD

PASSENGER SERVICE



LOCOMOTIVE CHARACTERISTICS

600 VOLTS



LOCOMOTIVE DATA

Weights-Lb.	
Total (excluding sand, fuel and water)	277,800
On Drivers	277,800
Per Driving Axle	34,725
Cab, Platform and Trucks	167,000
Traction Motors (excluding axles)	54,400
Other Equipment	56,400
Traction Motors	
Number	8
Type	GE91A
Rated Voltage	600
Method of Drive	Direct
Gear Ratio	Gearless
Ventilation,	Forced

Locomotive Ratings	One Hour-Blown 120°C. Rise by Res Full Fld. (FS-1)	Continuous-Blown 120°C. Rise by Res. Full Fld (FS-1)
Tractive Effort-Lb.	18,440	12,750
Coef. Adhesion-	6.64%	4.59%
Speed M.P.H.	50.6	56.1
Horse Power	2488	1908
Amperes*	3440	2600
Tractive Effort at 25% Coef. Adhesion		69,450 lb.
Maximum Safe Speed		75 M.P.H.

Control Type M-(S.U.) 3 Speeds F.F

Current Collector, Third Rail Shoes and Overhead Rail Collectors

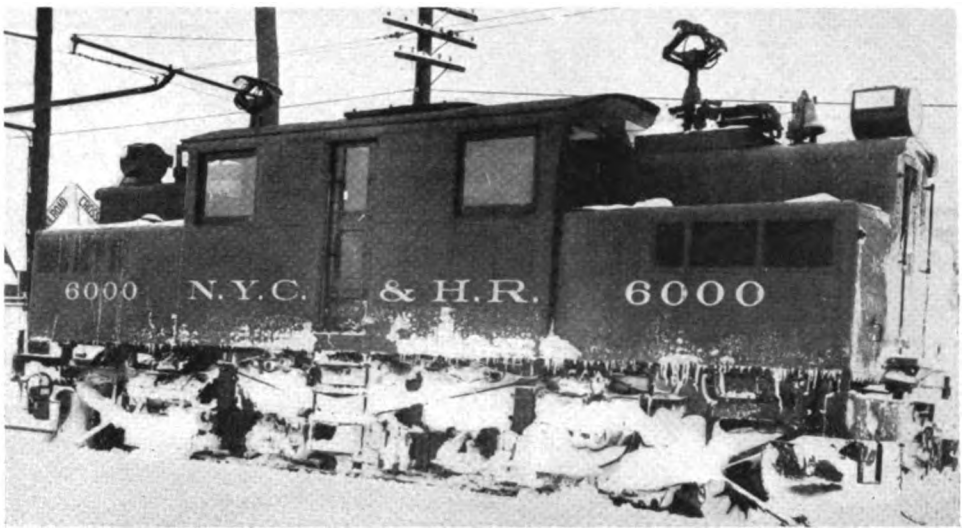
Braking Air

Train Heating Equipment, Oil fired boiler, Capacity 3500 lb. per hr.

First Locomotive Built	1926
Total Number in Service	10
Years Placed in Service	1926-1927
Road Engine Numbers (Class T-3)	1173 to 1182 inclusive

*Note:- Current values shown do not include auxiliaries.

Locomotive Data, Class T-3, 139 Ton



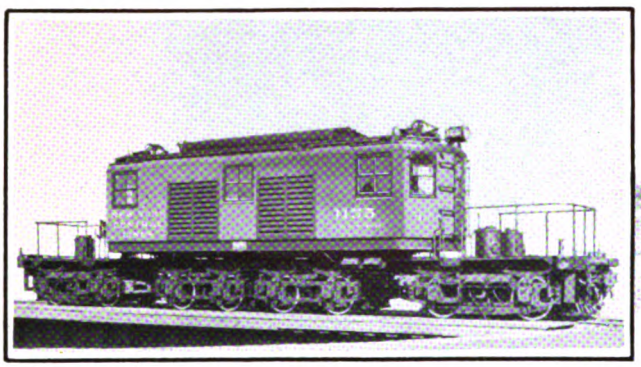
The First New York Central Locomotive on Test

LOCOMOTIVES

The first locomotives used on the New York Central terminal were known as Class "S." The first of these units was given initial tests in October, 1904. This locomotive was known as No. 6000 and was tested for several months under various conditions of loads, speeds, and weather. The Class "S" engine is of the gearless type built with four driving axles, each equipped with a gearless motor with the armature keyed to the axle, and with guiding wheels at each end. The 6000 type, upon which the initial tests were made, was built with a single guiding axle, front and rear. Later it was decided to change this to a two-axle truck, and all units of this type of locomotive now have a two-axle guiding truck at each end. The original design weighed 94½ tons complete, while the present locomotives weigh 112½ tons with about 70 tons on the driving axles. The normal one-hour rating is 1700 horsepower, giving a tractive effort of 15,200 pounds at 41.8 miles per hour. In comparison with the 171-ton steam locomotive which was then displaced on heavy passenger trains, this locomotive had the advantage of much higher horsepower rating, a reduction in weight, and a lower weight per driving axle. It was built to operate equally well in either direction.

The first order of these locomotives, delivery of which began in 1905, was for 35 units. Before delivery was completed, however, the number was increased to 47 units, and the last locomotive was delivered in 1909.

With the extension of electrification from the temporary terminals at High Bridge and Wakefield to present locations at Croton and White Plains, North Station, additional equipment consisting of ten 115-ton passenger locomotives, was ordered, and was delivered in 1913. These are also of the gearless type but designed to carry all the weight on driving wheels. Each of the eight axles is driven by a gearless motor. The increased capacity gave the necessary power for handling the gradually increasing train weights. These locomotives



Class T-1 115-ton Locomotive

Class Q 100-ton Switcher

Class S-2 113-ton Locomotive

Class T-3 139-ton Locomotive

Class T-2 130-ton Locomotive

Twentieth Century Limited with Class T-2 Locomotive. View Shows Main-line Signals

were tested for a maximum safe speed of 75 miles per hour and are rated for continuous operation up to about 57 miles per hour with a tractive effort of 11,500 pounds.

The following year, the first of 16 additional units was placed in service. These are of similar design, but have a total of 130 tons, all on the driving wheels, to handle heavier trains. The most recent of the gearless passenger locomotives, consisting of 10 units placed in service in 1926 and 1927, are of the same design with slightly greater total weight.

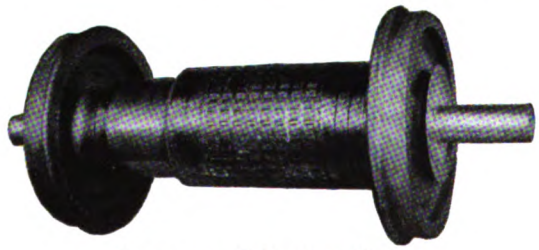
The eight-motor locomotives, known as the Class "T", now handle most of the through passenger trains in and out of the terminal. The Class "S" locomotives are used for passenger-train switching around the terminal and between Grand Central Terminal and Mott Haven Yards, and for some of the through trains on the Harlem Division.

Many features of the eight-motor locomotive follow closely those of the Class "S", but the arrangement of the running gear and cab is radically different. The frame of the locomotive is made up of two platforms which carry the draft gear at their outer ends and are articulated at the center of the locomotive. The axles are assembled in four-wheel trucks of which one is secured rigidly to each of the platforms near its inner end and one is placed near the outer end of each platform and supports it through a center bearing. This permits rotary motion but not lateral motion of the truck. The cab is mounted on center plates, one on each of the two platforms.

The control is of the three-speed type. The two motors on each truck are permanently connected in parallel, and the four pairs are successively connected in three ways just as the four motors of the earlier-type locomotive are, the resulting combination being: four pairs in series, the motors of each pair in parallel; two groups in series, the four motors

Class R Freight Locomotive

of each group in parallel; and eight motors in parallel. The addition of reversing contactors for four additional motors increased the number of contactors in the main cab. The cab is divided into three compartments. The end compartments contain accommodation for the crew, and space for the controller, brake valves, etc., and the train steam-heating apparatus, which is divided, the boiler being in one end of the locomotive and the oil and water tanks in the other. The middle compartment has a passageway at each side, and the apparatus space is between these passages. The center part of the floor space is occupied by the blower and air compressor with their respective motors. On the partitions at the end of the compartment (center), are placed the motor cutout switches, switch and fuse for auxiliary circuits, compressor-governor fuse and switch, ammeter shunt, connection boxes, tube resistances for the control circuits, and the main switch.



Armature of Gearless Motor, Class T Locomotive

The contactors are suspended at a height of about 6 feet 6 inches from the floor in two rows extending the length of the compartment, placed back to back facing outward, with room between for inspection of the connections at the back. The passageways are protected from arcing of the contactors by shields, hanging in front of the contactors, which can be opened upward when the contactors are inspected. The rheostats are placed directly above the contactors.

The trains are heated by an oil-fuel boiler of the vertical, fire-tube type. Water is fed by air pressure from a tank having a capacity of 5600 pounds of water. Fuel is supplied by gravity from a tank containing 102 gallons of fuel oil, which is located in the top of the water tank. The supply of fuel, and of air or steam, to the burner is regulated by hand.

Freight Locomotive with Train

FREIGHT AND SWITCHING LOCOMOTIVES

In anticipation of the electrical operation of the West Side tracks, two road-freight and seven freight-switching locomotives of the geared type were ordered in 1925 and delivered in 1926.

The running gear of the road locomotives consists of two swivel-truck units coupled by an articulated joint. The equipment consists of eight motors with a gear ratio to permit a maximum emergency speed of 60 miles per hour. The two cabs are of the box type, and the total weight of the locomotive is approximately 175 tons, all on the driving wheels.

The switching locomotive is of steeple-cab construction mounted on two-swivel equalized trucks, each equipped with four motors and geared for a maximum speed of 40 miles per hour. The running gear is similar to a half-unit of the freight locomotive. The total weight of the locomotive is 200,000 pounds.

Switcher with Train

Suburban Train with Motor Cars

MOTOR CAR OPERATION

The greater part of the local suburban passenger business is handled in multiple-unit motor cars. The initial equipment of the electric zone included 125 passenger motor cars, and 55 similar cars which were used as trailers. As the electrical service was extended, these trailer cars were all equipped with motors and control, and all subsequent cars for the electric zone were equipped for electrical operation. The earlier cars were 62 feet in length, and each was equipped with two 200-horsepower motors and type "M" multiple-unit control. These cars weighed about 51 tons each. Later cars are somewhat heavier and, during 1924 and 1925, a rebuilding program was instituted which provided for the lengthening of all the original motor cars and converted trailers then in service to approximately 69 feet over all. The weight was increased to about 65 tons, and the seating capacity from 70 to 82 or 100 passengers. It had been found that the margin in capacity of the electric equipment would permit this increase in weight without change in motor equipment. During the reconstruction, an intermediate relay was added, permitting the operation of 15 cars per train.

The more recent electric equipments include Type "PC" pneumatically operated control in place of the Type "M" which was originally furnished. Cars are normally operated in trains of from two to twelve units depending upon the volume of traffic, which

Suburban Level, Grand Central Terminal

varies throughout the day. All cars are motor cars, rather than a combination of motor cars and trailers as used on some roads. There is now in service, or on order, a total of 346 motor cars, and some of the original equipments have been run nearly 600,000 miles each.

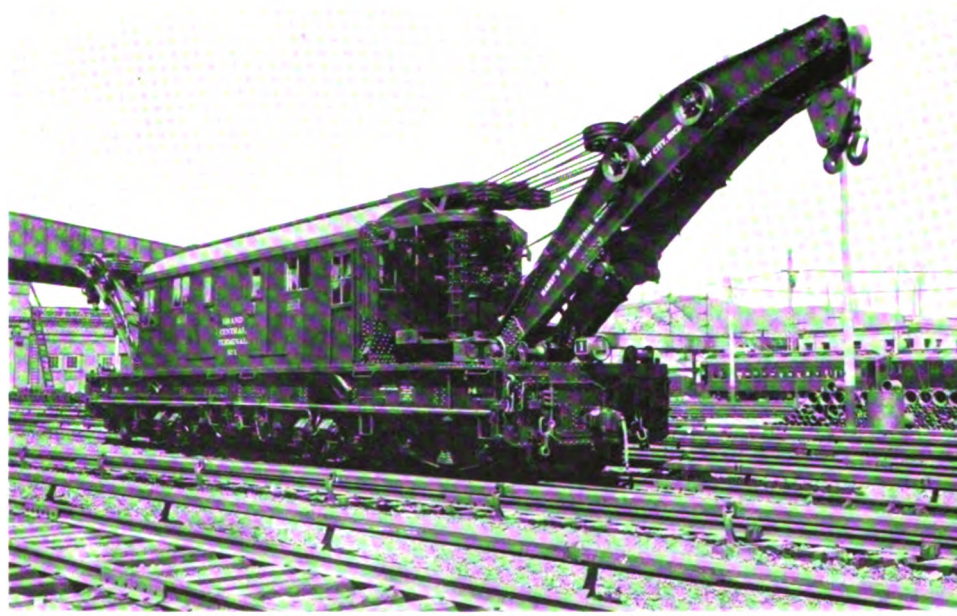
SPECIAL EQUIPMENT

When steam operation was abandoned in the electric zone, an electric wrecking crane was designed to be used in the Grand Central Terminal and on the electric zone. The crane weighs 370,000 pounds, and was designed to meet the special conditions existing in the terminal, such as restricted clearances, 135-foot radius loops, and the avoidance of excessive concentrated loads on the upper-level tracks carried on steel work. It is propelled and operated electrically.

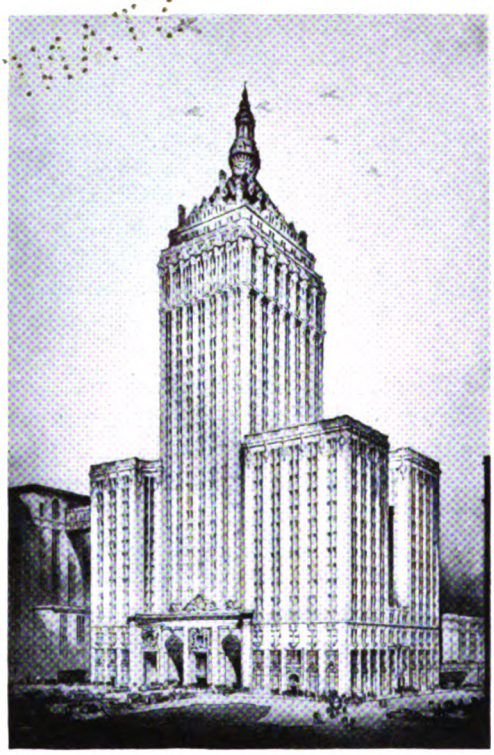
There is a 100-ton crane at each end, both of which may be operated at the same time if necessary. The maximum reach of the boom is 24 feet 2 inches and at this radius, with outriggers set, the 100 tons can be lifted and swung laterally 6 feet 6 inches either side of the track center; at the radius of 13 feet 8 inches, the same load can be moved to any point within a 180-degree swing of the boom.

Four GE-69-C 200-hp. motors are used for propulsion, one mounted on each of the four trucks. The motors are identical with those on the earlier multiple-unit cars except that a different gear ratio is used. A Sprague General Electric master controller is provided at each end to operate the 40 contactors, which are arranged to connect the motors in series, series-parallel, and parallel on third-rail current.

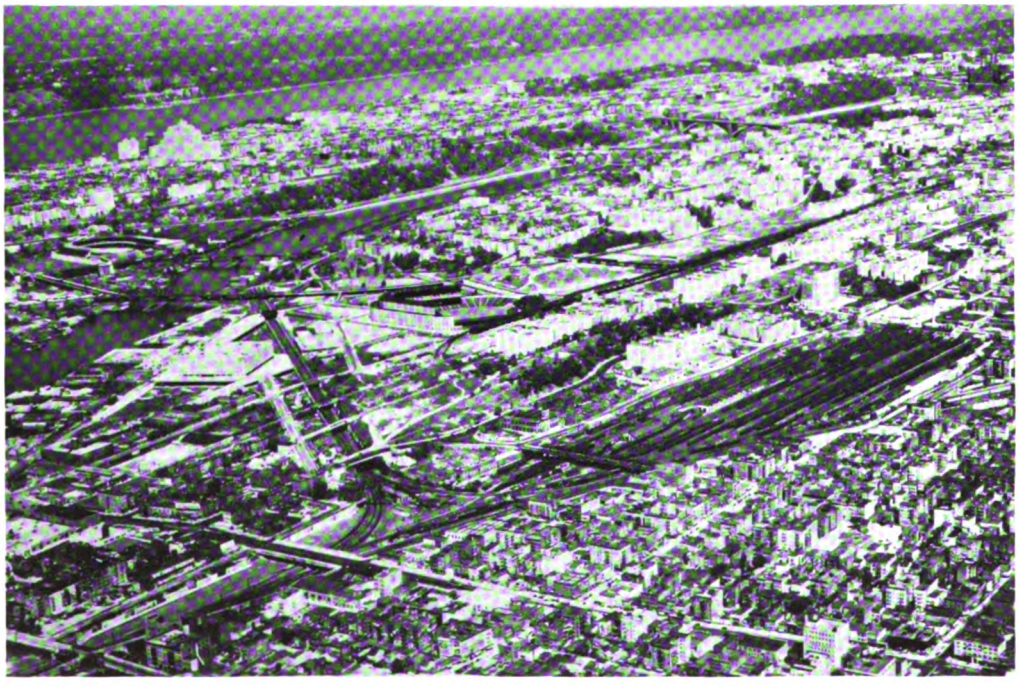
The crane is equipped with air brake sets for each pair of trucks, hand brakes, etc., and conforms with the U. S. safety appliance standards. Portable searchlights, which can be plugged into receptacles at the corners of the body, are provided.



185-ton Electric Wrecking Crane



New York Central Building



Airplane View of Upper New York City Showing Hudson and Harlem Rivers, New York Central Tracks, and Mott Haven Yards

View of Harmon Shops from the South

SHOP FACILITIES AND INSPECTION HARMON

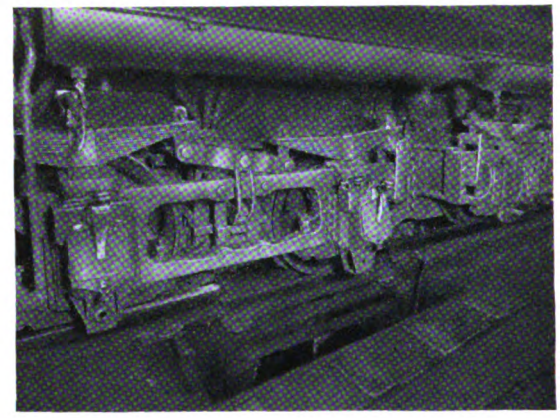
The principal repair shops for the Electric Division are located at Harmon, where the change is made from steam to electric locomotives and vice versa. All heavy repairs, both to locomotives and motor cars, are made in this shop. This plant not only includes the large electrical repair shop, but also a roundhouse and complete terminal facilities for the steam locomotives. The organization for the care of the steam locomotives, however, is entirely separate and is a part of the steam-operated Hudson Division north of Harmon. In addition to the main electrical repair shop, there is also a local power house which supplies the roundhouse and shops with power, heat, and light. There is, furthermore, a running-inspection shed, through which all locomotives pass upon their arrival at the terminal.

This inspection shed is 209 feet long by 24 feet wide and houses a single track with a pit. In addition to the running inspection which each locomotive receives at this point, provision is made for supplying the heater boilers with oil and water and for refilling the sand boxes on the locomotives. No third rail is installed in this shed, but a contact device is provided for supplying 600-volt current to move the locomotive.

The main shop building is of the transverse type, through which 17 tracks pass. Access is thus provided to both ends of the shop. West of the car shop proper, is a machine shop 182 feet by 66 feet, and directly south of this shop is another building, 140 feet by 66 feet, which houses the storeroom, oil room, and blacksmith shop.

Harmon Shops, Interior of Locomotive Shop

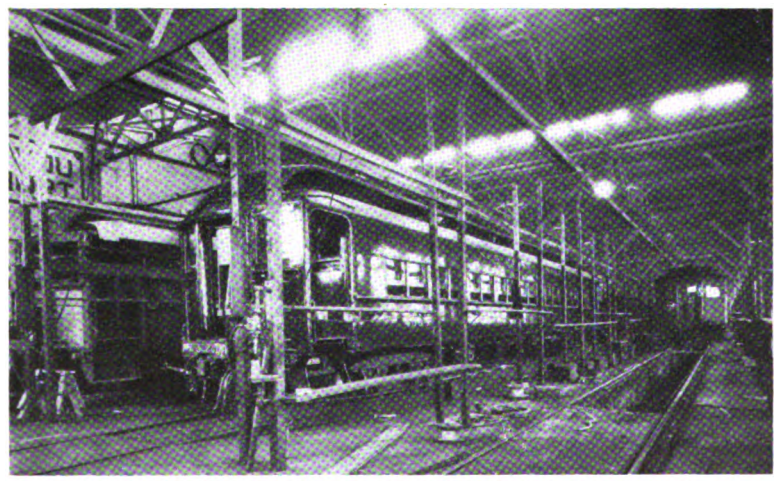
Harmon Shops, Inspection Shed



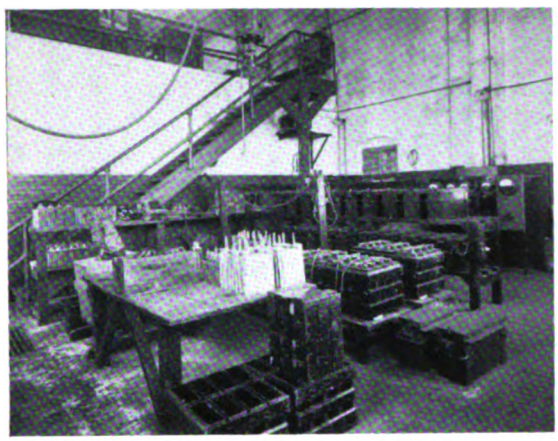
Harmon Shops, Jack for Armature Removal

The locomotive shop proper is located to the east of the car repair shop, in which are two tracks provided with hydraulic jacks and connected with the car shop by means of transverse pits. There are two jacks, one of 40-ton capacity and the other 75-ton, both of the one-cylinder, telescopic type. The capacity of both of these jacks can be raised considerably by increasing the base pressure in the hydraulic line. No overhead cranes are located in the locomotive repair shop, as the armature and wheels are handled by jacks through the transfer pits to the car shop, where a crane is available for transferring the equipment to the transverse track across the north end of the car and machine shop.

East of the locomotive shop are located the paint shop, sheet-metal shop, and paint-storage room. Here the cars are washed and painted. A carpenter shop and storage room also adjoin this shop. North of the paint shop are the sandblast house and paint-spray house where equipment is prepared and painted.



Harmon Paint Shop



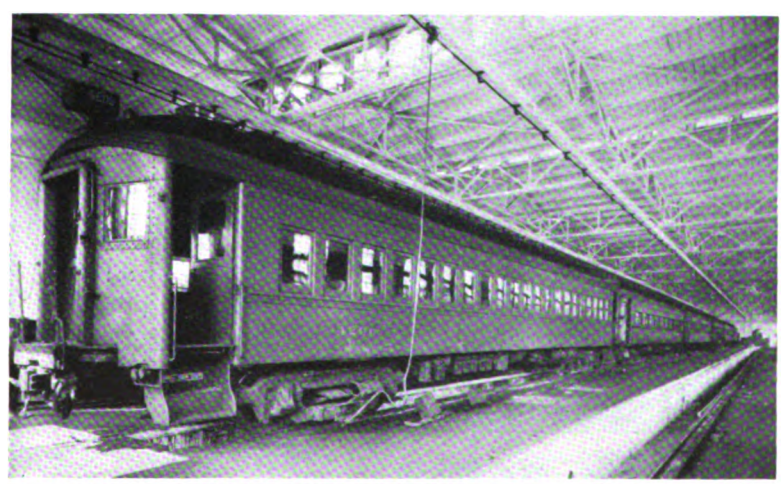
White Plains Shops, Battery Room

White Plains Shops, Exterior View

North of the car shop, but detached from it, is a wheel-press building with crane for handling wheels and axles. Small rooms on convenient locations are devoted to armature repairs, air-compressor repairs, air-brake equipment repairs, welding, pipe work, train-heating boiler repairs, and contactor and control overhauling, together with office space. Acetylene gas and inflammable material are stored at points removed from the shop in order to reduce fire hazard.

WHITE PLAINS SHOPS

Well-equipped shops are also provided at White Plains North Station, where the transfer is made from steam to electric locomotives on the Harlem Division. This shop is more particularly intended for handling light repairs and inspection on multiple-unit cars.



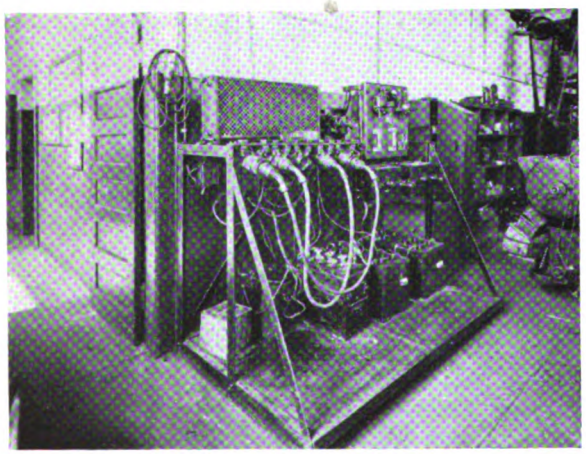
White Plains Shops, Interior View

Inspection and light repairs, however, are also given to the electric locomotives reaching this point. The inspection shed covers three tracks, all provided with pits for practically the entire length. In the rear, on one side, is a room for handling repairs and inspection to storage batteries and for calibrating thermostats; while on the other side is a room devoted to light repairs, calibration, and inspection of air valves, contactors, etc., in connection with Type PC control. This room contains complete provisions for testing both locomotive and motor-car jumper cables.

White Plains Shops, Car Jack

A number of special machines are used to care for the operations in this shop. Among these are a small refrigerating unit for the calibration of the car thermostats, an automatic device for testing locomotive jumper cables, two motor-operated, 25-ton jacks for lifting car bodies from the trucks, and a greasing machine which includes electric heating elements to facilitate handling heavy compounds.

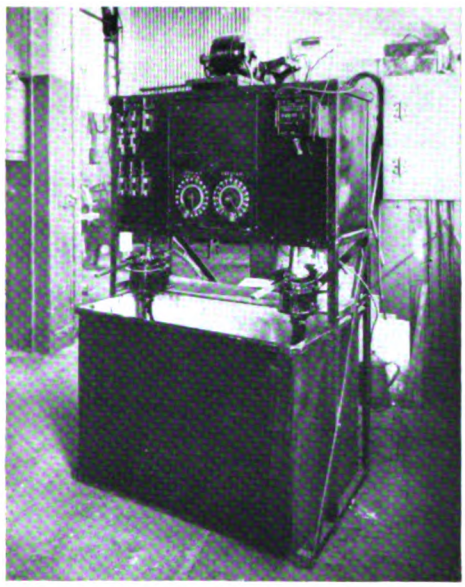
It is the practice of the inspection staff to anticipate possible interruptions to service; and any defect which is discovered on one car is usually a signal for the checking up of this piece of equipment on all cars. A careful record is kept of delays in the electric zone, and this shows an unusual freedom from delays due to electric equipment. In addition to the inspections given at Harmon and White Plains, some attention is also given to motive power and rolling stock in the Grand Central Terminal. For inspection and light repairs on the motor cars handling the service on the Yonkers branch, a small shop is maintained at High Bridge near the Sedgwick Avenue Terminal.



White Plains Shops, Equipment for Testing Motor-car Jumper Cables

SIGNALS

With the rebuilding of the Grand Central Terminal, accompanied by the change from steam to electric operation, it was decided that for traffic reasons radical changes in the signal equipment then in use were necessary. The operation of the old signals would also be deranged by the use of the track rails for the return of the



White Plains Shops, Equipment for Testing Locomotive Jumper Cables

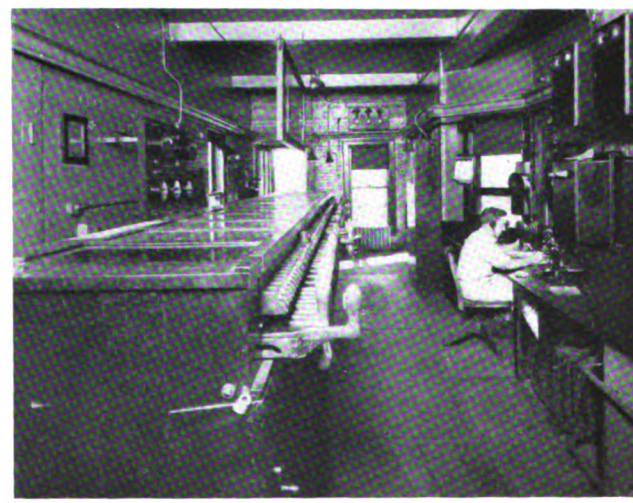
propulsion current. A new automatic signal and electric interlocking equipment was therefore adopted for the entire suburban zone. The signal circuits are operated by alternating current, and the influence of propulsion currents is prevented by the use of reactance bonds which permit the passage of direct current as desired, but, where necessary, interrupt the passage of the signal current.

MAINTENANCE OF EQUIPMENT

From the beginning of electrical operation, an efficient organization has been maintained by the New York Central Railroad Company for the repair and inspection of all electric rolling stock. From 1908 to the end of 1927, the electric locomotives used in the electric zone had operated a grand total of 38,404,000 miles. Records show that the cost of maintaining these locomotives during this entire period has averaged approximately 9 cents per locomotive mile.

Included in this figure are many items which might be termed extraordinary maintenance in connection with heavy repairs to the original class "S" locomotives which, after more than 20 years of service, are now undergoing the first back shop repairs. About half of these locomotives have already been overhauled.

Since starting electrical operation, the multiple-unit car equipment, consisting of 125 motor cars and 55 trailers at the beginning of operation and now totaling 336 motor cars, has made a total of 125,600,000 miles up to the end of 1927. The cost of maintaining these cars over this entire period has averaged approximately 5 cents per car-mile. There is now under way a program for rebuilding the first 180 cars. A portion of this expense is charged to maintenance and, therefore, in a way constitutes an extraordinary expenditure.



Interior of Signal Tower

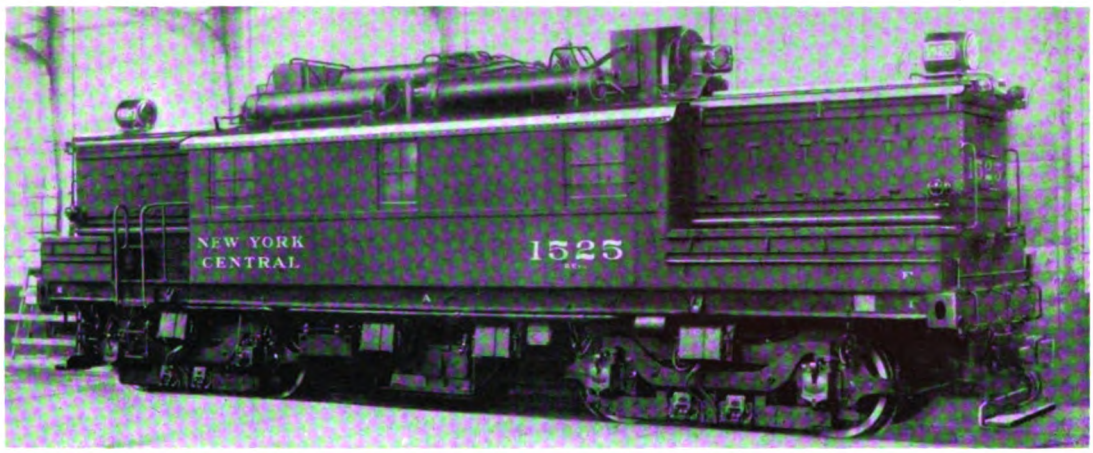
View of Right-of-way Showing Third Rail

DATA ON ELECTRIC LOCOMOTIVES

Type	Classification	No.	Road No.	WEIGHT LB.		ONE HOUR RATING			CONTINUOUS RATING			First Built
				Total	Drivers	T.E.	M.P.H.	Hp.	T.E.	M.P.H.	Hp.	
S1–S2	2–D–2–225/139–4GE84A	35	1100–1134	225100	139200	15200	41.8	1695	4870	61.0	792	1904–6
S-3	2–D–2–240/146–4GE84A	12	1135–1146	239600	146000	15200	41.8	1695	4870	61.0	792	1908–9
T-1	B–B+B–B–230/230–8GE92A	10	1147–1156	230000	230000	20350	47.6	2584	11500	57.2	1756	1913
T-2	B–B+B–B–261/261–8GE91A	16	1157–1172	260600	260600	18500	50.1	2475	12500	57.1	1905	1914–18
T-3	B–B+B–B–278/278–8GE91A	10	1173–1182	277800	277800	18440	50.6	2488	12750	56.1	1908	1926
Q	B–B–200/200–4GE286A	7	1250–1256	200000	200000	34100	18.3	1665	25260	19.75	1330	1926
R	B–B+B–B–351/351–8GE286A	2	1200–1201	351400	351400	55800	22.3	3320	41200	24.2	2660	1926

ELECTRIC OPERATION

Grand Central Terminal	to Highbridge	December 12, 1906
Grand Central Terminal	to Wakefield	January 29, 1907
Wakefield	to Mt. Vernon	February, 1907
High Bridge	to Yonkers	April 6, 1908
Wakefield	to N. White Plains	March 16, 1910
Yonkers	to Glenwood	December, 1910
Glenwood	to Hastings	February 1, 1911
Hastings	to Tarrytown	November 19, 1911
Tarrytown	to Croton	February 22, 1913
Through trains	to Harmon	June 20, 1913
Sedgwick Avenue	to Getty Square, Yonkers	February 1, 1926



Combination Oil-electric Storage-battery Locomotive Used in Switching Service

OIL-ELECTRIC LOCOMOTIVES IN SERVICE ON THE NEW YORK CENTRAL R. R.

In anticipation of needs for self-propelled locomotives on parts of its lines not provided with an electric distribution system, the New York Central has contributed largely to the development of the oil-electric type of locomotive.

Three designs are now in operation in and about New York City to determine their adaptability to three types of service; namely, yard switching, freight haulage, and passenger service.

SWITCHING LOCOMOTIVE

The first type is a 128-ton combination oil-electric storage-battery locomotive with provision for operating from the third rail or overhead trolley. In normal service, the 218-cell battery is used to assist in acceleration and for operation when the engine is shut down. A 300-hp. Ingersoll-Rand engine is sufficient to keep the battery properly charged. Motor and control equipment identical with that used on the Class "Q" locomotive permits operation from the 660-volt supply when in the electric zone. This unit has given most satisfactory service in the various duties required in the switching yards.

FREIGHT LOCOMOTIVE

The 145-ton, 750-hp. oil-electric locomotive now operating on the Putnam Division of the New York Central is the first of this type to be used in road-freight service.

The running gear is a 2-D-2 design, each of the four driving axles being equipped with a GE-286 motor identical with that used on the electric freight and switching locomotives. Sufficient capacity is provided for handling freight trains of the weights common on this division; that is, from 500 to 550 tons. The schedule maintained is approximately the same as with steam locomotives.

The oil engine is a four-cycle, six-cylinder Ingersoll-Rand design, developing 750 hp. at 500 r.p.m. It is of the solid-injection type, the fuel being delivered to the cylinders through a distributor which is timed to register with the power stroke of each cylinder.

750-horsepower Oil-electric Freight Locomotive Used on Putnam Division

The control provides for operating the locomotive alone, or in multiple with another of the same type. Provision is made for operating in several motor combinations.

Compressed air for the brakes is furnished by a motor-driven compressor, and lighting and control circuits are supplied by a motor-generator set together with a 32-volt, 135-ampere-hour storage battery.

PASSENGER LOCOMOTIVE

The first oil-electric locomotive to be designed for road-passenger service has also a 2-D-2-type running gear similar to the freight locomotive, but with a somewhat heavier equipment, and a 900-hp. McIntosh & Seymour oil engine.

Sufficient capacity is provided for handling the regular passenger trains over the grades of the Putnam Division. It will make the same running time as is now made by steam locomotives, and in general it is intended to duplicate their performance.

The oil engine, designed and built by the McIntosh & Seymour Corporation, is a four-cycle, air-injection Diesel of the 12-cylinder "V" type. The engine is direct-connected to the generator through special flexible couplings. Its full-load rating is 900 brake horsepower at 300 r.p.m. with a 10 per cent overload capacity.

The electric equipment includes a main generator and an auxiliary generator direct-connected to the engine, four GE-286 traction motors, control equipment, electric auxiliaries, lights, and instruments. The auxiliary generator supplies separate excitation at 250 volts for the main generator, as well as power for the auxiliaries. A regulator main-

tains practically constant voltage on this auxiliary generator throughout the range of engine speeds.

Three running combinations of the traction motors are used—series-parallel, parallel, and parallel with reduced fields. Provision is made for train-line couplers at each end of the locomotive, permitting the operation of two locomotives in multiple with the control of both from operator's position. The speed of the locomotive is regulated by the operation of the throttle, which automatically establishes the field strength of the generator which is most suited for the existing load.

For heating the train, an oil-fired steam boiler is provided similar to that now used on the electric locomotives. The 32-volt supply for lighting and control circuits is obtained from a motor-generator set driven from the 250-volt auxiliary circuit. A 150-ampere-hour storage battery, floating on the line, supplies lighting and control circuits when the engine is not in operation.

900-horsepower Oil-electric Passenger Locomotive in Service on the Putnam Division

WEIGHTS AND DIMENSIONS OF OIL-ELECTRIC LOCOMOTIVES

OIL-ELECTRIC-STORAGE-BATTERY SWITCHER

Weight locomotive complete	257,000 lb.
Weight on drivers	257,000 lb.
Traction effort 1-hour rating	34,000 lb.
Maximum tractive effort (25% coef.)	64,250 lb.
Maximum speed	40 m.p.h.
Length inside knuckles	46 ft. 8 in.
Height over cab	14 ft. 8 in.
Width over all	10 ft. 2 in.
Total wheelbase	34 ft. 1 in.
Rigid wheelbase	8 ft. 3 in.
Diameter driving wheels	44 in.
Engine	Ingersoll-Rand 300 hp.
Battery	Electric Storage Battery 680 amp. hr. (6 hr. rating)
Mechanical parts	American Locomotive Co.
Electric equipment	General Electric Co.

OIL-ELECTRIC FREIGHT LOCOMOTIVE

Weight locomotive complete	295,000 lb.
Weight on drivers	175,000 lb.
Tractive effort 1-hour rating	30,600 lb.
Tractive effort continuous	20,800 lb.
Maximum tractive effort (25% coef.)	43,750 lb.
Maximum speed	40 m.p.h.
Length inside knuckles	52 ft. 1 in.
Height over cab	14 ft. 9½ in.
Width over all	10 ft. 4 in.
Total wheelbase	42 ft. 10 in.
Rigid wheelbase	17 ft. 6 in.
Diameter driving wheels	44 in.
Diameter truck wheels	30 in.
Engine	Ingersoll-Rand 750 hp.
Mechanical parts	American Locomotive Co.
Electric equipment	General Electric Co.

OIL-ELECTRIC PASSENGER LOCOMOTIVE

Weight locomotive complete	350,000 lb.
Weight on drivers	180,000 lb.
Tractive effort 1-hour rating	28,000 lb.
Tractive effort continuous	16,000 lb.
Maximum tractive effort (25% coef.)	45,000 lb.
Maximum speed	60 m.p.h.
Length inside knuckles	59 ft. 4 in.
Height over cab	14 ft. 8½ in.
Width over all	10 ft. 0 in.
Total wheelbase	49 ft. 4 in.
Rigid wheelbase	18 ft. 6 in.
Diameter driving wheels	44 in.
Diameter truck wheels	30 in.
Engine	McIntosh & Seymour 900 hp.
Mechanical parts	American Locomotive Co.
Electric equipment	General Electric Co.