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TRAFFIC CONDITIONS OF NEW YORK CITY*

BY FRANK R. FORD

IN the vanguard of electrical invention and application, America is regarded by the world as the leader in the solution of transportation problems, and naturally its metropolis would be considered as exemplifying the most approved traction methods. The fact of its position, however, has imposed upon New York City a certain conservatism against the exploiting of untried devices and systems, together with a refusal to allow the unæsthetic overhead trolley in its central district, so that while the final result will be the best that the world has seen, there are still in evidence the horse omnibus, the horse car, and the steam locomotive for elevated railroad and tunnel service. The transportation problems of especial interest, however, are those produced by the peripatetic necessities of the workers among three and a half millions of people, wedging themselves every morning into the small business district of Manhattan Island and returning in the short space of a few hours by surface and elevated cars, by ferries and bridge, to each individual lodging place in zone upon zone of homes. And then, after the work-a-day necessities, in the summer time, the seekers of pleasure to the extent of hundreds of thousands ride to beaches and out-of-door resorts, and on Saturday afternoons and Sundays the workers and pleasure seekers combine their forces in an assault upon every available means of suburban transportation. This "commuter" travel and "pleasure" travel, as far as the surface and elevated systems are concerned, are the greatest in the world. It is estimated that at least 300,000 people travel on surface and elevated cars daily between their homes and the business district of Manhattan from 7 and 9 a. m. and from 5 and 7 p. m., and that on a clear summer Sunday 500,000 are carried by all railroad systems in the city for recreation trips.

HERALD SQUARE, MANHATTAN, WHERE 1070 SURFACE CARS PASS IN AN HOUR

With the exception of the single New York & Harlem line, which was started as a horse-car line in 1832, and which was the first street railway line in the world, the de-

* Statistics in this article do not include Richmond Borough.

velopment of the surface lines in New York City does not differ materially from that of other places. In 1835, following the opening of the Harlem road, the first stage line was started; four stages, seating ten passengers each, were run at intervals of one hour between the city and Yorkville, and thence by transfer to Harlem. In 1852 the Sixth Avenue horse railway was started in operation, with 4 miles of line; in 1854 the Third Avenue line, with 4 miles; also, in the same year, the Brooklyn City road, with 17 miles, and shortly after the Second and Eighth Avenue lines. The Fourth Avenue line was operated for a long time as a steam railroad, but the portion south of the present Madison Square Garden was changed to horse operation at about this period. By 1860, as shown in the first of the accompanying series of historical maps, there were 60 miles of these horse-car lines in operation. In 1870 this amount of track had increased, as shown, to 154 miles. The first elevated line, the Ninth Avenue, from the Battery to 30th Street, was started in the early seventies, and by 1880 practically the entire mileage of present Manhattan Elevated lines as double track was in operation. The Brooklyn Bridge began operation of its elevated line in 1883, and the Brooklyn elevated lines were started in operation in 1888. The first overhead trolley line in the limits of the present city, outside of a short line between Brooklyn and Jamaica, was started in September, 1892, the road being part of the Union Railway, in Bronx Borough. Electrical equipment in the territory now comprising Brooklyn, Bronx and Queens Boroughs was rapid after this, so that horse traction was soon almost entirely abandoned in these districts. Omnibuses on Broadway (Manhattan) were supplanted by horse cars in 1885, and these in turn by the cable system in May, 1893. The latter has just been abandoned for the electric conduit system during June of the present year. The first cable system in the city was that operated by the 125th Street and Amsterdam Avenue lines in 1885. The first electric conduit system was that on Lenox Avenue, started in operation in 1895. At present, of the 1141 miles of track in operation in the entire city, 178 miles are elevated lines

Table II.

Population of Territory now Comprising New York City.

Boroughs	1860	1870	1880	1890	1900
Manhattan ..	813,669	942,292	1,149,739	1,441,216	1,850,093
Brooklyn ..	279 122	419 921	599,495	838,547	1,166,582
Bronx	17,000	28,941	42,898	81,255	200,507
Queens	30,428	42,669	56,560	87,050	152,999
Totals....	1,140,219	1,433,823	1,848,692	2,448,068	3,370,181

Note.—Richmond Borough not included. 1860–1890 figures partly approximate.

operated by steam, 141 miles are surface electric conduit traction, 676 miles are surface overhead trolley electric traction, 5 miles are surface storage battery electric traction, 1 mile is surface cable traction, and 140 miles are surface horse traction. In addition, there are 4½ miles of route operated by electric and horse omnibuses. The passenger steam railroad mileage of route in the city is 123 miles. This is not so much of a factor in the transportation as usual, due to the fact that only one railroad runs into Manhattan Borough, one other into Bronx Borough, and one into Brooklyn and Queens, the other railroads being only accessible by ferries to New Jersey.

DEVELOPMENT

The great growth of the surface and elevated systems during the past forty years can be seen from the maps showing these systems in 1860, 1870, 1880, 1890, and by the inset map, which is of the transportation lines in 1901. These engravings were prepared from old maps and from data furnished by the railroad companies.

Table I. shows the total mileage of elevated and surface track in each borough in terms of single track. These figures and all yearly data in other tables are as reported in 1860, 1870 and 1880 to the State Engineer and Surveyor, and from 1890 to 1901 to the New York Board of Railroad Commissioners. The figures for the Brooklyn Bridge elevated line were obtained from the chief engineer, and all data for the exact subdivision of Brooklyn elevated and surface lines in 1899, 1900 and 1901 from the auditor of the Brooklyn Rapid Transit Company. All statistics in this and other tables before 1890 cover fiscal years to Sept. 30, and subsequently to June 30. The figures from 1860 to 1899 represent the relative increase closely, although they are in many instances not absolutely correct, due to the practice of the companies of reporting track operated instead of track owned and leased, thus duplicating the latter. In 1900 and 1901, however, the reports for the franchise tax assessment required more accurate returns, so that the figures for these years are correct. Where one line is operated in two boroughs it is included in the one containing the most trackage. The greatest increase shown in any one year was 130 miles, in 1896, due largely to the building of the Nassau lines in Brooklyn, now part of the Brooklyn Heights system. During the past thirty years the total track mileage has averaged about 50 per cent increase for each decade.

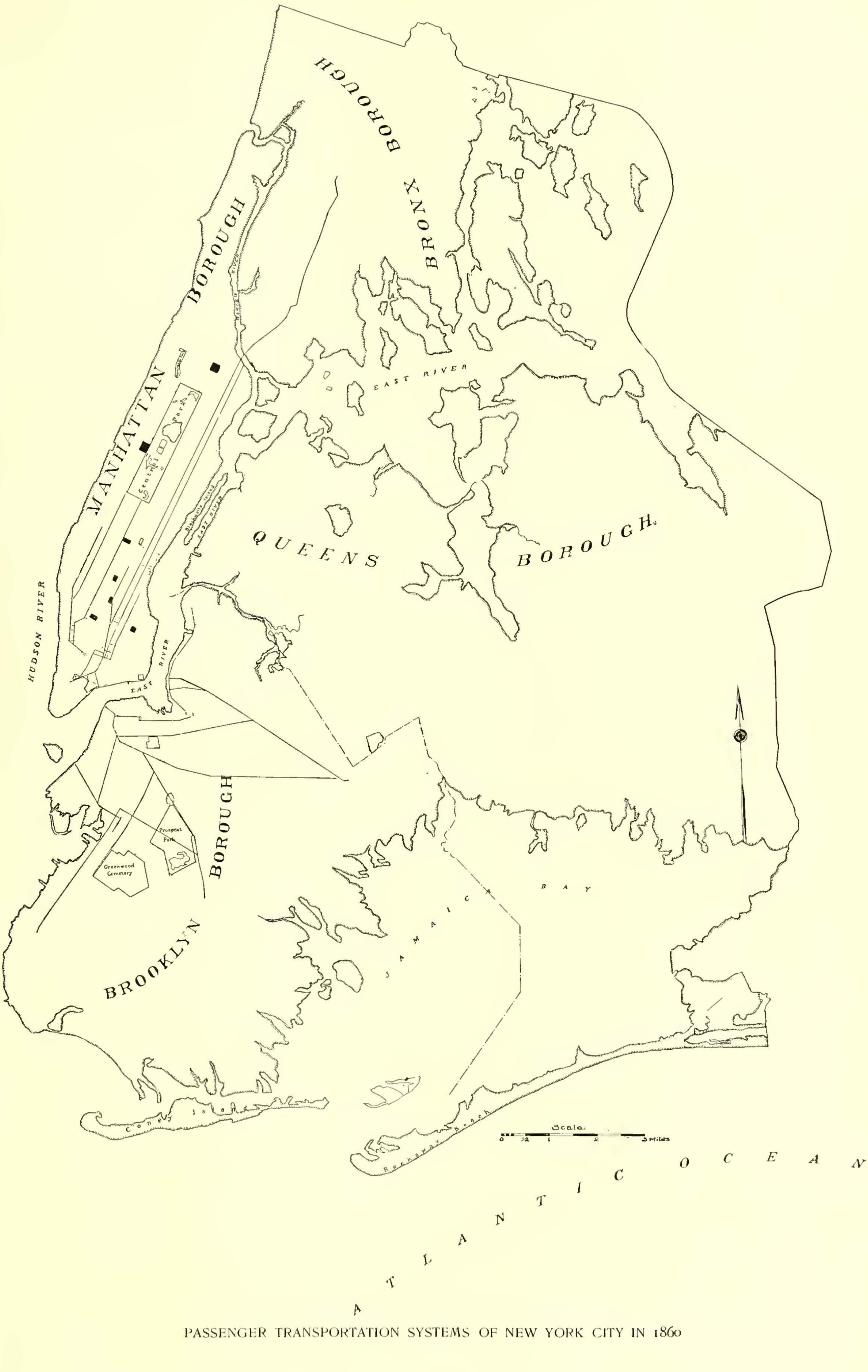
Table I.

Total Miles of Track.

	Surface Lines					Elevated Lines			
	Manhattan *	Brooklyn	Bronx	Queens	Total	Manhattan	Brooklyn † ‡ a	Total	Grand Total
1860	60	72			132				132
1870	154	178	10		342				342
1880	179	284	15	19	497	79		79	576
1890	247	302	21	39	609	94	61	155	764
1891	257	314	21	44	636	100	61	161	797
1892	272	320	21	43	656	100	60	160	816
1893	272	337	24	46	679	100	60	160	839
1894	283	337	28	46	694	100	67	167	861
1895	308	335	31	48	722	102	69	171	893
1896	336	419	48	49	852	102	69	171	1,023
1897	320	427	56	91	894	102	76	178	1,072
1898	307	450	65	92	914	109	76	185	1,099
1899	296	477	65	92	930	110	74	184	1,114
1900	282	502	70	98	952	110	68	178	1,130
1901	283	504	73	103	963	110	68	178	1,141

* On account of two or more companies reporting the same track on certain streets, the mileage given prior to the year 1900 is inaccurate. † Includes Brighton Beach Line to Flatbush, 1897–1899, subsequently included under Surface Lines. ‡ Includes Sea View Line, 1890–1898, subsequently included under Surface Lines. *a* Includes Brooklyn Bridge Elevated Line.

The population included in the district now covered by New York City increased, as shown by Table II., from 1,140,219 in 1860 to 3.370,181 in 1900. During the same time, as shown by Table III., the annual number of passengers carried increased from 50,830,173 to 1,124,432,660.



PASSENGER TRANSPORTATION SYSTEMS OF NEW YORK CITY IN 1860

It is interesting to note that since 1870, while the population increased about one-third for each decade, the total number of passengers nearly doubled during each similar

Table III.

Passengers Carried Per Year. †

	Surface Lines					Elevated Lines			Grand Total
	Manhattan	Brooklyn	Bronx	Queens	Total	Manhattan	Brooklyn *	Total	
1860	38,455,242	12,374,931	... .	....	50,830,173	....	....	....	50,830,173
1870	111,007,498	36,537,175	1,038,014	....	148.582,687	....	....	....	148,582,687
1880	148 615,107	75,208,691	1,792,995	1,052,380	226,669,173	60,831,757	. ...	60,831,757	287,500 930
1890	217,819,887	107,222,538	3,394.726	2 976,185	331,413,336	190,024,848	81,686,166	271,711,014	603,124,350
1891	226,248,245	115,261,992	3,560,370	3,346,196	348,416,803	201,202,518	89,862,350	291,064,868	639,481,671
1892	232,846,607	123,303,283	3,731,930	3,778,063	363,659,883	213,692,745	94,426,871	308,119,616	671,779,499
1893	233,300,301	137,715,699	6,510,126	4,024,673	381,550,799	221,407,197	100,181,372	321,588,569	703,139,368
1894	242,159,667	142,535,644	9,538,175	4,267,837	398,501,323	202,751,532	90,162,483	292,914,015	691,415,338
1895	285,926,558	153 420,479	8,774,252	4,768,808	452,890,097	187,614,985	97,378,890	284,993,875	737,883,972
1896	343,539,503	172,115,126	10,562,496	7,086,017	533,303,142	184,703,636	94,679,121	279,382,757	812,685,899
1897	385,097.830	200,185,819	12,049,137	8,373,496	605,706,282	182,964,851	90,240,073	273,204,924	878,911,206
1898	429,229,886	217,410,612	23.327,664	9,999,121	679,967,283	183,360,846	82,774,107	266,134,953	946,102,236
1899	504,298,052	216,704,139	22,010,420	10,727,440	753,740,052	174.324.575	57,650,084	231,974,659	985,714,711
1900	533,092,114	243 214,554	27,4 9.589	12,855 104	816,661,361	184,164,110	66,964,803	251,128,913	1,067,790,274
1901	550,610,435	271,588,153	36,514,321	13,086,649	871,799,558	190,045,741	62,587,361	252,633,102	1,124,432,660

* Includes Brooklyn Bridge Elevated Line. † Includes Transfers

period. The yearly increases of surface passengers have been nearly continuous. The maximum of elevated passengers in Manhattan was reached in 1893, due to the subsequent electrical equipment of the surface lines. The overflow from the crowded facilities of the latter, however, has returned to the elevated line, so that a steady increase is again being shown. The Brooklyn elevated lines also show a maximum in 1893. The large decrease in passengers for 1899 is explained by the operation of the Brooklyn Bridge elevated line by the Brooklyn Elevated Company with a free transfer, thus eliminating from the enumeration the passengers previously thus transferred. In a few instances in this and similar tables where reports have been incomplete in the earlier years, the figures have been approximated. "Passengers" in all cases include transfer passengers.

Table IV.

Surface Car Miles Operated Per Year.

	Manhattan	Brooklyn	Bronx	Queens	Total	Per Mile of Track
1860	*8,6-4,771	3,695,058	....	....	12,369,829	93,700
1895	46,463,765	29 853,408	2,013,739	1,255,387	79,586,299	110,200
1896	53,094.371	37,743,976	2,702,742	2,096,226	95,637,315	112,300
1897	55,594,518	41,455,869	3,213,284	2,257,946	102,521,617	114.700
1898	56,034,581	43,321,946	3,664,997	2,776,311	105,797,835	115.800
1899	59,878,684	45,868,421	4,025,891	2,898,417	112,671,413	121,10)
1900	60,642,057	43,824,960	4,828,243	3,066,444	112,361,704	118,000
1901	59,092,853	42,274,503	5,836,587	3,353,968	110,557,911	114,800

*No reports between 1860 and 1895.

Table V..

Elevated Train Miles Operated Per Year.

	Manhattan	*Brooklyn	Total	Per Mile of Track
1880	5,484.523	....	5,484.523	69,400
1890	8,083,520	4.290,403	12,373,923	79,800
1891	8,691,994	4,385,999	13,077,993	81,200
1892	9.106,870	4.356,450	13,463,320	84,100
1893	9,170,940	4,485,682	13,656,622	85,400
1894	9,026,586	4,874,938	13,901,524	83,200
1-95	9,275,558	5,388,082	14,663,640	85,800
1895	9 827,702	5,276,238	15,103,940	88,300
1897	9.910,965	5,287,628	15,198,593	85,400
1898	10,032,003	5,619,498	15,651,501	84,600
1899	10,205.773	5.388,773	15.594,546	84,700
	Car miles	Car miles	Car miles	Car miles
1900	44,878,601	16,900,186	61,778,787	347,000
1901	a44.500,000	14,314,986	58,814,986	330,000

*Includes Brooklyn Bridge Elevated Cars. a Approximate.

The surface car miles operated per year, as per Table IV., show a steady increase in Bronx and Queens Boroughs, due to the large increase in the suburban business. In Brooklyn and Manhattan the increase is continuous until 1899 and 1900, when a distinct saving is indicated, due largely to the economies of consolidation and to the use of larger cars.

Table V. demonstrates that it was necessary to increase the elevated train miles operated, due to surface line competition, even when the number of passengers decreased. Table VI. shows the large increase of passengers per mile of track, largely resulting from the electrical equipment of horse-car lines. The increase in number of passengers per car mile is due partly to the same cause. It is of interest to note that in 1901 the passengers per surface car mile are practically double those per elevated car mile, which demonstrates clearly the profitable nature of the short-haul business.

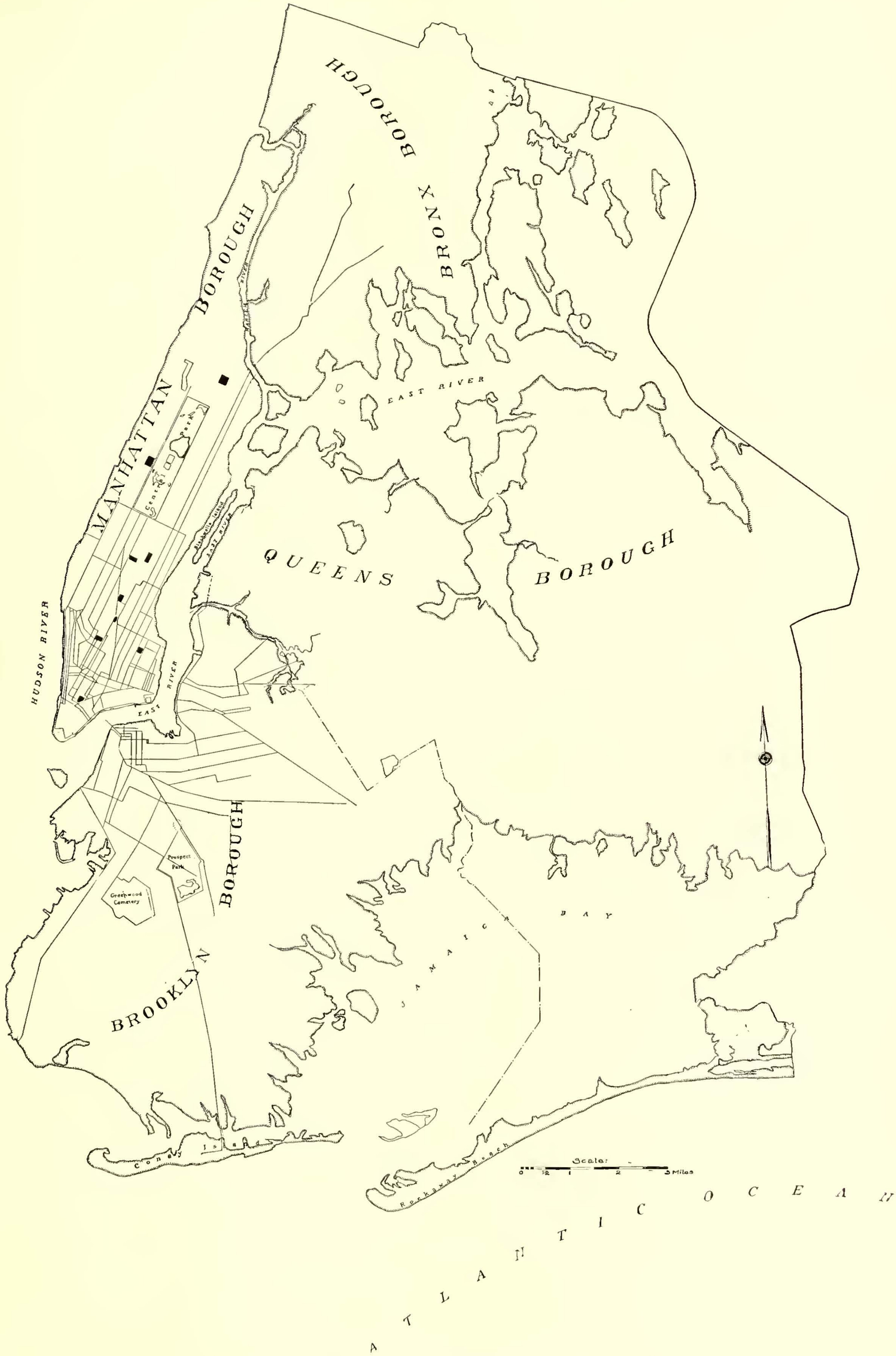
Table VI.

Passengers Carried Per Year, Per Mile of Track, Per Car Mile, and Per Train Mile.

	Per Mile of Track			Per Surface Car Mile	Per Elevated Train Mile*
	Surface	Elevated	Total		
1860	385,000	......	385,000	4.1	..
1870	434,000	......	434,000	..	..
1880	456,000	770,000	499,000	..	11.1
1890	546,000	1,753,000	789,000	..	21.9
1891	548,000	1,808,000	802,000	..	22.3
1892	554,000	1,926,000	862,000	..	22.9
1893	562,000	2,009,000	838,000	..	23.5
1894	574,000	1,754,000	803,000	..	21.1
1895	627,000	1,667,000	826,000	5.7	19.4
1896	626,000	1,634,000	794,000	5 6	18 5
1897	678,000	1,535,000	820,000	5 9	17 9
1898	744,000	1,438,000	661,000	6.4	17.0
1899	810,000	1,261,000	885,000	6.7	14.9
					Per Car Mile
1900	858,000	1,411,000	945,000	7.3	4 1
1901	905,000	1,419,000	985,000	7.9	4.0

* Includes Brooklyn Bridge Elevated line.

From Table VII. it will be seen that the rides per capita for all systems have more than doubled in the past twenty years, so that in 1900 the total rides per capita are equiva-



PASSENGER TRANSPORTATION SYSTEMS OF NEW YORK CITY IN 1870

lent to a ride each week day of every man, woman and child in the city. Table VIII. shows that Brooklyn has been overbuilt as compared with the rest of the city, the Bronx even containing more population per mile of track. Five times as many car miles are operated per capita in 1900 as in 1860, as shown in Table IX., thus vastly increasing the popular convenience.

FARES

The great increases shown in these tables are due principally to three causes—the extension in mileage, the added

Table VII.

Rides Per Capita Per Year.

	1860	1870	1880	1890	1900
Surface Lines					
Manhattan	47	118	129	151	288
Brooklyn	44	88	126	128	209
Bronx	....	36	42	42	138
Queens	....	....	11	34	84
Total	45	104	122	135	242
Elevated Lines					
Manhattan	....	....	53	132	100
Brooklyn	....	....	....	97	57
Total	....	....	33	111	75
Grand Total	45	104	155	246	317

conveniences in equipment and speed, and reduction in fare. In 1835 the stage fare from the City Hall to Harlem was 25 cents; in 1880, on the Eighth Avenue line, 5 cents was

Table VIII.

Population Per Mile of Track.

	1860	1870	1880	1890	1900
Surface Lines					
Manhattan	13,561	6,119	6,423	5,835	6,561
Brooklyn	3,877	2,359	2,111	2,777	2,324
Bronx	....	2,894	2,859	3 869	2,864
Queens	....	....	2,977	2,232	1,561
Total	8,638	4,192	3,720	4,020	3,540
Elevated Lines					
Manhattan	....	....	14,553	15,332	16,819
Brooklyn	....	....	...	13,747	17,156
Total	....	...	23,401	15,790	18,930
Grand Total	8,638	4,192	3,210	3,204	2,982

charged south of Fifty-First Street and 5 cents additional north of that point.

In 1900 the average fare on surface and elevated lines for the entire city was 3.87 cents per passenger (including transfers). All elevated lines charge 5 cents fare. This fare includes in the Brooklyn system a free transfer across the Brooklyn Bridge. It is now possible for a passenger to ride from South Ferry to Fort George by surface line, 12 miles, for 5 cents, and from the Manhattan City Hall, without change, to Coney Island, 11 miles by one line, for 5 cents on week days. This latter charge is 10 cents on this line on Sundays and holidays, and by all other lines is 10 cents daily. Free transfers at practically all principal intersecting points are issued by the lines of each surface system, and at the suburban terminals of the Brooklyn elevated system to surface lines, while 3-cent transfers are issued between the Manhattan Elevated and Third Avenue surface systems. The 5-cent limit in Manhattan extends to the Harlem River on the surface system, and beyond to the limits of the city the fare is 5 cents. On the Manhattan Elevated system 5 cents is charged for the ride from South Ferry to Fordham, a distance of 13 miles.

In Brooklyn the fare on surface or elevated and surface lines from Manhattan City Line to Corona, Jamaica, Kings Highway or Twenty-Second Avenue is 5 cents, and beyond to the terminals at Flushing and Coney Island is 5 cents additional. The fare by various East River ferries is 2 and 3 cents, except on the shorter lines between 5 and 7:30 a. m and 5 and 7:30 p. m., when it is 1 cent. The fare across Brooklyn Bridge by elevated line is 2½ cents. In Queens the fare from the Long Island ferry terminals to

Table IX.

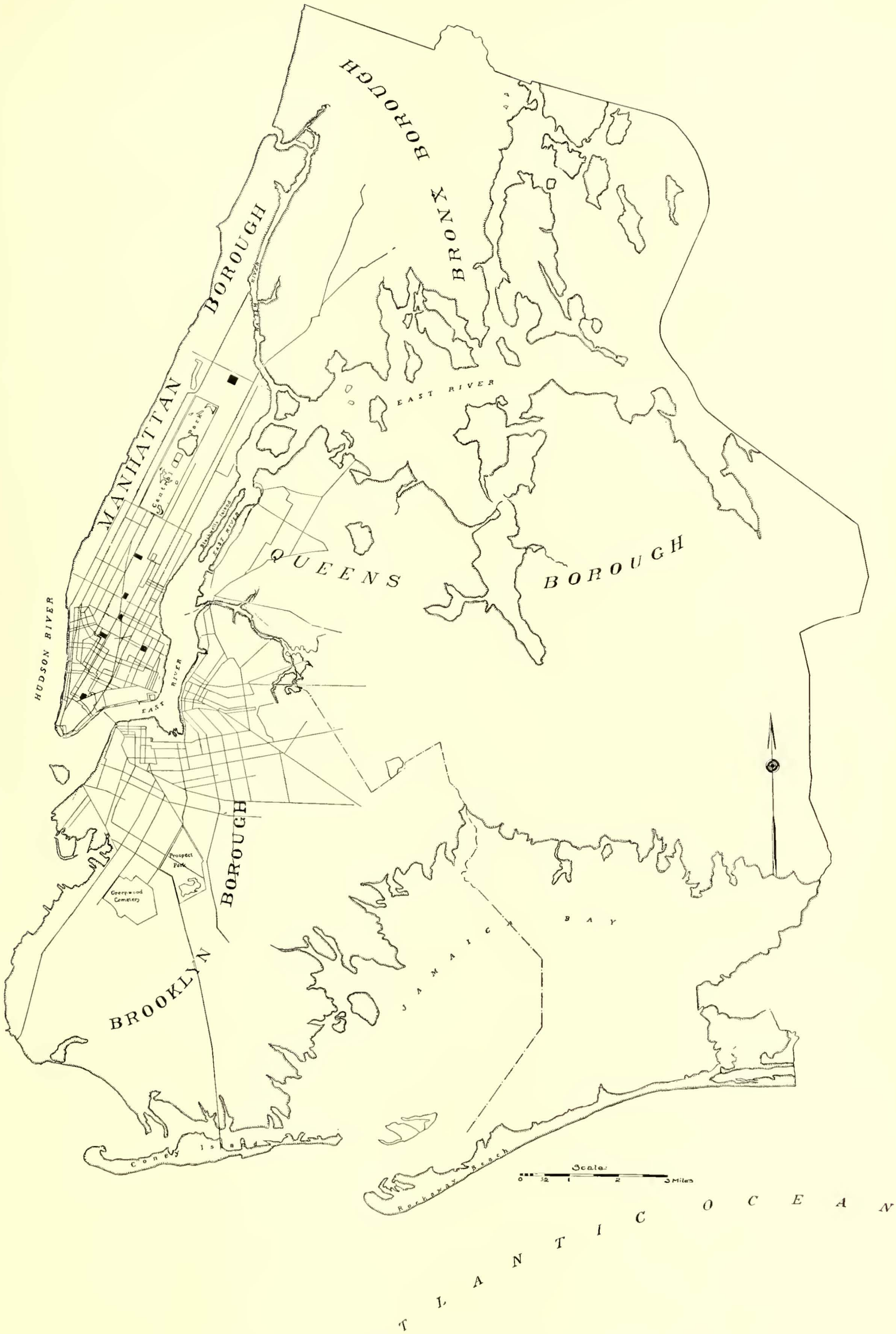
Car Miles Operated Per Capita.

	1860	1900
Surface Lines.		
Manhattan	10.7	32.8
Brooklyn	13.2	37.6
Bronx	....	24.2
Queens	....	20.0
Total	10.8	33.3
Elevated Lines.		
Manhattan	....	24.3
Brooklyn	....	14.5
Total	....	18.4
Grand total	10.8	51.7

Flushing and College Point is 5 cents, and beyond to Jamaica 5 cents, with an additional 5 cents to Far Rockaway, a total distance of 24 miles for 15 cents, which is the longest line under one company's control in the city.

ORGANIZATION OF COMPANIES

This reduction in rates of fare has been made possible by the process of centralization of ownership of these systems, which has been continuous since the first purchases for control of the Manhattan surface systems by the Widener-Elkins Syndicate, assisted locally by the Whitney-Ryan interests. The first purchases were in 1885 of the Chambers Street line and the Houston Street, West Street & Pavonia Ferry Railway Company, and the control of company after company was secured to form first the Metropolitan Traction Company, and finally the present Metropolitan Street Railway Company. A continual contest for supremacy was waged with the Third Avenue Railroad Company, until practically all surface lines in Manhattan and the Bronx were controlled by one or the other. Poor management in the financing and electrical equipment of the Third Avenue Railroad cable system threw this company into difficulties, and eventually, in 1900, a controlling interest was secured by its rival. At the present time all surface lines in Manhattan and all in the Bronx, with one insignificant exception, are controlled by the Metropolitan Street Railway Company. Similarly, all elevated lines in these boroughs are controlled by the Manhattan Railway Company, owned largely by the Gould and Sage interests, and all steam suburban passenger railroad lines by the New York Central & Hudson River Railroad Company and the New York, New Haven & Hartford Railroad Company.



PASSENGER TRANSPORTATION SYSTEMS OF NEW YORK CITY IN 1880

In Brooklyn Borough the consolidation of the surface lines began with the acquirement in 1895 by the Brady interests of a number of lines, which were placed under the control of the Brooklyn City Railroad. This company was later leased to the Brooklyn Heights Railroad Company. Shortly afterward the Johnsons acquired the Atlantic Avenue Railroad, which was united to their Nassau system, then under construction. The resulting competition was so energetic as to compel the purchase and consolidation of this line with the Brooklyn City Railroad in 1900; this consolidation forming the present Brooklyn Rapid Transit Company. The control of the two elevated railroad systems was obtained in 1899, together with some of the minor surface branches of the Long Island Railroad running to Coney Island; and in 1898 the right was obtained to operate the Brooklyn Bridge elevated cars, and to run surface and elevated cars on the Bridge to Park Row, Manhattan Borough. The Long Island Railroad, Flower and Vanderbilt interests are also identified with this property. There are two other independent surface lines, the Coney Island and Brooklyn Railroad, and another small line.

In Queens Borough the two principal systems, the New York & Queens County Railway and the New York & North Shore Railway, are controlled by the Shelmerdine-Matthews interests. The other surface line at Rockaway Beach is operated by the Long Island Railroad Company. The steam surface lines in Brooklyn and Queens are controlled by the Long Island Railroad, which is in turn controlled by the Pennsylvania Railroad Company. The principal East River ferries are controlled by the Union Ferry Company, the Brooklyn & New York Ferry Company and the Long Island Railroad Company.

Table X. shows the relative proportions of these various systems of surface and elevated lines, and the totals suggest interesting possibilities for the future.

TABLE X.

INDEPENDENT SURFACE AND ELEVATED LINES OF NEW YORK CITY, YEAR ENDED JUNE 30, 1901.

	Miles of Track Owned and Leased	Power Houses	Car Houses or Yards	Maximum Cars Operated during Average Busy Day	Passengers for Year	Car Miles for Year
Manhattan						
Metropolitan Street Railway Co.	283	2	24	2,143	550 610,435	59,092 853
Manhattan Railway Co. (Elevated)	110	0	7	1,089	190,045,741	*44,500,000
Total	393	2	31	3,232	740,656,176	103,592,853
Brooklyn						
Brooklyn Rapid Transit Co. (Surface)	454	6	15	1,287	234,500,337	35,840,939
Brooklyn Rapid Transit Co. (Elevated)	68	0	9	559	62,857,361	14,314,986
Coney Island and Brooklyn Railroad Co.	47	3	5	230	35,489,353	6,209,719
Van Brunt Street and Erie Basin Railroad Co.	3	0	2	6	1,598,463	222,821
Total	572	9	31	2,082	334,175,514	56,588,465
Bronx						
Metropolitan Street Railway Co.	70	1	2	155	36,211,950	5,776,927
City Island Railroad Co. } Pelham Park Railroad Co. }	3	0	1	10	302,371	59,660
Total	73	1	3	165	36,514,321	5,836,587
Queens						
New York and Queens County Railway Co. } New York and North Shore Railway Co. }	102	2	4	125	12,980,397	3,341,046
Ocean Electric Railway Co.	1	1	1	2	106,252	12,922
Total	103	3	5	127	13,086,649	3,353,968
Grand Total	1,141	15	70	5,606	1,124,432,660	169,371,873

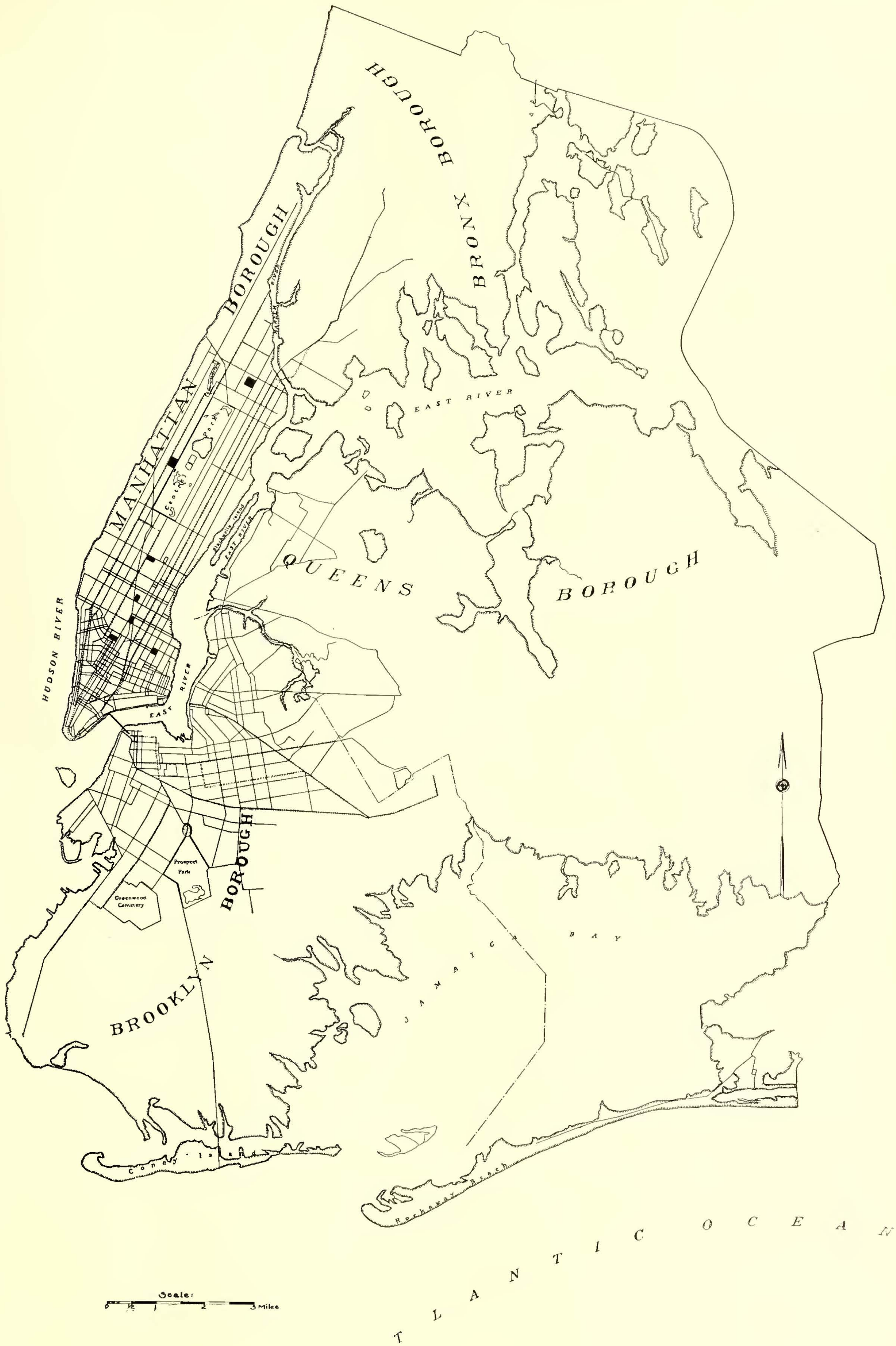
*Approximate

NEW CONSTRUCTION AND EQUIPMENT

The Rapid Transit Subway Construction Company, which is owned by the Belmont-Vanderbilt-Long Island Railroad interests, has now under construction the "Subway," or underground railroad, from the Manhattan City Hall to Kingsbridge, with an East Side branch to Fordham, as shown by the inset map. This work is under contract to be completed by Aug. 24, 1904. There will be four tracks from a loop at the City Hall to 104th Street, and thence three tracks to Washington Heights, and two beyond to Kingsbridge, and also two tracks on the East Side branch. The rights are now being obtained for an extension from the City Hall under Broadway to the foot of Whitehall Street, thence under the East River and Joralemon Street to a loop at the Brooklyn City Hall, and thence under Fulton Street and Flatbush Avenue to the Flatbush Avenue station of the Long Island Railroad, where connection will be made with the Long Island Railroad tracks. Another underground connection with the "Subway" is proposed by the Long Island Railroad from Long Island City under the East River, and thence under Thirty-Third Street (with a connecting station under the "Subway" at Fourth Avenue) to Seventh Avenue, and thence under Seventh Avenue to Broadway, with a track connection there with the "Subway."

A second East River bridge is now being built from Delancey Street, Manhattan, to South Fifth Street, Brooklyn, to accommodate the present Grand Street-Broadway ferry traffic. A third bridge at Pike Street, Manhattan, to Washing Street, Brooklyn, and a fourth at Fifty-Ninth Street, Manhattan, to Ravenswood, Queens, with a pier on Blackwell's Island, are under contract. These bridges and tunnels to Brooklyn and Queens will largely relieve the excessive congestion on the present bridge.

In Manhattan Borough all horse lines of the Metropolitan Street Railway are gradually being equipped with



PASSENGER TRANSPORTATION SYSTEMS OF NEW YORK CITY IN 1899

the electric conduit system. The Seventh Avenue line and the Eighth Street line are now under such reconstruction. Compressed air motors have been tried unsuccessfully on some of the crosstown lines, and experiments are now being carried on with storage battery cars. The short Montague Street Line in Brooklyn is the only remaining cable line in the city. The Manhattan Railway lines will abandon their steam locomotives for the third-rail electric system, beginning with the Second Avenue line, which is expected to make the change early in 1902, and the entire reconstruction is expected to be completed by the end of next year.

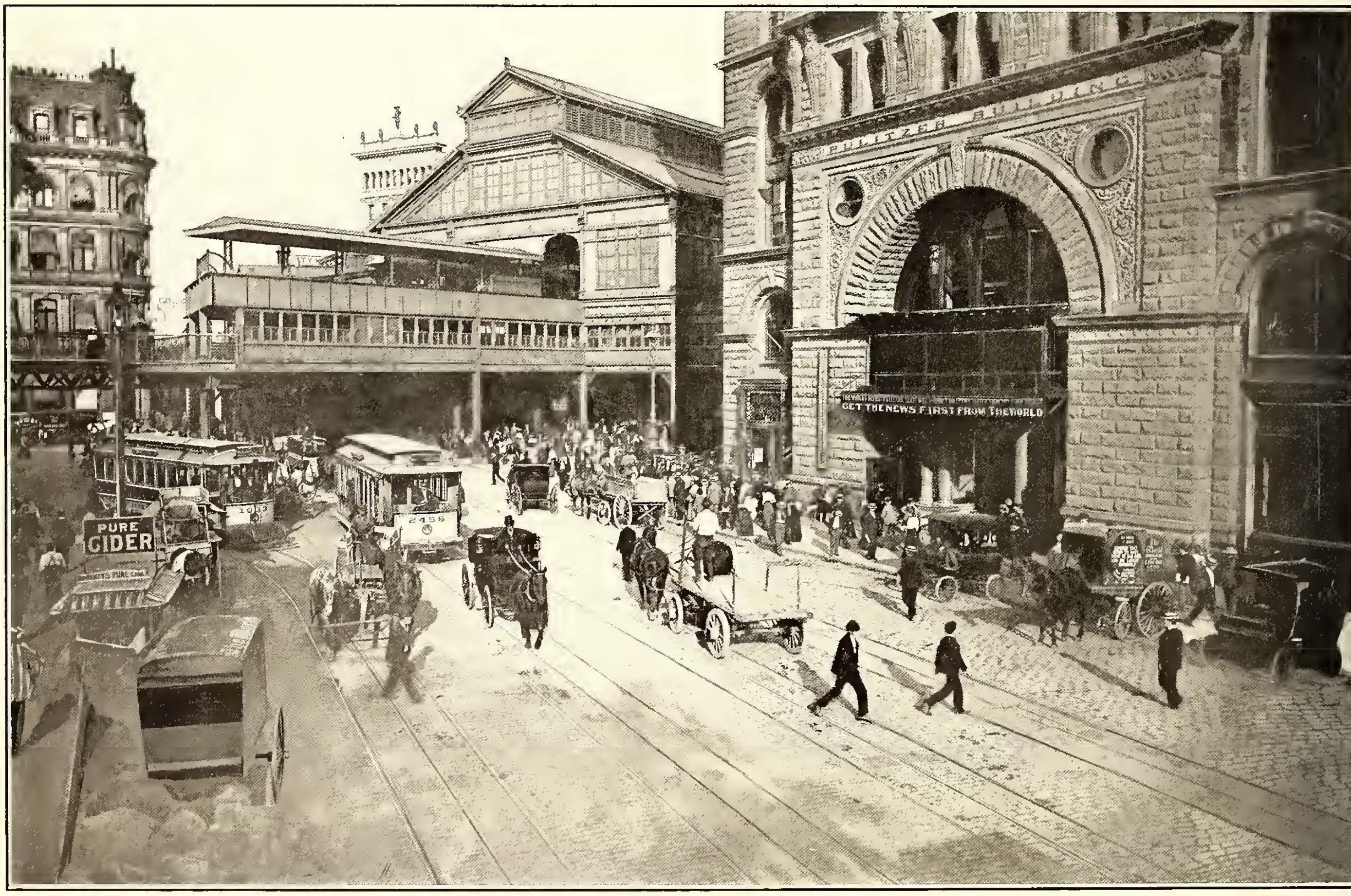
On the other side of the city, it has been announced that the unfinished Hudson River tunnel from Fifteenth Street, Jersey City, to Christopher Street, Manhattan, has been refinanced, and will shortly be completed. Renewed agitation on the part of the steam railroads terminating in Jersey City for a Hudson River Bridge, to cross the river between Twenty-Third Street and Forty-Second Street, apparently has secured sufficiently substantial backing to render it a probability in the near future. This bridge will be designed both for suburban and trunk line steam railroad service, and for surface electric cars.

TRAFFIC DISTRICTS

To understand the intricate traffic problems of New York City it is necessary to consider present conditions which make this situation unique among the cities of the world.

The Boroughs of the Bronx and Queens are the most sparsely settled with populations, respectively of 4932 and 1181 per square mile, and here the street railway facilities can well keep pace with the traffic offered. The summer excursion or pleasure travel is developed to large proportions, and with sufficient advertising presents almost unlimited possibilities to attract patrons from an adjacent clientele of over 3,000,000. The Boroughs of Manhattan and Brooklyn have populations respectively of 1,850,093 and 1,166,582, or 84,363 and 15,029 per square mile, with a large floating population in Manhattan, composed of visitors and suburban residents.

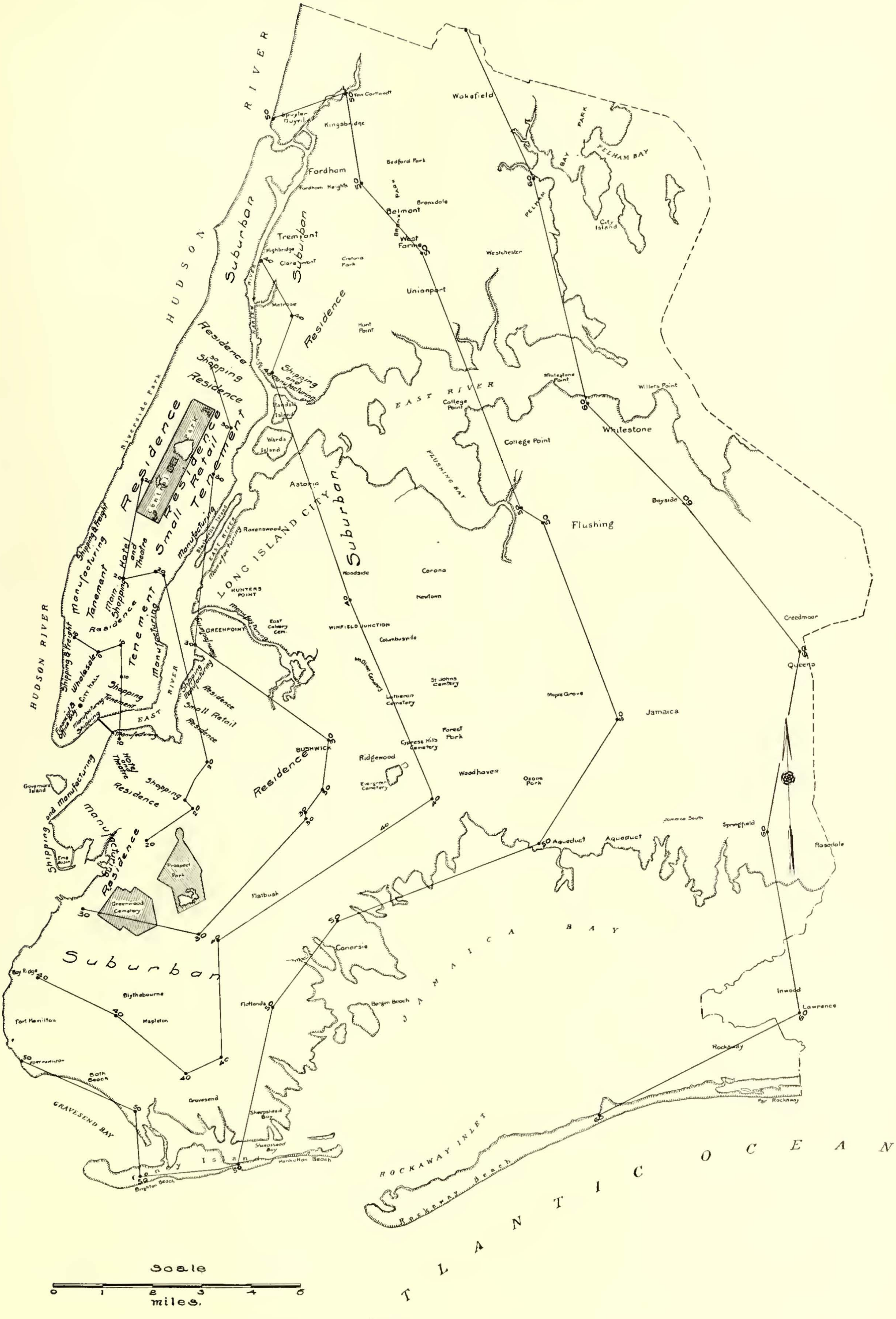
The approximate locations of the various traffic districts in these boroughs are shown on the map on the opposite page. Manhattan Borough, below Fourteenth Street, is practically all devoted to business, and into this triangle of about 3 square miles there is daily crowded the business workers of the Greater City, including its New Jersey suburbs to the west. These latter, however, are widely distributed, and well served by numerous ferries, so that the greatest congestion on Manhattan Island occurs from the north, on account of its desirability for metropolitan residence, and on the one all-land route to Brooklyn.



THE MANHATTAN TERMINUS OF THE BROOKLYN BRIDGE

The transportation problem is essentially one depending upon the peculiarities of human nature. For a daily performance, a person will submit to nearly any inconvenience, to almost unbearable overcrowding on surface lines, to the disagreeable features of tunnels or of tiresome stair climbing to steam elevated lines for the privilege of a continuous ride between home and business. It is to this fact, and also to the peculiar physical configuration of the city that the immense traffic in Manhattan and upon the Brooklyn Bridge is due.

Manhattan Island, which formerly comprised New York



TRAFFIC DISTRICTS AND RAPID TRANSIT LINES OF NEW YORK CITY

City, is about 13 miles long, with an average width below 155th Street of 2 miles. Apart from its elongated shape, the location of the traffic districts for delivery of passengers are in many respects conducive to a steady business. Each of the several business districts, such as those devoted to shopping, hotels, wholesale business and office buildings, instead of being co-extensive, as in most large cities, is distinct. Each occupies a zone largely to itself, and thus subdividing the terminals of the long-haul traffic provides a large amount of short-haul business for all transportation lines. It has been stated that the Sixth Avenue Manhattan elevated line averages one and a half passengers per seat for each single trip, and the Broadway surface line, from Fifty-Ninth Street to South Ferry, three passengers per seat per single trip; the latter has probably the greatest proportion of short-haul traffic on any surface line.

The financial and office building district of Manhattan, the business center of the country, occupies the inverted triangle bounded on the North by Chambers Street, the base of which is 1 mile, and the height 1 mile. Property in this half square mile is so valuable as to force a continuous increase in the height of buildings, the present maximum being thirty stories. The narrow, old-fashioned streets in this part of the city contract the terminal facilities of the surface and elevated lines to four main arteries of travel, which feed its center. This congestion practically prohibits crosstown travel, involving a half-mile walk from ferry terminals to the center, to the further disadvantage of the New Jersey suburbs and Brooklyn ferry routes.

North of Chambers Street are the great wholesale business districts for the distribution of the imports of Europe and the manufactures of the Eastern United States. On the North and East Rivers in this zone are the principal shipping terminals of the great steamship lines, for foreign and domestic trade respectively. Along both waterways are the passenger ferries to nearby boroughs and suburbs, the terminals of the Western and Southern railroad trunk lines. In this section is also the great East Side tenement district, east of Center Street and Elm Street, a human beehive of small industries. The mass of people located here, however, is probably the least remunerative per capita, from a traffic standpoint, of any in the city, as the distances of necessary travel are the shortest and the amount of wealth the smallest.

From Fourteenth Street to Twenty-Third Street, between Fourth Avenue and Seventh Avenue, is the great retail shopping district, the delivery point of a large, profitable midday travel. This district is now being extended to Thirty-Fourth Street and Broadway by the building at that point of two immense department stores. From Twenty-Third Street to Fifty-Ninth Street are the hotel, club and theatre districts, interdependent and tending to center about Forty-Second Street, although at present centering at Thirty-Fourth Street.

The residence district begins at Eighth Street and Fifth Avenue, mixed with and surrounding the other traffic districts north to Fifty-Ninth Street, and thence spreads out on each side of Central Park to 155th Street, where the solidly built-up section ends. The position of Central Park for outdoor recreation is most central and convenient to this district. West of Sixth Avenue and Broadway, and south of Sixty-Eighth Street is the cheaper apartment and tenement district on the West Side, and the section east of Third Avenue on the East Side is similarly devoted. The Harlem district north of 110th Street and Central Park is almost entirely given over to apartment houses of the cheaper class, and this part of Manhattan is growing faster than any other section. The population of Manhattan and Bronx Boroughs north of 110th Street amounted, in 1900, to over 475,000. The extreme upper portion of Manhattan Island north of 155th Street, including the most beautiful and picturesque part of the city, will be opened to development by the construction of the "Subway" through Washington Heights, and the surface Kingsbridge Road line.

In addition to the main shopping district mentioned, all the north and south avenues south of Fifty-Ninth Street are largely given over to retail trade, as are those on which are located elevated roads north of Fifty-Ninth Street. The same is true of the principal cross streets, Forty-Second Street, Fifty-Ninth Street and 125th Street.

MANHATTAN SURFACE LINES

The main surface travel north and south is carried by electric lines on two streets from South Ferry to City Hall, thence on four streets north to Fourteenth Street. Thence it branches out to seven lines north to Fifty-Third Street, and thence to eight lines to Harlem. South of Fourteenth Street there are numerous short cross lines operated by horse traction. North of Fourteenth Street are crosstown lines between the two rivers at Twenty-Third Street, Twenty-Eighth Street and Twenty-Ninth Street, Thirty-Fourth Street, Forty-Second Street, Fifty-Ninth Street, Eighty-Sixth Street, 116th Street and 125th Street, mostly operated by electric traction. These were formerly unimportant, but with the institution of free transfers to the north and south lines their business has increased to enormous proportions.

The large inset map shows the location of the various Manhattan lines, with the method of traction, and the car distribution maps of these lines in one inset show graphically the distribution of cars on all Manhattan lines during the rush hour. It will be noted from the map of the surface lines that the maximum car movement is upon the Broadway line from South Ferry to Fifty-Third Street, and on the Fourth Avenue line from the City Hall to Eighty-Sixth Street, while the busiest crosstown lines are shown to be those on Fourteenth Street, Twenty-Third Street, Thirty-Fourth Street and Fifty-Ninth Street. The difficult points in the handling of this car movement are at the downtown terminals of the busy lines, which are not provided with loops, and at the intersections of busy north and south with east and west lines. South Ferry is the terminal of the Eighth Avenue, Sixth Avenue and Broadway lines, and it is here that the greatest terminal congestion occurs.

Table XI. gives the busiest Manhattan surface intersections. The maximum number of cars passing a given intersection in one hour is at Sixth Avenue, Broadway and Thirty-Fourth Street, with 1070 cars. The intersection of Fourth Avenue and Twenty-Third Street, while there are fewer cars, is more troublesome, however, because the number of cars is more evenly divided between the north and south and east and west lines. The Columbus Circle crossing at Eighth Avenue and Fifty-Ninth Street, and that at Twenty-Third Street and Broadway are also busy points. It is really the capacity for passing cars at these intersecting points which principally determines the capacity of the north and south lines.

VIEW AT THE CORNER OF BROADWAY AND PARK ROW, THE SOUTHERN TERMINUS OF THE FOURTH AND THIRD AVENUE LINES

The management states, however, that owing to special experience which has been obtained by the car operators in passing cars, a reduction of the headway has been effected several times, after what had been considered the maximum number of cars on the line had been reached. Increased capacity for passenger movement has also been obtained by the electrical equipment of the cable lines and by the use of large double-truck cars in place of single-truck cars.

Table XI.

Busiest Surface Track Intersections.

	Headway	Car Movement in Busiest Hour, Sept. 9, 1901
Fourth Avenue and 23d Street, Manhattan. (Two Tracks Crossing Two Tracks.)	Seconds	Cars
Fourth Avenue, Northbound	24	150
Fourth Avenue, Southbound	27	135
Total North and South Bound		285
23d Street, Eastbound (including Lexington Ave. Cars)	17	210
23d Street, Westbound (including Lexington Ave. Cars.)	18	200
Total East and West Bound		410
Grand total at Intersection		695
Broadway, Sixth Avenue and 34th Street, Manhattan. (Four Tracks Crossing Two Tracks, Triangular Crossing.)		
Broadway, Northbound	14	250
Broadway, Southbound	15	240
Sixth Avenue, Northbound	15	240
Sixth Avenue, Southbound	17	210
Total North and South Bound in Four Tracks		940
24th Street, Eastbound	55	65
34th Street, Westbound	55	65
Total East and West Bound in Two Tracks		130
Grand Total at Intersection		1,070
Eighth Avenue and 59th Street, Manhattan. (Two Tracks Crossing Two Tracks.)		
Eighth Avenue, Northbound	50	72
Eighth Avenue, Southbound	50	72
Total North and South Bound		144
59th Street, Eastbound	30	120
59th Street, Westbound	30	120
Total East and West Bound		240
Grand Total at Intersection		384
Fulton Street and Adams Street, City Hall Square, Brooklyn. (Two Tracks Crossing Two Tracks Diagonally with Curves on One Line at Each Side of Intersection.)		
Adams Street, Northbound	31	115
Adams Street, Southbound	31	115
Total North and South Bound		230
Fulton Street, Eastbound	13	284
Fulton Street, West bound	13	284
Total East and West Bound		568
Grand Total at Intersection		798

Table XII. shows the maximum passenger movement on three of the busiest north and south lines, the Broadway, Fourth Avenue and Eighth Avenue lines, and on the busiest crosstown line, the Twenty-Third Street line. The figures are for the busiest year, that ending June 30, 1901; and the busiest day, Dec. 24, 1900. Dewey Day, Sept. 29, 1899, had previously been the busiest day for these lines, but the regular traffic has increased to such an extent as to make the traffic on this busiest regular day of the year surpass the extraordinary amount of the maximum holiday. Of course, the fact that Dec. 24 was a Monday, and the day before Christmas, are the reasons for the heavy traffic.

It is interesting to note that the Fourth Avenue line operated more cars than the Broadway line during the rush hours of this busiest day, although the latter carried more passengers. The car movement on the north and south lines here shown is the total for each line, and it should be noted that the maximum movement on certain portions is, of course, much heavier.

Table XII.

Maximum Passenger Movement on Busiest Manhattan Surface Lines During Year Ended June 30, 1901.

	Broadway, 146th St and Lexington Ave. to South Ferry *	Fourth Ave. 135th St., and Madison Ave to Post Office †	Eighth Ave., 155th St. to South Ferry ‡	23d Street, North River to East River §
Miles of route	10.3	8.3	10.2	2.1
" track	20.6	16.6	20.4	4.2
Passengers for year	62,391,814	44,794,764	32,120,754	11,735,445
Ditto per mile of track	3,029,000	2,699,000	1,575,000	2,842,000
Average passengers per day	170,936	122,726	88,002	32,152
Ditto per mile of track	8,298	7,393	4,314	7,786
Car miles for year	7,938,433	6,785,755	5,005,119	935,831
Average car miles per day	21,749	18,577	13,712	2,564
Passengers per car mile	7.9	6.6	6.4	12.5
Date of busiest day	Monday,	Dec. 24,	1900	
Passengers for busiest day	226,774	190,478	103,630	39,397
Ditto per mile of track	11,008	11,475	5,080	9,380
Car miles for busiest day	25,275	20,416	14,976	3,221
Passengers per car mile	9.0	9 3	6.9	12.2
Maximum cars on busiest day	325	331	149	55
Minimum headway on busiest day (sec.)	10	20	40	40
Standing load average car	90	90	90	90

* Includes Lexington Avenue cars south of 23d Street, all Broadway cars and all Columbus Avenue cars. † Includes 2d Avenue cars south of Astor Place. ‡ Does not include 6th Avenue cars south of Canal Street. § Includes East 34th street Ferry cars on 2d Avenue and 34th Street.

The heaviest traffic on the Broadway line is below Twenty-Third Street, at which point the Lexington Avenue line branches off. Similarly on the Fourth Avenue line, the maximum traffic is north of Eighth Street, where the Astor Place cars are switched back, although the traffic is very heavy again south of this point, due to the Second Avenue cars passing into it there. On the Broadway line during the rush hours about 8 per cent of the cars are switched back north at Houston Street, thus slightly relieving the congestion south of this point. Of the total cars on the Broadway and Columbus Avenue lines approximately 25 per cent run to 146th Street and Lenox Avenue, 30 per cent to 109th Street and Columbus Avenue and 45 per cent to Fifty-Ninth Street and Seventh Avenue.

On the Fourth Avenue line cars are switched back north at Astor Place and south at Forty-Second Street, Eighty-Sixth Street and 116th Street. On the Eighth Avenue line cars are switched back north at Cortlandt Street Ferry, Canal Street and Thirteenth Street, and south at 116th Street.

BROOKLYN BRIDGE FROM THE BROOKLYN SIDE

The principal difficulty of operation of these surface lines, apart from those already mentioned, is the crowded street traffic south of Fourteenth Street, especially on the Broadway and Sixth Avenue and Eighth Avenue lines. Cars are also required to come to a full stop at crossings where fire companies are located, at transfer points and at intersections with other lines. At the present time the "Subway" construction also proves a considerable delay to operation. For instance, it is not unusual during the rush hours to have 180 to 200 stops and slow-ups on the Broadway line between South Ferry and 146th Street, and similarly on the Fourth Avenue line to have 125 to 150 stops and slow-ups between the Postoffice and 135th Street.

The accompanying diagrams, Nos. 1, 2 and 3, show the hourly variation of passengers on the Broadway, Fourth Avenue and Twenty-Third Street lines. It will be noted that the maximum number of passengers in the morning rush hours is smaller, and the average "peak" of the curve flatter than in the afternoon. This is, of course, the usual case with these transportation curves, as the hours of opening business vary more than the hours of closing. The Broadway curve shows a theatre "peak" for down traffic. The Metropolitan management makes a special point of providing extra car service for theatre and other special demands. All of these curves are extremely flat, compared with the usual transportation curve, showing the large amount of midday business, which, on the Broadway and Twenty-Third Street lines, is largely due to the shopping business, and on the Fourth Avenue line to this and also to the depot traffic. In fact, this depot traffic shows a distinct "peak" after the morning rush hours. On this curve will also be noticed the excellent evening riding.

TABLE XIII.

MAXIMUM PASSENGER MOVEMENT ON MANHATTAN ELEVATED LINES FOR BUSIEST DAY AND HOUR DURING YEAR ENDED JUNE 30, 1901.

	2d Avenue, 129th St. to South Ferry	3d Avenue, 177th St. to South Ferry *	6th Avenue, 155th St. to South Ferry ‡	9th Avenue, 155th St. to South Ferry	Total
Miles of route	8 7	12.6	11.0	10.1	....
Date of busiest day	Mon	day, D	ec. 17,	1900	
Passengers for busiest day	81,734	258,589	298,550	62,938	701,811
Train single trips	530	1,012	1,040	686	3,268
Car " "	1,980	4,410	5,074	2,542	14,006
Train miles	4,732	10,808	9,590	6,243	31,374
Car miles	17,468	45,812	46,267	23,481	133,027
Average cars per train	3.73	4.35	4.88	3.70	4.28
Passengers per train	154.2	255.5	287.1	91.7	214.7
" car	41.3	58.6	58.8	24.7	50.1
" train mile	17.3	23.9	31.1	10.9	22.4
" car mile.	4.7	5.6	6.4	2.7	5.3
Busiest hour of busiest day		5 to 6	P. M.		
Passengers for busiest hour	8,246	23,656	29,514	10,414	71,830
Train single trips	53	83	74	54	264
Car single trips	219	415	370	238	1,242
Train miles	430	757	659	500	2,346
Car miles	1,781	3,784	3,297	2,188	11,050
Average cars per train	4.1	5.0	5.0	4.4	4 7
Passengers per train	155.6	285.0	298.8	192.8	272.1
" car	37.6	57.0	79.8	43.7	57.8
" train mile	19.2	31 2	44.7	20.8	30.6
" car mile.	4.6	6.2	8.9	4.8	6 5
Maximum trains in service	....	....	...	....	231
Maximum cars in service	....	....	....	....	1,089
Minimum headway (sec.)	....	....	57	....	....
Standing load five car train	....	....	500	....	....

* Includes branches Chatham Square to City Hall and on 34th Street and 42d Street.
‡ Includes branch 53d Street to 58th Street.

Diagram No. 4 gives the variation of the total Manhattan surface cars. The small variation between the number of cars during the rush hours and at midday is surprising, being only about 10 per cent. Very few cars are taken off, although they are shifted around between the different lines better to accommodate the midday traffic. The fact is that nearly the maximum number of cars which can operate on the principal lines are in service throughout the day, the accommodation during the middle of the day being comfortable, and during the rush hours being very much restricted. The same condition of small variation of total car service will be noticed in the curves of the busiest Manhattan Elevated lines, and to a less extent in the curves of the Brooklyn surface lines.

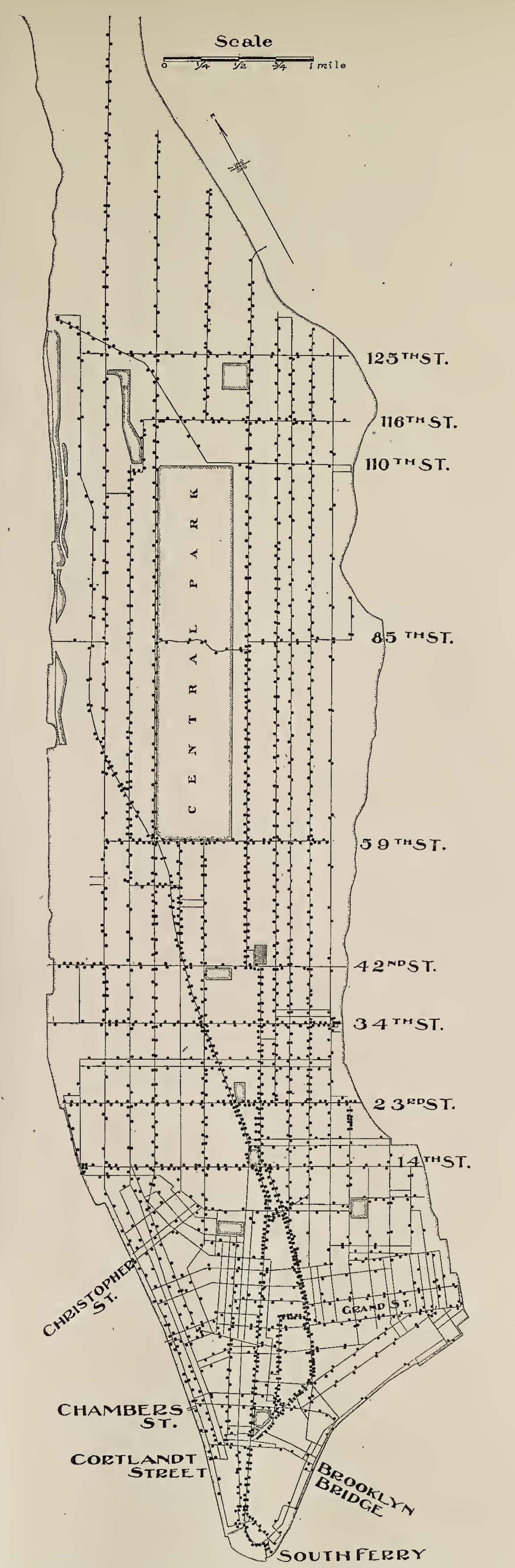
MANHATTAN ELEVATED LINES

The elevated railroad service of New York City is a north and south service, with the exception of two short spurs to reach the Forty-Second Street Grand Central Station and the Thirty-Fourth Street Ferry. On the East Side there are two lines north to the Harlem River, and above that point a suburban line to Fordham. On the West Side there are two lines north to Fifty-Eighth Street, and thence both lines run over one track to the Harlem River, connecting with the suburban service of the New York Central & Harlem River Railroad. All east and west lines connect at South Ferry, their southern terminus. The Third Avenue and Ninth Avenue lines have third tracks for express service north of Ninth Street and Fourteenth Street. The location of these lines is shown on the large inset map, and distribution of trains during the rush hour by the Manhattan train distribution map in an inset. The maximum train length allowed by the present station arrangement is five cars, although with electrical equipment it is expected to reconstruct the platforms to allow the use of six-car trains.

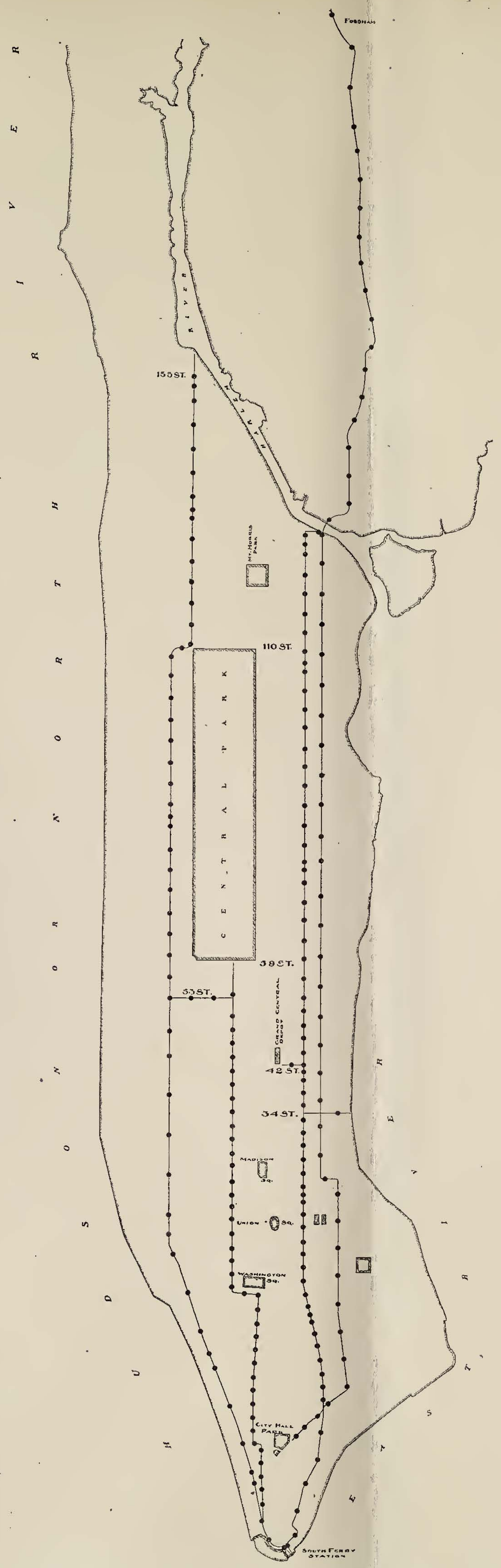
The Third Avenue and Sixth Avenue lines carry the most passengers. Table XIII. gives the maximum passenger movement for these and the other two lines for the busiest day of the past fiscal year, Monday, Dec. 17, 1900, and the busiest hour, from 5 p. m to 6 p. m., of this day. Tables XIV., XV. and XVI. show the hourly variation for each line of ticket sales, train single trips and car single trips for the same busiest day. Diagrams Nos. 5 to 14 show the hourly variation of the same items for an average week day during the year, Wednesday, Oct. 10, 1900. Diagram No. 15 shows the hourly cars per train on the same day.

In Diagrams Nos. 5 to 9, and tables XIV. to XVI., giving ticket sales, or practically the number of passengers per hour, the same general character of the morning and evening "peak" loads will be noted as those of the surface lines, although the morning "peak" is higher than the evening. This latter fact is somewhat accounted for by the habit of a large number of passengers of purchasing two or more tickets on the down trip in the morning. The Third Avenue line shows the highest "peak" load, which is due both to the large amount of its Manhattan business and also to the long-haul suburban passengers from the branch in the Bronx. The noonday depot and shopping travel on this line and the Sixth Avenue is large. The Sixth Avenue curve shows the wealthier class of riders, by reason of the small 6 to 7 a. m. business, and the large 9 to 10 a. m., and 4 to 5 p. m. business. Diagram No. 9 on the Ninth Avenue line covers only the part of the line south of Fifty-Ninth Street, and, therefore, does not show the morning "peak."

In diagrams Nos. 10 to 14 the small variation in the maximum number of trains operated by the different lines

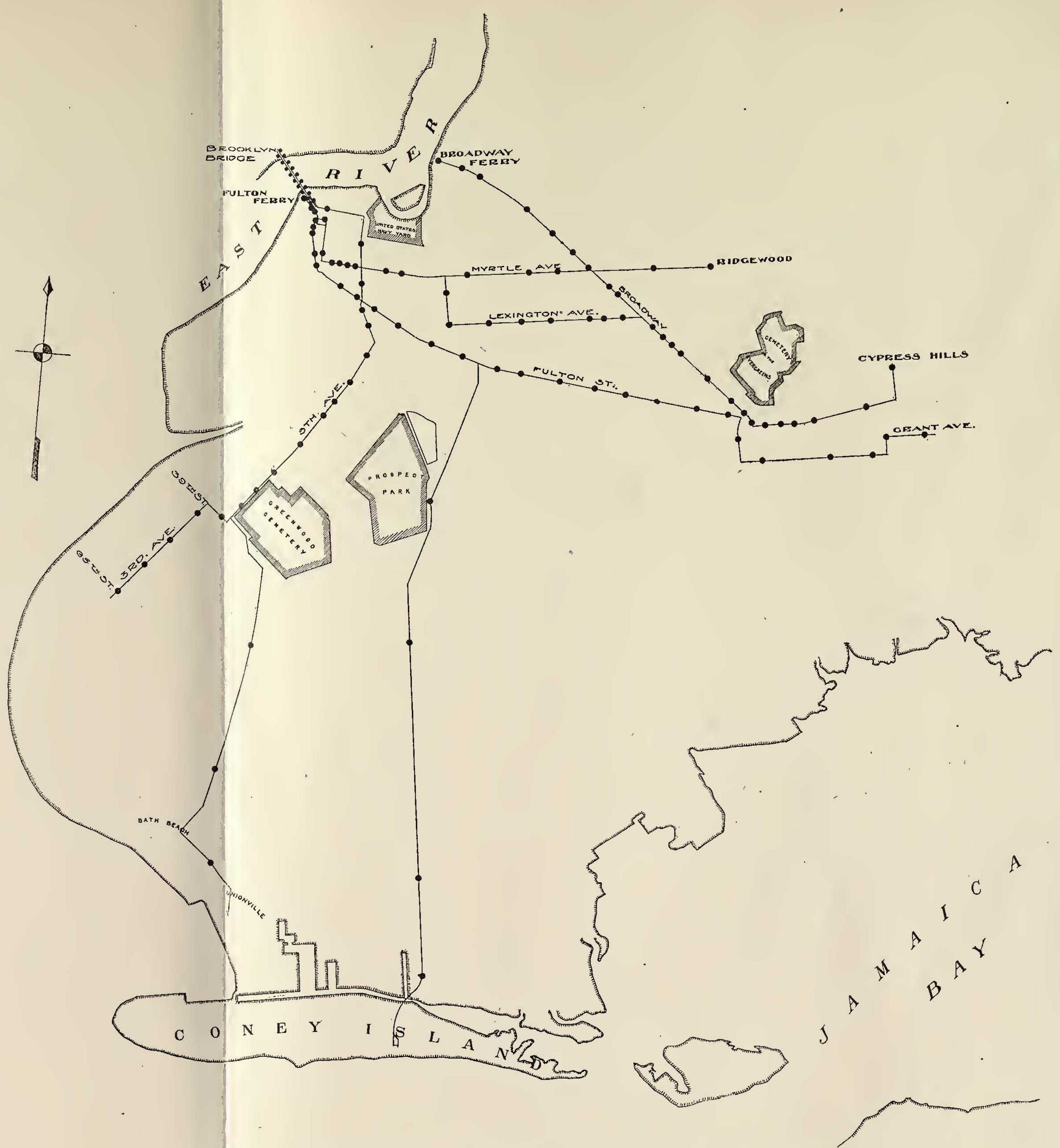


Distribution of Manhattan Surface Cars at Rush Hour, Tuesday, Sept. 3, 1901.



Distribution of Manhattan Elevated Trains at Rush Hour on Weekday, December, 1900.

Distribution of Brooklyn Surface Cars (B. R. T. Co.) at Rush Hour on Weekday, August, 1901.

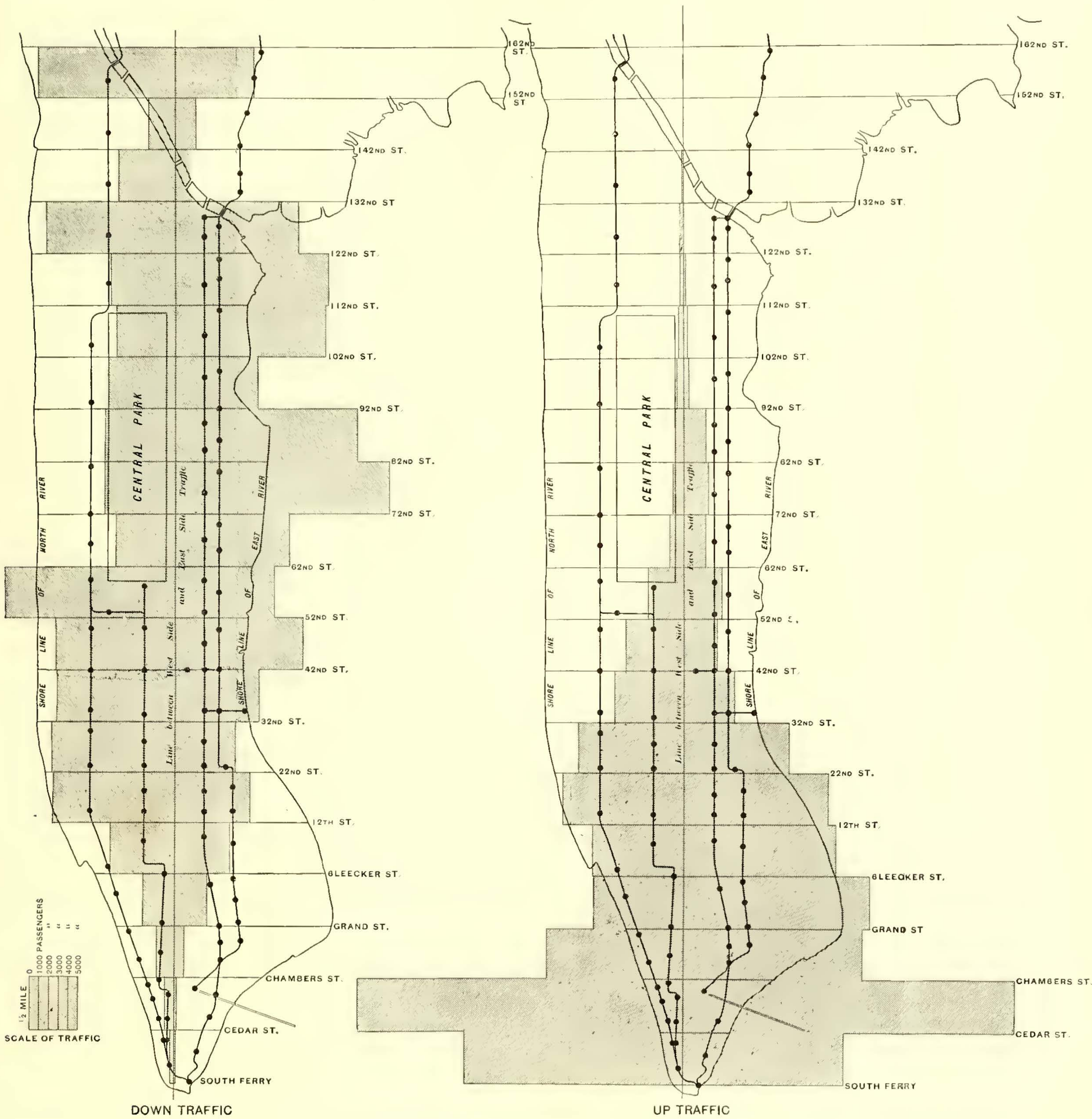


Distribution of Brooklyn Elevated Trains at Rush Hour on Weekday, August, 1901.

MAPS SHOWING DISTRIBUTION OF CARS AND TRAINS DURING RUSH HOURS ON SURFACE AND ELEVATED LINES IN NEW YORK CITY ☘ ☘ ☘ ☘ ☘ ☘ ☘ ☘ ☘ ☘ ☘ ☘ ☘

in comparison with the variation of passengers carried is very marked. The Third Avenue and Sixth Avenue curves are extremely flat, showing the same characteristics as the Manhattan surface lines; that is, the small variation in the car service between the rush hours and midday.

The accompanying diagram, or map, shows the proportion of down traffic and up traffic on eastern and western divisions of the Manhattan Elevated Railroads for each of the half mile districts from South Ferry north, the data being furnished by the number of ticket sales on Monday, May 25, 1896. This diagram is reproduced from a paper by J. J. R. Croes, appearing in the proceedings of the New York Railroad Club, under date of March 18, 1897, later data on this subject not being available. It may be assumed, however, that the conditions have not changed very appreciably, as only 5 per cent more passengers were carried on these lines in 1901 than in 1897, the most considerable change probably being the increase in the number of passengers in the Harlem district north of 110th Street. This shows that the maximum down traffic is in the district between Seventy-Second Street and Eighty-Second Street, and the maximum up traffic is in the terminal district between Cedar Street and Chambers Street, which district also is the largest for both up and down traffic. The second largest for total up and down traffic is the shopping district, between Twelfth Street and Twenty-Second Street, the travel here being more equally divided between north and south passengers.



STATION TRAFFIC DISTRIBUTION, MANHATTAN ELEVATED LINES

BROOKLYN LINES

The transportation problem of Brooklyn is different from that of Manhattan, and probably from that of any other large city in the world, due to the fact that its delivery points are on its borders. It is estimated that at least 55 per cent of the morning and night "commuter" travel on the surface lines is delivered to New York via the Brooklyn Bridge and the various ferries. Of the total passengers during the entire day by surface lines, about 30 per cent travel to and from New York, and upon all of the Brooklyn elevated lines, exclusive of the Brooklyn Bridge local traffic, about 75 per cent of all passengers travel to and from New York City. At the other extremity of the Brooklyn lines, are Coney Island and the other ocean beach resorts, forming, in summer time, heavy delivery points for the "pleasure" travel from Brooklyn and Manhattan.

TABLE XIV.
HOURLY TICKET SALES ON MANHATTAN ELEVATED LINES FOR BUSIEST DAY OF YEAR, MONDAY, DEC. 17, 1900.

	Second Avenue	Third Avenue	Sixth Avenue†	Ninth Avenue*	Total
12- 1 A. M..	825	3,673	1,571	544	6,613
1- 2......	......	1,796	809	221	2,826
2- 3......	.....	1,104	511	198	1,813
3- 4......	......	969	494	173	1,636
4- 5......	65	1,496	1,125	371	3,057
5- 6......	1,487	4,209	2,513	777	8,986
6- 7......	7,997	21,733	9,108	2,931	41,769
7- 8......	14,519	36,196	34,515	5,978	91,208
8- 9......	7,448	23,003	37,117	5,080	72,648
9-10......	3,458	13,360	20,630	2,978	40,426
10-11......	2,937	10,446	15,308	2,414	31,105
11-12......	2,602	9,478	13,639	2,326	28,045
12- 1 P. M..	2,469	8,918	12,436	2,340	26,163
1- 2......	2,565	10,200	12,303	2,446	28,414
2- 3......	2,665	10,599	14,29[illegible]	2,642	30,197
3- 4......	3,291	11,462	19,489	3,244	37,486
4- 5	4,262	12,736	21,403	4,848	43,249
5- 6	8,246	23,656	29,514	10,414	71,830
6- 7......	6,367	17,140	16,699	6,819	47,025
7- 8......	4,191	12,425	10,226	2,205	29,047
8- 9......	2,39[illegible]	7,745	7,137	1,421	18,7[illegible]2
9-10......	1,802	6,401	6,023	1,136	15,362
10-11......	1,323	6,371	6,790	887	15,3[illegible]1
11-12......	816	3,473	3,999	545	8,833
Total....	81,734	258,589	298,550	62,938	701,811

*South of 59th St. †Includes 9th Ave Line North of 59th St

TABLE XV.
HOURLY TRAIN SINGLE TRIPS ON MANHATTAN ELEVATED LINES FOR BUSIEST DAY OF YEAR, MONDAY, DEC. 17, 1900.

	Second Avenue	Third Avenue	Sixth Avenue	Ninth Avenue	Total
12- 1 A. M	6	16	12	13	47
1- 2...............	...	12	8	8	28
2- 3...............	...	12	8	8	28
3- 4...............	...	12	8	8	28
4- 5...............	3	15	10	9	37
5- 6	18	28	16	20	82
6- 7...............	45	50	31	26	152
7- 8....	48	73	61	45	227
8- 9...............	35	68	65	61	229
9-10...............	27	55	62	43	187
10-11...............	22	52	61	29	164
11-12 NOON.	20	52	60	33	165
12- 1 P. M...........	20	51	62	31	164
1- 2...............	20	52	60	32	164
2- 3...............	19	50	60	35	164
3- 4	24	48	61	40	173
4- 5....	37	60	76	53	226
5- 6....	53	83	74	54	264
6- 7..............	37	58	57	32	184
7- 8...............	26	41	58	29	154
8- 9	19	36	49	22	126
9-10...............	17	31	30	21	99
10-11...............	17	30	30	19	96
11-12 MID...........	17	27	21	15	80
Total............	530	1,012	1,040	686	3,268

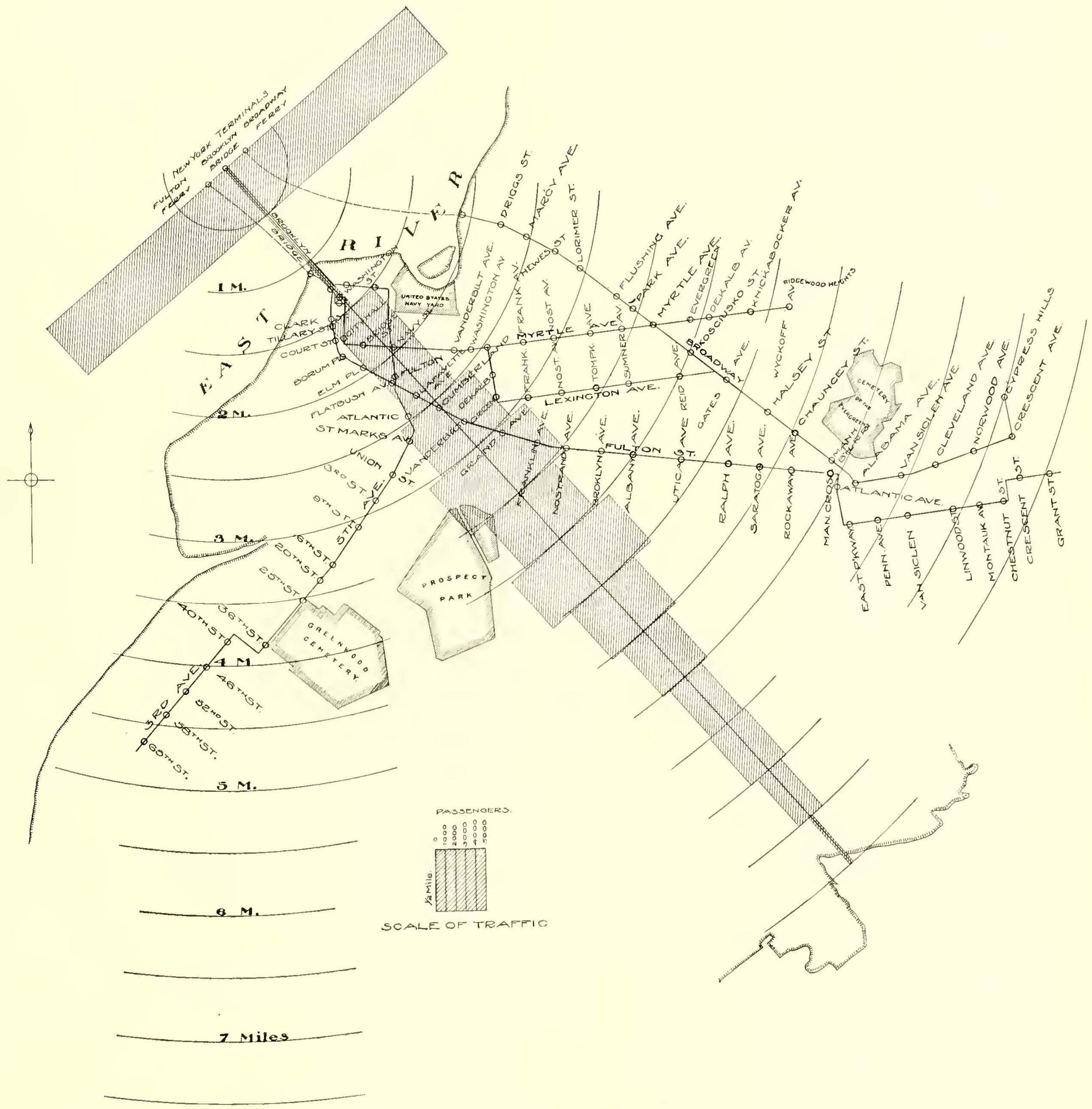
The most difficult features of the Brooklyn transportation problem are: First, the extreme congestion of the "commuter" travel to New York on the single land terminal, the Brooklyn Bridge, and to a lesser extent at the ferry terminals; and, second, the handling of the immense summer "pleasure" travel. The latter point will be sufficiently apparent to railroad men from the fact that every spring 1500 new motormen and conductors must be employed, and, with a short period of coaching, entrusted with cars operating this crowded and difficult service.

The inset map shows the location of the various surface lines, of which there are sixty, and one of the smaller maps approximately the traffic districts. The office building and financial district is a very small one, comprising a few buildings on Montague Street and Fulton Street. Almost all of this class of business is transacted in New York City. This is also largely the case with the hotel and theatre business and retail shopping business. In other words, Brooklyn is largely a manufacturing and residential suburb to Manhattan Borough.

TABLE XVI.
HOURLY CAR SINGLE TRIPS ON MANHATTAN ELEVATED LINES FOR BUSIEST DAY OF YEAR, MONDAY, DEC. 17, 1900.

	Second Avenue	Third Avenue	Sixth Avenue	Ninth Avenue	Total
12- 1 A. M	18	53	43	26	140
1- 2......	..	36	24	16	76
2- 3............	..	36	24	16	76
3- 4..............	..	36	24	16	76
4- 5......	12	56	30	24	122
5- 6........	72	131	66	80	349
6- 7........ ...	180	250	155	104	689
7- 8..............	197	365	305	193	1,060
8- 9............	148	340	325	276	1,089
9-10......... ..	110	275	310	187	882
10-11...	75	232	305	99	711
11-12 NOON	60	194	300	99	653
12- 1 P. M..........	60	184	310	93	647
1- 2	60	188	300	96	644
2- 3	62	188	300	107	657
3- 4..............	92	213	305	158	768
4- 5............	148	298	380	224	1,050
5- 6............	219	415	370	238	1,242
6- 7........... ..	155	287	285	134	861
7- 8..............	99	186	290	116	691
8- 9..............	60	139	245	86	530
9-10............	51	110	150	64	375
10-11..............	51	105	141	59	356
11-12 MID..........	51	93	87	31	262
Totals.........	1,980	4,410	5,074	2,542	14,006

The various surface lines run from the East River ferries and from the Brooklyn Bridge terminus to the outskirts of the built-up portion of the borough and to beach resorts. There are also a number of crosstown lines, mostly originating at one ferry, and terminating at another, forming a semi-loop through the city. The lines to the beaches run over the various street car lines as far as Prospect Park and Greenwood Cemetery, whence they take either the Culver route, the Gravesend Avenue route, both of which were originally operated entirely by steam, or the Coney Island & Brooklyn Railroad route over Coney Island Avenue. In some cases, as with the Bath Beach and Brighton Beach lines, the elevated lines run on the surface upon leaving the elevated structure at the outskirts of the built-up portion of the city. In the case of the Brighton Beach line (Culver route), elevated trains and surface cars are run over the same tracks. The use of private right of way for a large portion of these beach surface lines permits the operation over such portion at a reasonably high rate of speed. In fact, this is absolutely necessary for the satisfactory operation of these lines, owing to the onerous speed restrictions by municipal ordinance in the central portion of the city, this limit being, in a large part of the city, 6 and 8 miles per hour as a maximum. A considerable portion of the surface track in the suburbs of Brooklyn has been built, apparently, in anticipation of future development.



STATION TRAFFIC DISTRIBUTION, BROOKLYN ELEVATED LINES

From the inset map showing distribution of surface cars of the Brooklyn Rapid Transit Company during the rush hours, can be seen the excessive congestion of cars on the Brooklyn Bridge and Fulton Street, and, to a less extent, near the Broadway ferry and on Nostrand Avenue and Atlantic Avenue. It will be noted that this map contains only the cars of the Brooklyn Rapid Transit Company, there being about 15 per cent additional cars operated by the other two independent lines. Another similar map shows the position of all elevated trains, including the Brooklyn Bridge elevated trains, operating during the rush hour, together with the elevated train service to Bath Beach and Coney Island. It should be noted that since June 15, 1901, the Brooklyn elevated lines have been operated almost entirely with steam locomotives, due to shortage of electric power, thus decreasing the schedule speed considerably; and also that since July last, no elevated trains have been operated across the Brooklyn Bridge other than the regular Brooklyn Bridge elevated trains, which ordinarily are operated by the third-rail electric system, and during the rush hours by cable.

Table XVII. gives the maximum movement on the busiest Brooklyn surface and elevated lines for the busiest year and busiest day. The hourly variation on the Fulton Street surface line is further shown in diagram No. 16, the regular travel throughout the day, somewhat similar to the Broadway, Manhattan, line, being distinctly noticeable, and due to short-haul and shopping travel. The late afternoon "peak" is pronounced, together with the excellent evening riding. Diagram No. 17 shows the busiest day's business on the Culver Coney Island line on Sunday, June 30, 1901. It is interesting to note the great difference between this curve and the usual traffic curve, there being a steady increase in travel during the day to 3 p. m. The

TABLE XVII.

MAXIMUM PASSENGER MOVEMENT ON BUSIEST BROOKLYN SURFACE AND ELEVATED LINES.

	Surface Lines		Elevated Lines	
	Fulton St., East New York to Park Row, N. Y., and Fulton Ferry	Culver—Coney Island, Culver Route with Vanderbilt Ave., 15th St. and Tompkins-Lorimer—Coney Island Lines	Lexington Ave., Cypress Hills to Bridge	Brooklyn Bridge Elevated Division
Miles of route	6.6	39.3	7 9	1.1
Miles of track	13.2	78.7	15 8	2.2
Date of busiest fiscal year	1901	1901	1893	1897
Passengers for year	16,816,575	10,738,524		44.409,243
Ditto per mile of track	1,275,000	136,000		20,186,000
Average passengers per day	46,073	29,421		121,670
Ditto per mile of track	3,490	374		55,305
Car miles for year	1,917,984	2.362,513	2,991,116	* 1,453,870
Average car miles per day	5,255	6,473	8,195	3,983
Passengers per car mile	8.7	4.5		30.5
Date of busiest day	Monday Dec. 24, 19 0	Sunday June 30, 1901	Monday Dec, 24, 1900	Columbus Day, Oct. 12, 1892.
Passengers for busiest day	66,937	165,773		223,625
Ditto per mile of track	5,071	2,106		101,648
Car miles for busiest day	6,280	24,224	11,125	
Passengers per car mile	10.7	6.8		
Maximum cars on busiest day	67	186	143	72
Minimum headway on ditto (secs.)	90	40	138	60
Standing load average car or train	82	140	460	400

* Approximate.

return travel from the beaches begins about 2 p. m., and is heaviest between 6:30 and 9:30 p. m.

Table XI. shows the busiest Brooklyn surface track intersection at Fulton Street and Adams Street, at the City Hall Square, where 798 cars per hour pass during the rush hours. On account of the even division between the north and south, and the east and west cars, and the fact that this is a diagonal crossing, with curves at the end of one line, it is an extremely difficult point to pass cars.

Tables XVIII. and XIX., and diagram No. 18, show the variation of train service and car service on Brooklyn elevated lines, and diagram No. 19 shows the variation of average cars per train. From these will be noted the small midday service compared with Manhattan, corresponding to the smaller midday travel.

The accompanying diagram, or map, of the Brooklyn elevated system shows graphically the proportion of ticket sales or passenger traffic, exclusive of local Bridge elevated passengers, for Wednesday, Sept. 4, 1901, by half-mile districts from the Manhattan end of the Bridge. This is on lines somewhat similar to the previous Manhattan diagram, and demonstrates graphically the overwhelming proportion of Manhattan "commuter" business on this system.

TABLE XVIII.

HOURLY TRAIN ROUND TRIPS ON BROOKLYN ELEVATED LINES FOR AVERAGE WEEKDAY, WEDNESDAY, SEPT. 4, 1901.

	Bridge	Fifth Avenue	Ridgewood	Lexington Avenue	Broadway	Fulton Street	Total
12– 1 A. M.	9	6	2	4	3	5	29
1– 2	8	2	..	2	2	2	16
2– 3	8	2	..	2	2	2	16
3– 4	8	2	..	2	2	2	16
4– 5	8	2	..	2	2	4	18
5– 6	14	9	9	8	8	9	57
6– 7	13	15	10	18	8	17	98
7– 8	54	16	10	22	9	21	132
8– 9	52	15	11	22	8	16	124
9–10	31	12	9	8	5	13	78
10–11	21	10	9	8	11	9	68
11–12 NOON	22	11	8	7	11	10	69
12– 1 P. M.	22	10	8	8	11	10	69
1– 2	22	11	8	7	11	10	69
2– 3	22	11	8	7	11	11	70
3– 4	22	10	8	12	10	14	76
4– 5	29	14	8	13	9	18	91
5– 6	63	16	12	23	9	19	142
6– 7	46	12	8	19	10	17	112
7– 8	19	11	8	18	8	14	78
8– 9	16	8	5	8	8	9	54
9–10	16	8	5	7	8	10	52
10–11	15	8	3	8	7	9	50
11–12 MID.	13	7	3	5	6	7	41
Total	570	228	150	240	179	258	1,625

TABLE XIX.

HOURLY CAR ROUND TRIPS ON BROOKLYN ELEVATED LINES FOR AVERAGE WEEKDAY, WEDNESDAY, SEPT. 4, 1901.

	Bridge	Fifth Ave.	Ridgewood	Lexington Ave	Broadway	Fulton Street	Total
12– 1 A. M	18	12	4	8	6	10	58
1– 2	16	4	..	4	4	4	32
2– 3	16	4	.	4	4	4	32
3– 4	16	4	..	4	4	4	32
4– 5	16	4	..	4	4	8	36
5– 6	33	29	25	23	21	26	157
6– 7	120	64	40	81	29	68	402
7– 8	216	79	40	103	27	88	553
8– 9	208	61	28	75	19	57	448
9–10	124	34	14	16	12	38	238
10–11	63	24	14	16	23	19	159
11–12 NOON	66	26	12	14	22	20	160
12– 1 P. M.	66	24	12	16	23	21	162
1– 2	66	26	12	14	23	21	162
2– 3	66	26	12	14	23	22	163
3– 4	66	25	12	32	22	32	189
4– 5	116	47	12	50	30	55	310
5– 6	249	79	35	104	36	73	576
6– 7	182	48	29	62	28	57	406
7– 8	66	37	12	45	22	35	217
8– 9	32	24	9	16	22	22	125
9–10	32	20	6	14	22	20	114
10–11	30	20	6	16	17	18	107
11–12 MID.	26	18	6	10	12	14	86
Totals	1,909	739	340	745	455	736	4,924

Table XX. shows the variation of passengers by surface and elevated cars over the Brooklyn Bridge for an average summer week day, Wednesday, Sept. 4, 1901, showing a grand total of 285,165 passengers both ways. This enormous travel is handled by two double-track lines, each 1.1 miles in length.

Table XXI. shows the hourly variation of number of surface cars on the Brooklyn Bridge by days for an average summer week, Aug. 12 to 18, 1901. This hourly number of surface cars is shown graphically by diagram No. 20 for Wednesday, Sept. 4, 1901. The large number of cars taken off this route at midday represent, to a considerable extent, the reduction in cars on the entire system, as the bridge travel is "commuter" travel more than on any other line. Diagram No. 21 gives the variation of the total Brooklyn Rapid Transit Company surface cars during the day, showing about 25 per cent of the maximum number of cars taken off at midday, these being represented, as stated, largely by the cars crossing Brooklyn Bridge.

The difficulty of operating surface cars over the Brooklyn Bridge and the crowded driveways during the rush hours is the greatest problem in the operation of the entire system. Each track occupies about one-half of each driveway crossing the bridge, terminating at the Manhattan end with a four-track loop. On the suspended structure there must be an interval of 102 feet between the rear of each car and the front of the next, equivalent to an average spacing between fronts of cars of 142 ft. The cars crowding the approaches to the suspended structure during the rush hours are practically solid blockades.

The schedule time from Park Row, Manhattan, to Sands Street, Brooklyn, is 7 minutes, equivalent to a speed of 9.4 miles per hour. At 142-ft. distance between cars, this will be equivalent to a headway of 10.3 seconds, which would allow 350 cars to pass per hour. There are numerous delays, however, caused by repairing and cleaning the bridge plank pavements, by vehicle traffic, and by the numerous usual small car accidents. The maximum number of cars operated per hour was formerly 315, equivalent to a headway of 11.4 seconds, although on account of the recent large increase of vehicle traffic the present maximum operation is about 275 cars per hour, equivalent to a headway of 13.1 seconds.

In view of the many blockades encountered, both on the bridge and on the Fulton Street approach, the present number of cars seems to be absolutely the maximum that can be operated. During the rush hour, by actual count, the number of stops on the Fulton Street line between East New York and Park Row, Manhattan, a distance of about 6.6 miles, averages over 100.

GENERAL TRAFFIC FEATURES

An interesting feature shown in Table XX. is that there were 7326 passengers to Manhattan by bridge elevated cars more than returned from Manhattan, or about 12 per cent of the west-bound passengers. It will be noted that practically all of these return by surface cars. The same feature has already been noted regarding the Manhattan elevated lines, that more passengers travel down town than up. In other words, it is a peculiarity of human nature that the average person travels in the morning directly to business and returns by a slower and less direct route, stopping off, it may be, during the home journey.

Another fact bearing on this point is that about 20 per cent more transfers are issued from the Manhattan crosstown lines to south-bound cars than are issued from cars running north to the same crosstown lines; which would seem to show that passengers walk the short crosstown distances on the home trip, either for recreation or to perform certain errands. There are a large number of people who ride to their business in the morning and walk home in the evening. The discrepancy between the total num-

GRAND CENTRAL STATION, FORTY-SECOND STREET, MANHATTAN ber of passengers crossing the Brooklyn Bridge east and the total west is probably caused by this fact.

Table XXII. gives the monthly variation of passenger travel for one year. On the Manhattan surface lines the best month is October, and the best travel the late fall and late spring, the summer and winter months showing the smallest travel. On the Brooklyn surface lines the three summer months are the best, July showing maximum travel and the winter and early spring months the minimum. On the Brooklyn elevated lines the largest travel is in the late fall, winter and spring, practically during the cold weather. In this case, where passengers have the option of traveling by surface or elevated lines, they will naturally take the more comfortable, and a rainy or cold day produces a large increase in the Brooklyn elevated traffic. The Brooklyn Bridge elevated line shows practically the same results as the Brooklyn surface lines, although the business during the last half of the year seems to have increased very considerably.

TABLE XX.

HOURLY PASSENGERS ON SURFACE AND ELEVATED BRIDGE CARS FOR AVERAGE SUMMER WEEKDAY, WEDNESDAY, SEPT. 4, 1901.

To Manhattan

	By Elevated Bridge Cars			Total by Surface Cars	Grand Total
	From Elevated Lines	From Street	Total		
12- 1 A. M.	205	54	259	836	1,095
1- 2	117	41	158	711	869
2- 3	39	17	56	329	385
3- 4	81	19	100	204	304
4- 5	176	45	221	322	543
5- 6	1,083	248	1,331	1,238	2,569
6- 7	5,559	975	6,534	7,524	14,058
7- 8	14,215	2,647	16,862	13,418	30,280
8- 9	12,565	1,853	14,418	11,090	25,508
9-10	2,962	794	3,756	6,237	9,993
10-11	1,501	418	1,919	4,523	6,442
11-12	864	333	1,197	3,326	4,523
12- 1 P. M.	696	292	988	2,962	3,950
1- 2	840	365	1,205	2,986	4,191
2- 3	903	250	1,153	3,352	4,505
3- 4	759	280	1,039	2,802	3,841
4- 5	774	310	1,084	3,073	4,157
5- 6	1,170	830	2,000	3,066	5,066
6- 7	1,738	473	2,211	3,330	5,541
7- 8	778	297	1,075	2,996	4,071
8- 9	604	202	806	2,540	3,346
9-10	742	137	879	1,852	2,731
10-11	871	149	1,020	1,667	2,687
11-12	553	71	624	1,752	2,376
Total	49,795	11,100	60,895	82,136	143,031

From Manhattan

	By Elevated Bridge Cars			Total by Surface Cars	Grand Total
	To Elevated Lines	To Street	Total		
12- 1 A.M.	287	61	348	1,038	1,386
1- 2	100	38	138	583	721
2- 3	101	46	147	430	577
3- 4	83	29	112	367	479
4- 5	76	31	107	308	415
5- 6	143	25	168	408	576
6- 7	416	231	647	1,196	1,843
7- 8	504	601	1,105	1,574	2,679
8- 9	446	270	716	1,961	2,677
9-10	604	212	816	2,496	3,312
10-11	681	249	930	4,740	5,670
11-12 NOON	897	237	1,134	4,275	5,409
12- 1 P. M.	1,189	308	1,497	3,626	5,123
1- 2	1,213	320	1,533	4,503	6,036
2- 3	791	203	994	4,409	5,403
3- 4	1,284	260	1,544	4,334	5,878
4- 5	2,460	463	2,923	6,980	9,903
5- 6	12,792	2,120	14,912	12,789	27,701
6- 7	14,240	2,133	16,373	14,025	30,398
7- 8	2,903	482	3,385	6,110	9,495
8- 9	1,289	239	1,528	5,591	7,119
9-10	884	222	1,106	2,947	4,053
10-11	617	171	788	2,204	2,992
11-12 MID	462	156	618	1,671	2,289
Total	44 462	9,107	53,569	88,565	142,134
Grand Total Both Ways	94,257	20,207	114,464	170,701	285,165

TABLE XXI.

HOURLY SURFACE CARS ON BROOKLYN BRIDGE FOR AVERAGE SUMMER WEEK, AUG. 12-18, 1901.

	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
12- 1 A. M.	140	88	93	93	96	94	103
1- 2	101	76	87	78	80	83	111
2- 3	67	48	57	46	53	51	78
3- 4	36	35	34	31	35	31	48
4- 5	34	33	34	32	34	35	40
5- 6	55	56	55	61	59	63	36
6- 7	164	171	163	155	152	170	54
7- 8	237	245	253	240	274	234	85
8- 9	214	232	253	260	232	249	103
9-10	261	236	237	233	241	241	130
10-11	208	212	208	212	228	217	183
11-12 NOON	178	217	204	201	196	208	204
12- 1 P. M.	205	206	220	208	202	241	203
1- 2	190	199	193	190	211	258	207
2- 3	201	215	221	235	209	235	230
3- 4	220	240	251	218	187	225	249
4- 5	236	250	234	246	258	212	214
5- 6	252	266	269	261	253	241	226
6- 7	223	239	231	243	238	230	207
7- 8	207	178	192	206	194	206	192
8- 9	189	181	190	163	190	203	227
9-10	167	154	172	181	163	219	173
10-11	175	163	174	153	183	193	176
11-12. MID	146	159	164	156	161	191	174
Totals	4,106	4,099	4,189	4,102	4.129	4,330	3,653

TABLE XXII.

MONTHLY VARIATION OF PASSENGERS FOR MANHATTAN SURFACE AND BROOKLYN SURFACE, ELEVATED AND BRIDGE LINES FOR YEAR ENDED JUNE 30, 1901.

	Manhattan Surface Lines	Brooklyn Surface Lines (B. R. T. Co.)	Brooklyn Elevated Lines, except Bridge Line	Brooklyn Bridge Elevated Line
1900				
July	45,303,908	23,541,991	4,301,386	361,695
August	44,705,456	22,357,386	4,046,129	362,158
September	46,740,325	20,950,367	4,045,615	378,308
October	50,073,460	19,573,461	4,770,273	459,182
November	46,423,066	18,223,485	4,781,872	437,982
December	47,013,224	18,647,619	5,139,042	451,529
1901				
January	42,474,532	17,325,217	4,075,971	518,265
February	40,508,406	15,646,158	4,559,909	631,561
March	46,198,882	17,665,003	5,118,013	663,891
April	45,729,250	17,680,138	5,035,432	646,214
May	47,790,666	19,885,862	5,134,208	631,486
June	47,649,260	23,003,650	4,581,458	555,782
Total	550,610,435	234,500,337	56,489,308	6,098,053

Table XXIII. shows a similar variation by days, of passenger travel for a summer week and a winter week. In general, Monday has the best travel of any of the week days, due to the fact that it is bargain day at the stores, and also that the average passenger has more ready funds at the beginning of the week than at the end. The week of Dec. 16 to 22, 1900, on the Manhattan surface lines shows a gradual increase toward the end of the week, due to the approach of the Christmas holiday. Sunday is the minimum day for the Manhattan surface lines; the difference between summer and winter travel on this day due to the "pleasure" riding being marked. On the Brooklyn surface lines during the summer week Sunday is shown to have the largest number of passengers, with Friday and Saturday also large days, due to this excursion travel. In the winter time Sunday is the minimum day, similar to the Manhattan lines. On the Brooklyn elevated lines in the summer time Saturday is the largest day and Sunday the smallest, due to their being largely "commuter" and excursion lines. In the winter time Monday is the maximum day and Sunday the minimum. The Brooklyn Bridge elevated line shows practically the same results as the rest of the elevated system, although this travel is more largely "commuter" than the other elevated lines.

SPEED

Table XXIV. gives the schedule speed of the busiest surface lines of Manhattan and Brooklyn, which schedule is unfortunately subject to considerable delays at rush hours. It will be noted that the Fulton Street line, Brooklyn, maintains about the same schedule speed as the Broadway, Manhattan, line south of Twenty-Third Street. The electric lines in Manhattan average about $8\frac{1}{2}$ miles per hour, which is about three city blocks per minute. The Coney Island line shown operates at an average schedule of $10\frac{1}{2}$ miles per hour, due to the private right of way already mentioned. At rush hours the schedule speed of the Bridge surface lines, which is given at 9.4 miles per hour, is practically reduced to a maximum of 7.4 miles per hour.

TABLE XXV.

SCHEDULE SPEED OF PRINCIPAL ELEVATED LINES, JULY, 1901.

	Length of Single Trip, Miles	Time for Single Trip, Minutes	Number of Regular Stops	Average Distance Between Stops, Miles	Schedule Speed Between Given Terminals, Miles per Hour
Regular Trains—Manhattan					
2d Ave. (129th St. to South Ferry)	8.7	40	25	.35	13.1
3d Ave. (177th St. to South Ferry)	12.2	57	36	.34	12.8
6th Ave. (155th St. to South Ferry)	10.8	49	29	.37	13.2
9th Ave. (155th St. to South Ferry)	10.1	42	27	.37	14.4
Brooklyn					
Lexington Ave. (Steam operation, Cypress Hills to Bridge)	7.9	37	22	.36	12.8
Fulton St. (Steam operation, Grant Ave. to Fulton Ferry)	8.2	39	27	.30	12.6
Brooklyn Bridge (Sands St. to Park Row, cable operation)	1.1	6	0	....	11.0
Brooklyn Bridge (electric operation)	1.1	5	0	....	13.2
Express Trains—Manhattan					
3d Av. (177th St. to City Hall)	11.3	48	25	.45	14.1
" (106th St. to 42d St.)	3.2	11	0	....	17.5
6th Av. (155th St. to Rector St)	10.3	37	9	1.14	16.7
" (116th St. to 42d St.)	4.4	10	0	....	26.4
9th Av. (155th St. to Rector St)	9.6	34	12	.80	16.9
" (116th St. to Christopher St.)	5.9	17	0	....	20.8

The schedule speed of the principal elevated lines, both for regular trips and for express trips is shown in Table XXV. The average schedule speed of the regular Manhattan trains is about 13 miles per hour, although, practically, at rush hours this is often reduced to 12 miles per hour. It is expected that electric operation, however, will permit of an average schedule speed of at least $13\frac{1}{2}$ miles per hour. It will be noted that the Brooklyn elevated lines operate at a slightly slower speed than the Manhattan, due principally to the larger number of track curves and stops. The Brooklyn Bridge elevated car operation is restricted both by the limitations of the structure and by the steep grades. The schedule speed of the elevated express trains, as shown, is a most excellent performance, the best run without a stop being 4.4 miles at an average speed of 26.4 miles per hour. The performance of the Ninth Avenue express line, covering a distance of 9.6 miles with twelve stops at a speed of 16.9 miles per hour, is probably without an equal for steam service.

The proposed speed on the "Subway" is a matter of much public interest. According to the terms of the operating contract, the required schedule speed for local trains,

TABLE XXIII.

DAILY VARIATION OF PASSENGERS FOR AVERAGE SUMMER AND WINTER WEEKS ON MANHATTAN SURFACE AND BROOKLYN SURFACE, ELEVATED AND BRIDGE LINES.

Summer Week	All Manhattan Surface Lines, July 14–20, 1901	All Brooklyn Surface Lines (B. R. T. Co.), Aug. 25–31, 1901	Brooklyn Elev. Lines, Except Bridge Line, Aug. 25–31, 1901	Brooklyn Bridge Elev. Line, Aug. 25–31, 1901
Sunday	873,557	993,580	116,085	8,960
Monday	1,129,859	726,853	131,813	21,404
Tuesday	1,115,695	690,949	125,059	18,235
Wednesday	1,082,351	725,686	128,389	18,170
Thursday	1,062,969	667,044	122,716	17,692
Friday	1,055,934	814,152	118,659	19,700
Saturday	1,085,860	804,035	150,783	20,059
Total	7,406,225	5,422,299	893,514	124,220
Winter Week	Dec. 16–22, 1900	Jan. 13–19, 1901	Jan. 13–19, 1901	Jan. 13–19, 1901
Sunday	691,747	446,257	93,083	7,471
Monday	1,058,285	609,480	186,158	18,238
Tuesday	1,069,639	569,398	167,062	14,72[illegible]
Wednesday	1,110,950	591,260	169,116	14,989
Thursday	1,102,023	591,093	165,201	13,903
Friday	1,204,540	538,008	162,954	16,442
Saturday	1,102,273	564,338	175,522	16,598
Total	7,339,454	3,909,834	1,119,096	102,361

TABLE XXIV.

SCHEDULE SPEED OF BUSIEST SURFACE LINES, AUGUST, 1901.

	Length of Single Trip, Miles	Time for Single Trip, Minutes	Schedule Speed between Given Terminals Miles per Hour
Manhattan			
Broadway (South Ferry to 146th St. and Lenox Ave. via 53d St. and Columbus Ave.)	10.3	72.5	8.5
Broadway (South Ferry to 23d St.)	3.2	27.0	7.1
Fourth Ave. (Post Office to 135th St.)	8.3	57.5	8.7
Eighth Ave. (South Ferry to 155th St.)	10.2	70.0	8.7
23d St. (East River to North River)	2.1	15.0	8.4
Brooklyn			
Fulton St. (East New York to Park Row, New York)	6.6	55.0	7.2
Culver—Coney Island (West Brighton to Greenpoint Ferry)	13.5	77.0	10.5
Bridge Surface Line (Sands St. to Park Row)	1.1	7.0	9.4

including stops averaging .42 mile apart, is 14 miles per hour, and for express trains 20 miles per hour. The minimum headway for local trains will probably be one minute, and for express trains two minutes, and the maximum speed to be attained will be at least 38 miles per hour. It is expected that the running time from Manhattan City Hall to 104th Street, a distance of 6.8 miles, will be 13 minutes, or at the rate of 31.4 miles per hour, including three stops and two short radius curves.

On one of the page maps are shown lines 10 minutes apart, representing rapid transit time from the Manhattan City Hall to points of intersection with elevated and steam railroad suburban lines. That is, at the points on these lines denoted by figures, the shortest time is given in which it is possible at present to travel from the City Hall by the fastest regular express or local train. The first line of 10 minutes includes the time necessary to walk from the City Hall to the nearest elevated station. Immediate connections are assumed at all connecting points. The lines between the points marked are simply to join the points, and do not correctly represent the rapid transit time between. It is interesting to note that the 60-minute limits almost coincide with the external boundary of the city. The west side of Manhattan is shown to be more convenient in point of time than the east side. The 104th Street station of the "Subway," mentioned above, is here shown about 25 minutes minimum time from the City Hall, which it is expected to reduce by one-half. Of this 25 minutes' time of transit, however, 5 minutes have been spent in walking to the elevated station from the City Hall, and if the passenger lives a half-mile from the 104th Street station, an additional 10 minutes would be occupied in walking this distance. In other words, 20 minutes would be spent on the train and 15 minutes on foot. The "Subway" line proposes to save 7 minutes of the train journey, so that unless the walking time could be shortened, over one-half the total time for this given case would be spent in covering a comparatively short distance. Half the time would be spent at a rate of 3 miles per hour, and half at 30 miles per hour. This forces the conclusion that until frequent crosstown lines are operated, and with the north and south surface lines provided with practically free and unlimited transfers to high-speed elevated and underground lines, the benefits of rapid transit will be restricted. If the economic result of a general consolidation of all the transportation lines in the city would secure this condition it would accomplish a great benefit to the community.

THE CENTER OF THE THEATRE DISTRICT, BROADWAY AND FORTY-SECOND STREET, MANHATTAN

In conclusion, the writer wishes to express his appreciation of the courtesies extended by the officials and staffs of the various railway companies the data of which are included herein, and especially to Messrs. Vreeland, Warren, Root and Moorehead, of the Metropolitan Street Railway Company; Messrs. Skitt and Baker, of the Manhattan Railway Company; Messrs. Wheatley, Folger, Longyear and Gearhart, of the Brooklyn Rapid Transit Company, and C. C. Martin, of the Brooklyn Bridge.

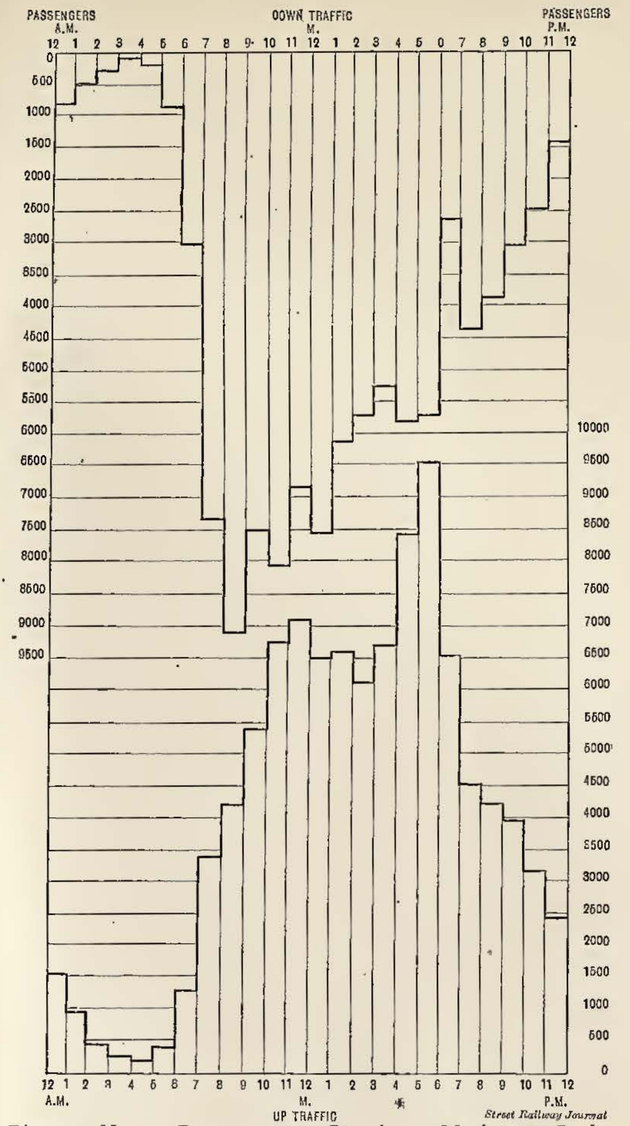


Diagram No. 1—Passengers on Broadway, Manhattan Surface Line, Monday, June 24, 1901.

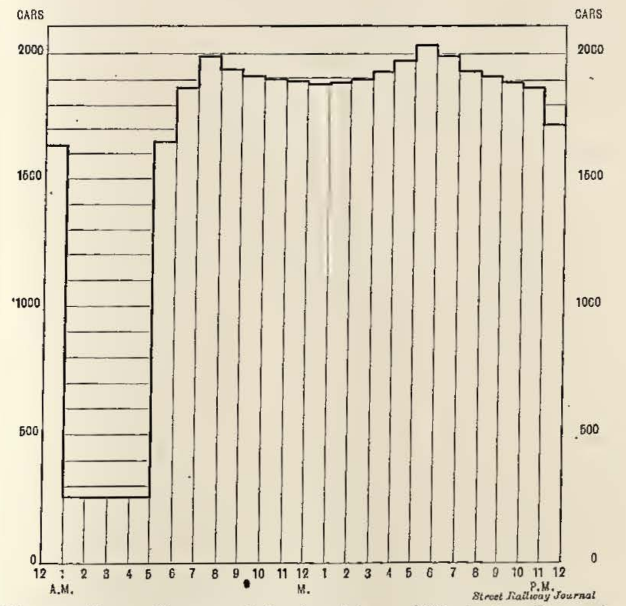


Diagram No. 4—Cars on all Surface Lines of Manhattan Borough, Wednesday, Sept. 4, 1901.

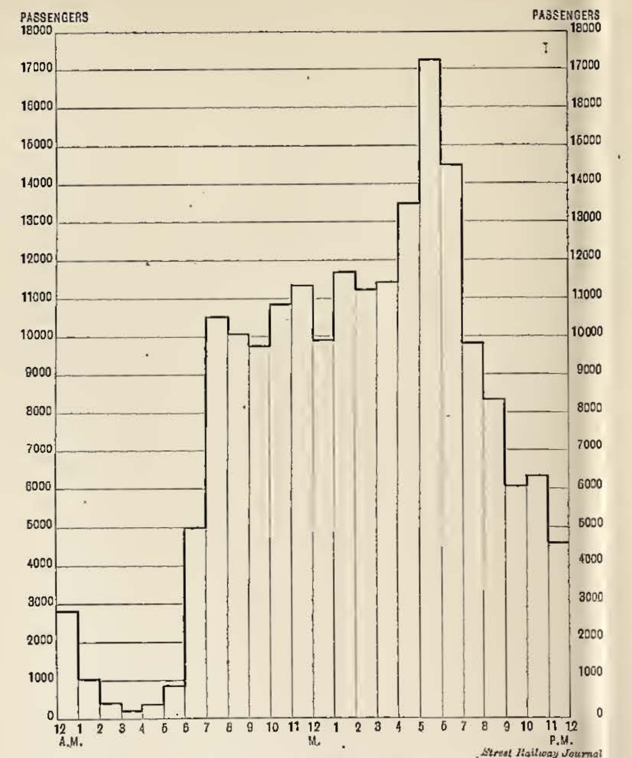


Diagram No. 2—Passengers on Fourth Avenue, Manhattan Surface Line, Monday, June 24, 1901.

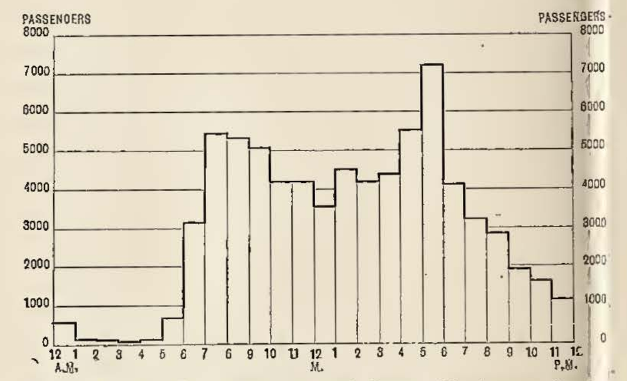


Diagram No. 3—Passengers on 23d Street, Manhattan Surface Line, Monday, June 24, 1901.

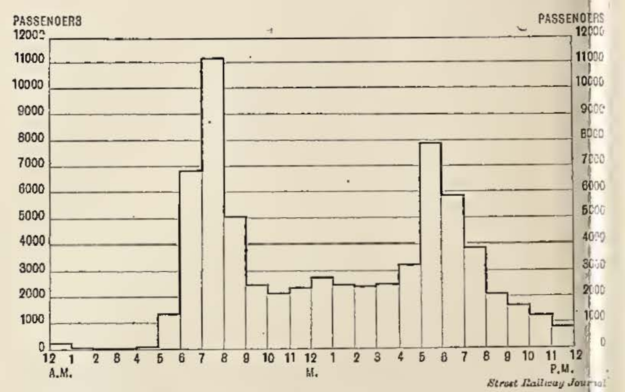


Diagram No. 6—Passengers (Ticket Sales) on Second Avenue, Manhattan Elevated Line, Wednesday, Oct. 10, 1900.

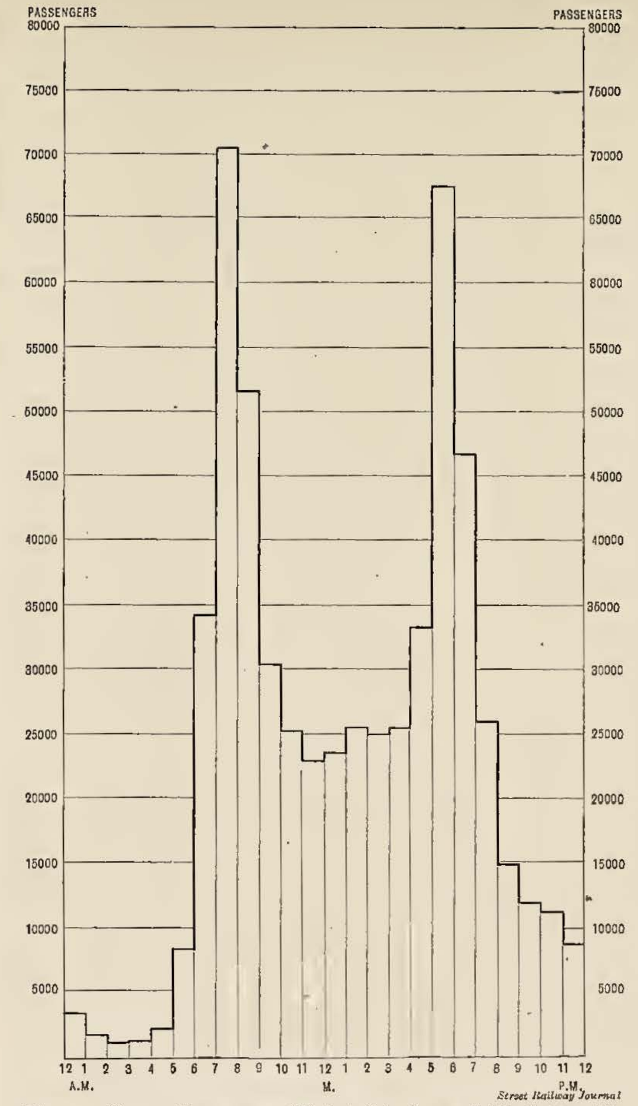


Diagram No. 5—Passengers (Ticket Sales) on all Manhattan Elevated Lines, Wednesday, Oct. 10, 1900.

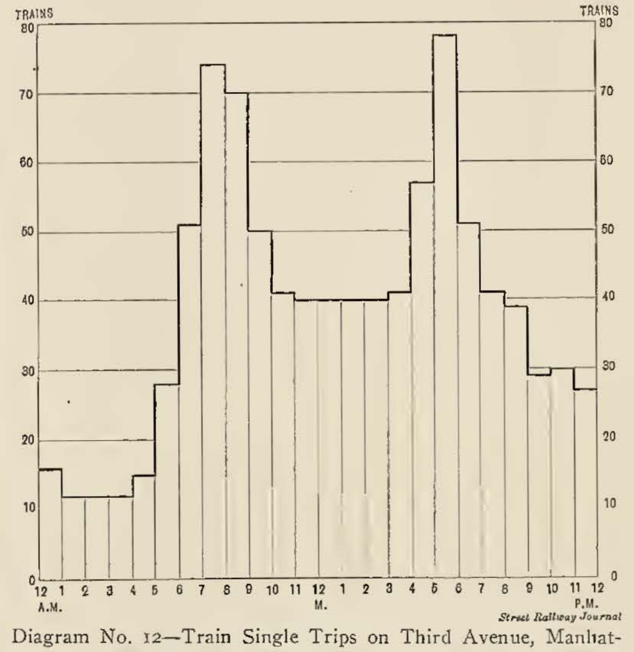


Diagram No. 12—Train Single Trips on Third Avenue, Manhattan Elevated Line, Wednesday, Oct. 10, 1900.

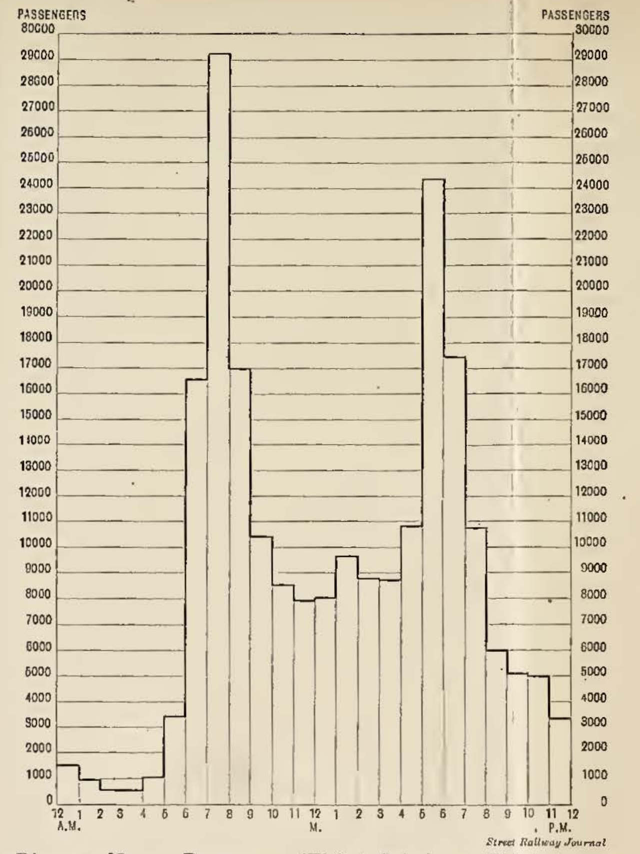


Diagram No. 7—Passengers (Ticket Sales) on Third Avenue, Manhattan Elevated Line, Wednesday, Oct. 10, 1900.

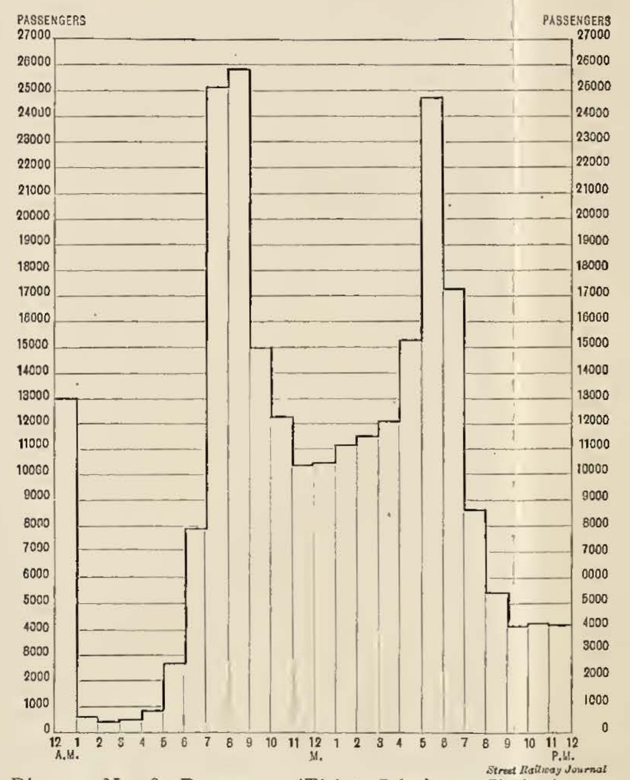


Diagram No. 8—Passengers (Ticket Sales) on Sixth Avenue, Manhattan Elevated Line, Wednesday, Oct. 10, 1900.

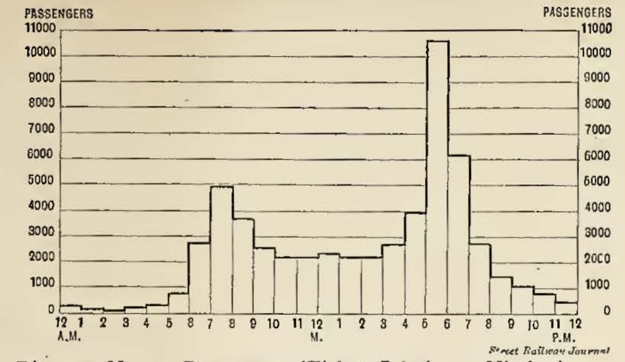


Diagram No. 9—Passengers (Ticket Sales) on Ninth Avenue, Manhattan Elevated Line, Wednesday, Oct. 10, 1900.

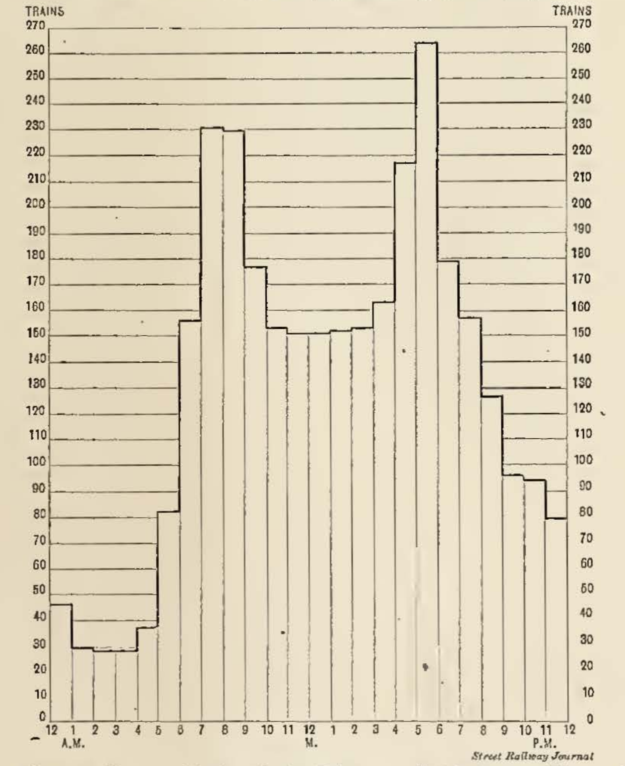


Diagram No. 10—Train Single Trips on all Manhattan Elevated Lines, Wednesday, Oct. 10, 1900.

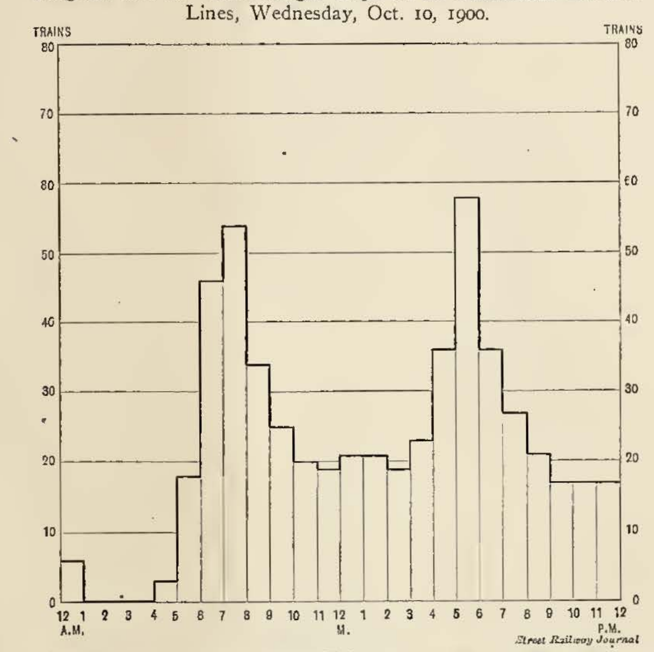


Diagram No. 11—Train Single Trips on Second Avenue, Manhattan Elevated Line, Wednesday, Oct. 10, 1900.

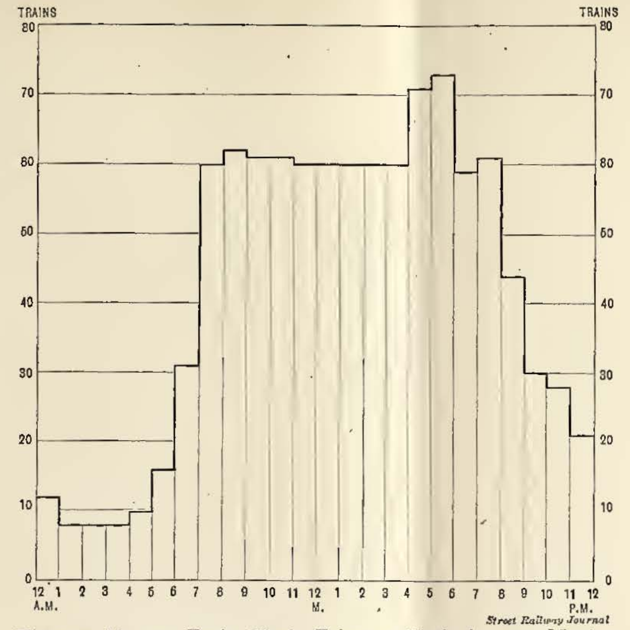


Diagram No. 13—Train Single Trips on Sixth Avenue, Manhattan Elevated Line, Wednesday, Oct. 10, 1900.

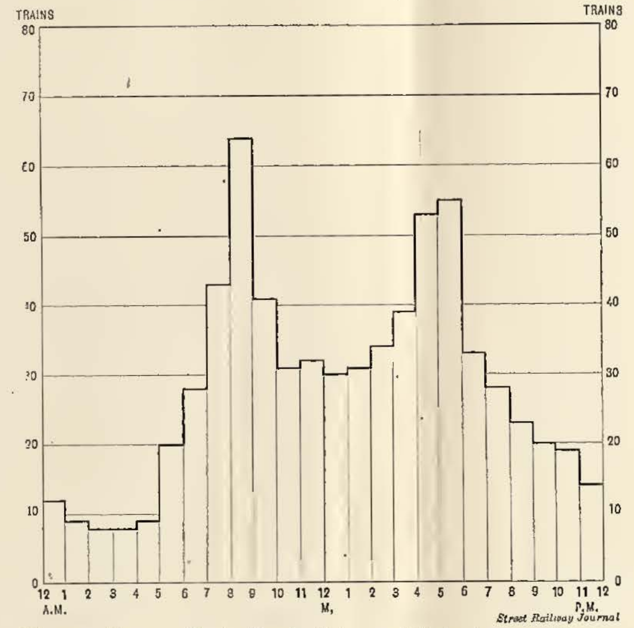


Diagram No. 14—Train Single Trips on Ninth Avenue, Manhattan Elevated Line, Wednesday, Oct. 10, 1900.

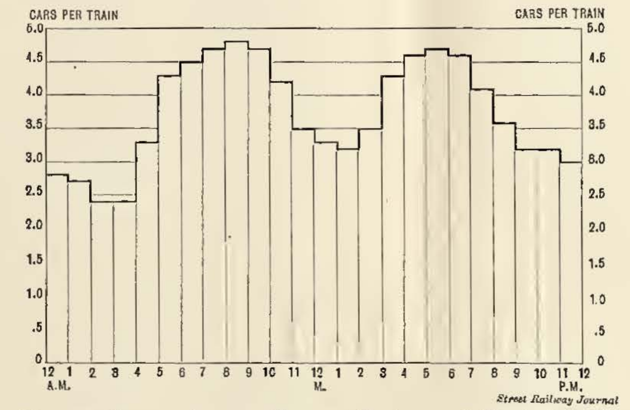


Diagram No. 15—Average Cars per Train on all Manhattan Elevated Lines, Wednesday, Oct. 10, 1900.

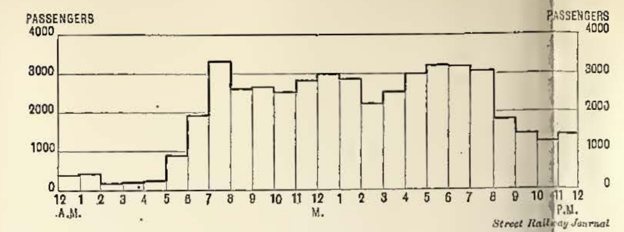


Diagram No. 16—Passengers on Fulton Street, Brooklyn Surface Line on Average Weekday, August, 1901.

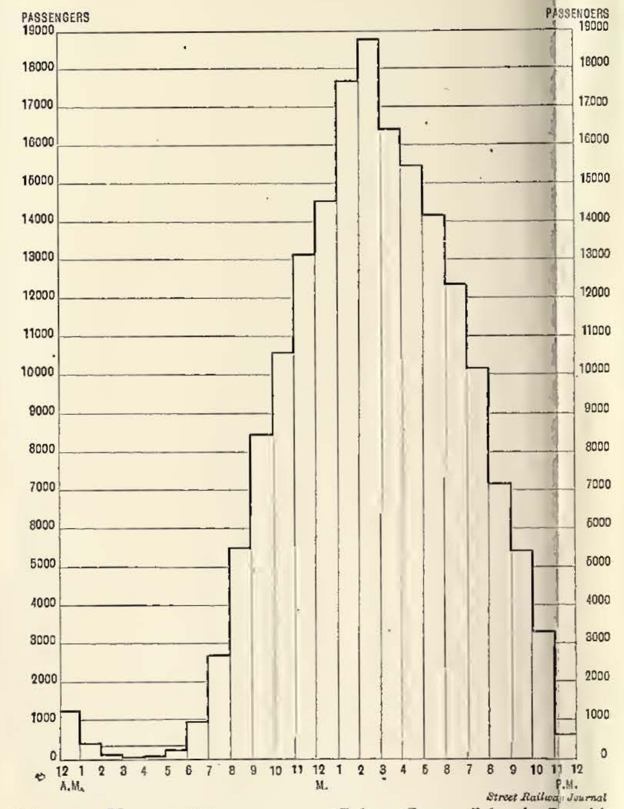


Diagram No. 17—Passengers on Culver-Coney Island, Brooklyn Surface Line, Sunday, June 30, 1901.

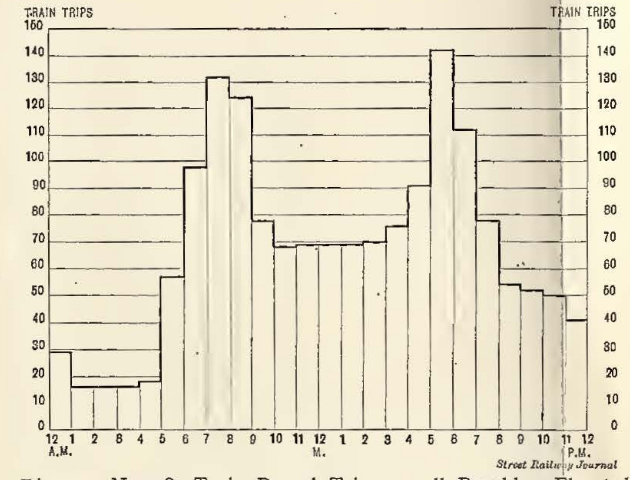


Diagram No. 18—Train Round Trips on all Brooklyn Elevated Lines, Wednesday, Sept. 4, 1901.

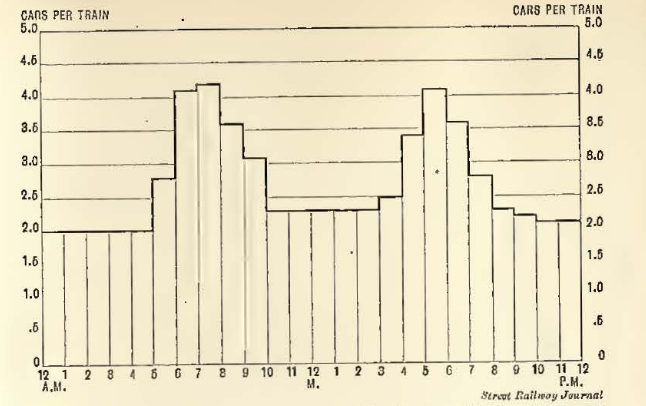


Diagram No. 19—Average Cars per Train on all Brooklyn Elevated Lines, Wednesday, Sept. 4, 1901.

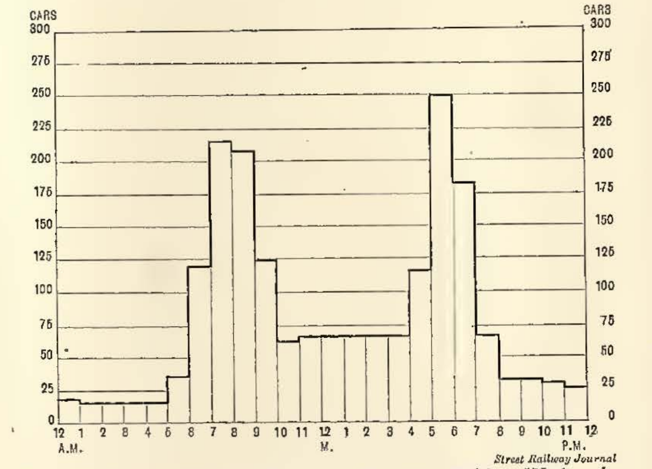


Diagram No. 20—Surface Cars over Brooklyn Bridge, Wednesday, Sept. 4, 1901.

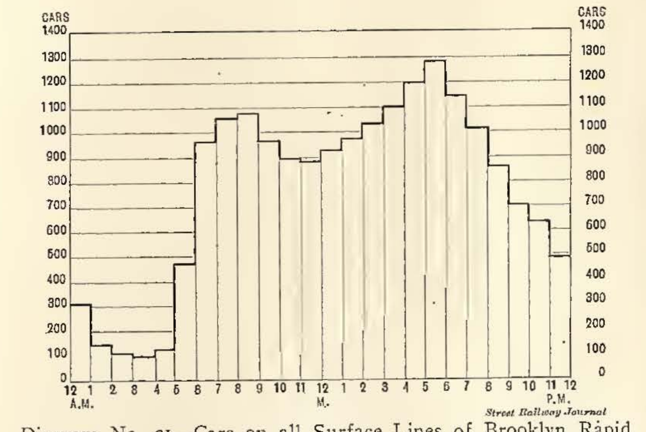


Diagram No. 21—Cars on all Surface Lines of Brooklyn Rapid Transit Company on Average Weekday, August, 1901.

DIAGRAMS SHOWING VARIATIONS OF TRAFFIC AND CAR SERVICE IN NEW YORK CITY

THE UPBUILDING OF THE METROPOLITAN ORGANIZATION

BY H. H. VREELAND

President, Metropolitan Street Railway Company.

THE history of the organization and development of the Metropolitan Street Railway Company, while covering a long period of years and full of interesting details, can, I think, be very briefly told. The transit facilities of the City of New York, like those of nearly every other center of population in the East, were originally developed at haphazard, yet I suppose most of the enterprises that devised the "Neighborhood" railroads of the early days were regarded as adventurous achievements. As one reads the history of the heated debate in public bodies as to the necessity of railways in streets, where even the horse car bell no longer jingles, the idea grows that maybe the city has changed a little since the days when Bleecker Street and Beekman Street and various other alley-like thoroughfares were main arteries of travel. Considering the struggles the pioneer street railway men had in their effort to furnish the riding public accommodation, and remembering the means at their disposal, I sometimes think they were greater men than history esteems them. The opposition they encountered, in the way of public prejudice and official ignorance, was greater than that met to-day, and while their successors boast a great superiority, it is well to remember that conditions have changed, and that the problem presented to us to-day, difficult as it is in some aspects, is not so great as that which confronted them. When I grew familiar with the history of these pioneers I wondered at their resource and persistency, and when I learned that, in the early days, some of them paid for the hay they fed their horses with certificates of the capital stock of the concern, I thanked the discrimination of the Providence that cast me into the late instead of the early days of street railroading in these parts.

Up to 1854 such internal transportation as the population of Manhattan Island had was furnished by various stage lines. In the thirty years, between 1854 and 1884, the street car lines had been constructed along most of the north and south avenues, and, with some exceptions, the present east and west roads were in operation. The ownership and management of these various properties was of great variety, and a great deal of energy and influence was wasted in rivalries that made impossible any development on broad lines. After the scandal which the granting of the Broadway charter developed, the old regime of railroading management was utterly discredited, and into the situation came the present owners and managers of the Metropolitan Street Railway, to whose broad and enlightened policy the present great development is due. Beginning with the acquisition of a small road, known as the Houston, West Street & Pavonia Ferry Road, about 5½ miles long, they have acquired, either by purchase, lease or development, practically all of the street surface railway lines in the Boroughs of Manhattan and the Bronx. The property now consists of 475 miles, made up as follows:

LINES CONTROLLED BY THE METROPOLITAN STREET RAILWAY COMPANY.

	Miles
Avenue C Railway	7.56
Chambers Street Railway	4.80
Metropolitan Crosstown Railway	7.67
Columbus Avenue Railway	6.52
Lexington Avenue Railway	11.12
116th Street East & West Railway	3.76
Broadway Railway	10.26
Broadway & Seventh Avenue Railway	11.42
Ninth Avenue Railway	15.61
Eighth Avenue Railway	18.31
Sixth Avenue & Lenox Avenue Railway	13.54
Fourth Avenue Railway	18.61
Second Avenue Railway	28.59
Central Park North & East River Railway	26.62
Twenty-Third Street Railway	5.78
Bleecker Street Railway	9.97
Fourteenth Street Railway	3.40
Forty-Second Street & Grand Street Railway	8.66
Thirty-Fourth Street Crosstown Railway	1.74
Fulton Street Railway	2.00
Twenty-Eighth & Twenty-Ninth Street Railway	4.85
Central Crosstown, Chambers & Tenth Street Ry.	11.24
Third Avenue Railway	26.84
Forty-Second, Manhattanville & St. Nicholas Ave.	25.71
Dry Dock & East Broadway Railway	10.48
Union Railway	70.86
Southern Boulevard Railway	7.00
Tarrytown & White Plains Railway	23.19
Westchester Electric Railway	23.72
Yonkers Railway	24.32
Kings Bridge Railway	10.50

While bringing these properties under a single control for the ultimate purpose of rationally treating the transportation problem of the most congested center of population on the Continent, physical revolutions have been made in the application of new kinds of power traction, with which everyone is now familiar, and reforms have been initiated by means of which the whole of the street facilities under the control of the corporation have been thrown open for public accommodation, and by the development of a transfer system, which is the subject of special comment elsewhere, single-fare access has been given to and from all parts of the territory covered by the company's lines.

In working out the details of this comprehensive scheme none was more interesting to me than that of the organization of the human factors involved in the operation of the property, and on that account, perhaps, I have been requested to say something on that subject.

Quite aside from the obvious effect of this consolidation on public comfort and security of investment, this side of the work is of deep interest. The effects of it have been far-reaching; first, upon the individual lives of the employees and upon their elevation as a class. I have always thought that one of the most demoralizing influences at work among men who labor was the insecurity of their tenure and employment. Having been in the ranks myself, I know the unsteadying influence of this kind of insecurity, and it was one of the first subjects that received my atttention when this property was put in my hands.

Of the methods employed to bring about the *esprit de corps* that now exists among our employees I will speak later. It is sufficient for the moment to say that, broadly speaking, its result has been to reclaim from the mass of what might be called "miscellaneous laborers" about 15,000 individuals, and establish them into what may, without exaggeration, be called a craft. If the effect of this combination and consolidation had done no more than this, it would have worked a benefit to the community greater than that accomplished in longer time by some institutions which had no other ostensible motive than the protection and elevation of the laboring class. To establish in any community a class of men of this numerical strength, impressed with the idea of individual responsibility and loyalty to the service in which they are engaged, is a respectable contribution to civic order. Some idea of the steadying influence of rational treatment of men may be gathered from the fact that with a force of a little over 4000 men in 1893 there were discharged an average of 300 men a month. Now, with over 200 per cent more men in employment, the monthly discharges are not within 30 per cent as great as eight years ago.

It is important to point out in this connection that this result is very largely due to the men themselves, and its growth has been continuous, for the reason that the association which the men have organized has not been demoralized by patronage of any kind from the owners of the property. In other words, the men have been assured that any effort to improve their status or help one another without outside interference would not be objected to, in fact, would be encouraged, and during the last eight years, as several crises have arisen, during which the truth of this assurance was tested, it is established, and no one now questions it.

The financial results of this co-operation among the employees of the Metropolitan Street Railway Company are not less extraordinary than the success of the corporation itself, since it has, during the five years of its existence, collected from its members $92,799.84, paid out $14,699 in death benefits, and $44,392 in sick benefits, furnished itself with $14,748 worth of entertainment, in the way of receptions and balls, and accumulated $18,443.34, which the members of the association, of their own motion, have invested in the securities of the company that employs them.

I linger on the consideration of this particular aspect of the organization of the Metropolitan with satisfaction, for the reason that I think it peculiar to this corporation alone. It is unique in the idea underlying it, and is based on the individual employee instead of on the corporation. It is an evidence to me that, notwithstanding the inevitable irritation that must necessarily arise at times between employers and employees, an appeal to manhood and to the individ-

THE JUNCTION OF BROADWAY, SIXTH AVENUE AND THIRTY-FOURTH STREET, A BUSY TRAFFIC CORNER

VIEW ON BROADWAY, NEW YORK, NEAR POST-OFFICE ual's better side will, in the long run, be successful. I have seen very small results from efforts at combining men in a single employment under the patronage of their employers, and this has been due, in my opinion, based on my experience, to the fact that there is in workingmen a spirit of resistance to patronage of any kind. There is no compulsion exercised on any of the men employed on the Metropolitan property to join the association, and membership in it secures no kind of immunity. It in no way affects the relationship between the company and its employees, which is based upon the contribution of efficient service on the one hand, and just treatment and prompt payment of wages on the other.

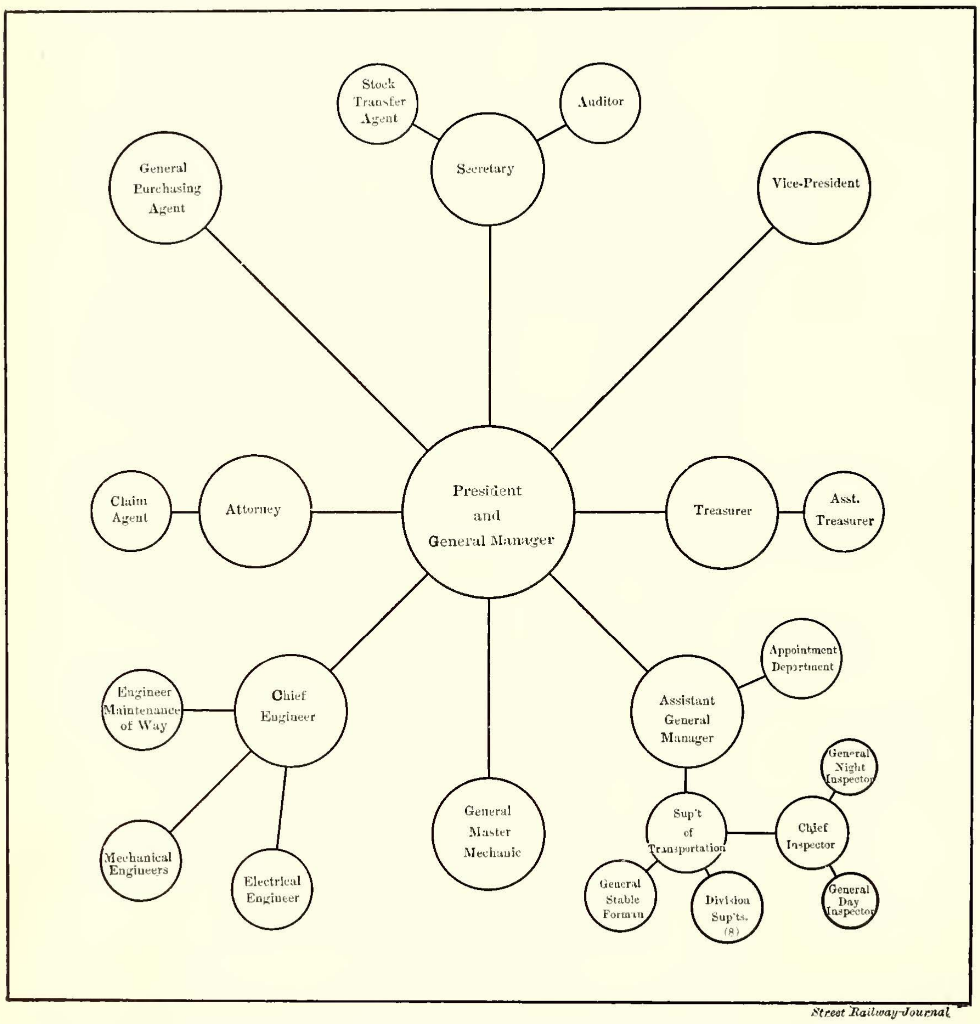


DIAGRAM SHOWING ORGANIZATION OF METROPOLITAN STREET RAILWAY COMPANY

When I originally took charge of the operation of the Metropolitan system, as it then existed, in 1893, I made many investigations, among others, one concerning the method of recruiting the working force, and I found, as was to be expected in a mass of properties developed by different interests and conditions, a great variety of practice. To my mind, they all seemed to lack much in addition to uniformity. Influences, local, State and personal seemed to control, and from the numerous discharges, it was evident that unless some reform was inaugurated, the supply of male individuals available for this kind of work in the community would presently be exhausted, and thereupon was set in motion a system of recruiting, which, in a short time, secured us the class of men we now have, who have, on more than one occasion, demonstrated their efficiency and loyalty. It soon became known that any man within certain age-ranges, of good physique and intelligence, with the recommendation of any householder as to his character and honesty, could find employment on the property, and in a short while, instead of having a mass of left-over inefficients, the personnel improved, discharges decreased and efficiency was established. I do not wish to be understood as claiming that perfection has been achieved, or that the employees of the company have been organized into army regularity, but I do wish to point out that a new system has been thoroughly rooted; that by means of it discipline is stricter and more easily enforced; that the status of the men has, for the first time in this kind of employment, been so fixed that it can be terminated only by misconduct on their part, and that a great mass of men has been emancipated from the whimsical tyranny of small sub-officials. With us, when a man is discharged, he knows the reason, and only in most aggravated cases is he discharged for a first offense. Complaints are always investigated, the men are given a hearing, and the conditions surrounding the offense are always taken into consideration.

Among the most significant results of this change in recruiting and steadying of status has been the marked lengthening of the term of employment, which, in eight years, has, notwithstanding our rapid recruiting, risen from an average of something like nine months to about eighteen months.

With the introduction of electricity and the adoption of entirely new mechanism, it became necessary for us to open a school of instruction, since there existed nowhere a body of men skilled in the handling of vehicles thus controlled, and out of this necessity has grown a school of preparation which might be called a street railway kindergarten. Applicants for appointment, having complied with the conditions precedent I have just named, are sent to this school of instruction, where, under the direction of an instructor, they are shown, in a class, the interior mechanism they are to control on the street. Everything from the wheels, brakes, trucks, motors and light wiring of the car is exposed in half section. The controller is explained, and we have rigged up a number of dummy platforms, upon which the men are exercised and instructed in the controlling of the brake and the current. A section of the roadbed is shown, exposing the conductor-bars, cables and the plow mechanism, so that a man, before he is put upon the platform of a car for instruction, is thoroughly informed, whether he be motorman or conductor, of the mechanism and its management. After sufficient schooling and actual practice on the thoroughfares, where he begins to learn the difficulties of operation at congested points, he is put on the extra list, from which he is soon recruited and given a regular run. Once fixed in this employment, his status is secure, and he knows that he has secure employment, the duration of which depends solely upon himself. He is moved up as places ahead of him become vacant, not by special favor, but by reason of his place in the line. From those highest on the list and longest in the service, this being of itself evidence of efficiency, are recruited the men who get the choice runs and barn jobs.

Before dismissing this subject, it may be well to say a word in reference to the effect of consolidation upon wages. We are all familiar with the claim frequently made that the consolidation of properties of this kind is against the interests of labor, and it has been pointed out, with elaborate sophistries by labor agitators, that the ultimate result of consolidations would be a reduction of the working force and of wages. I suppose that, in a modified way, the experience of the Metropolitan Street Railway Company is that of every other corporation, which is the result of consolidation. With us, computing on a mileage basis, the result has been that the corporation now furnishes work for twenty-five men where, ten years ago, it found employment for one. So far as my experience goes, there has been no curtailment so great, as the result of consolidation, as that effected among ornamental officials. Now we have one president instead of twenty odd, to say nothing of secretaries, managers, superintendents and the like. Among the working force, from which the loudest protest is heard against combinations, the effects have all been good, and instead of diminishing, wages have increased during the time under discussion, largely owing to consolidation, 15 per cent.

As the organization of the operating force of the Metropolitan Railway Company has been somewhat modified since it was last subject of comment, by the Street Railway Journal, in September, 1896, I give, on the opposite page, a graphic scheme of the interdependence of the various department heads, as developed in our practice of to-day.

Some idea of the contraction that has gone on in the official class may be gathered from this diagram, if one bears in mind that each of the underlying companies, if properly organized and managed, should support, down to a certain point, a similar staff.

The subdivision of authority shown in this chart has, in Metropolitan practice, resulted in great operating efficiency. In each of the departments shown, the head has practically absolute control, and is held responsible for its smooth working. He is virtually a vice-president in charge of his special department; he has absolute power to deal with emergencies and details as his judgment dictates; he is held responsible for general results and the maintenance of a standard of efficiency. In a system of this kind the sudden calls for the exercise of experienced judgment are so frequent as to make this liberty of action absolutely necessary. I have found that it diminishes hesitation, develops the initiative of sub-officials, and reduces the tendency (soon developed in all large systems) to let some one else take the responsibility or to wait until to-morrow.

If I might be permitted a comment before dismissing the subject of the human factor involved in the operation of a street railway system, and, for that matter, in any system, I would say that men of the class from which such help is recruited are as quickly demoralized by wet-nursing as by abuse, and that the surest way to manage them is to have discipline, just and equal. In a mass thus governed, efficiency asserts itself, and if the crop is not always as big as expected, such as you get is at least healthy and reliable.

TRANSFERS AND TRANSFER PROBLEMS WITH SPECIAL RELATION TO NEW YORK

BY OREN ROOT, Jr.,

Assistant General Manager, Metropolitan Street Railway Company

THE designation of transfers as a necessary evil is so trite that it has come to be almost an axiom among managers that if they could only rid themselves of the necessity of giving these free tickets they would greatly increase the net earning capacity of their lines. This feeling, I believe, has been brought about in large part by the fact that all systems of this kind, and none is perfect, have certain undeniable drawbacks and are open to a number of abuses. These defects, being constantly and necessarily brought to the attention of those in close touch with the operation, often make more impression upon their minds than the ninety and nine benefits which accrue from the use of the transfer system, and which are reflected directly in the number of passengers carried.

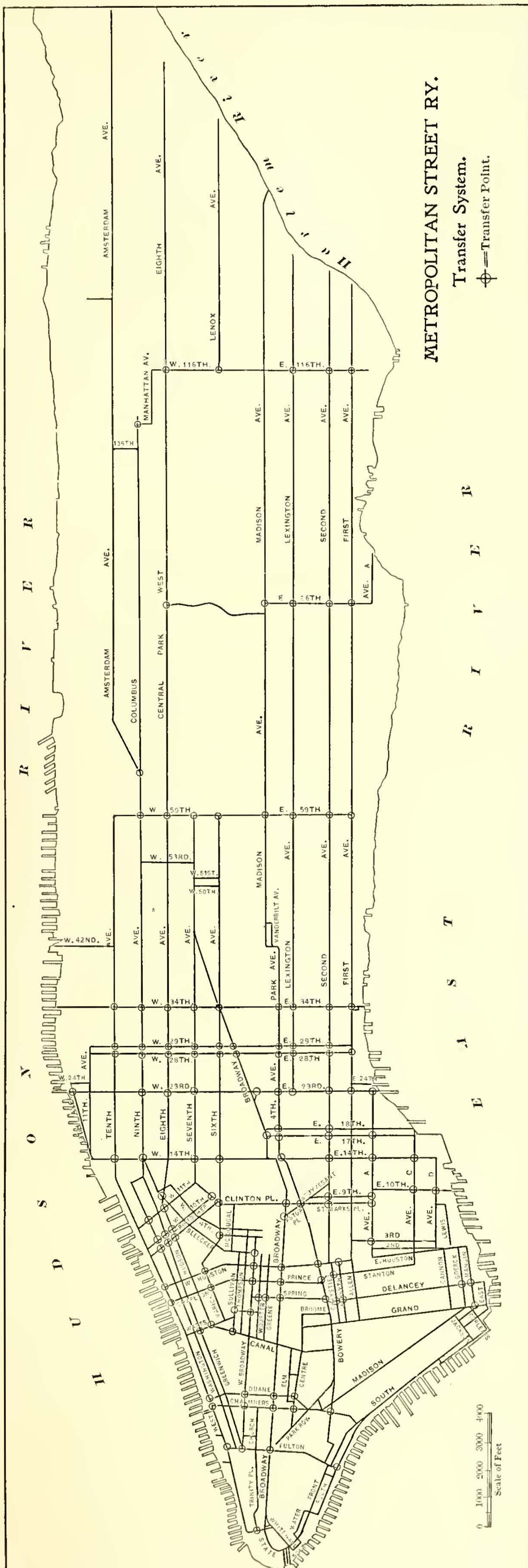
Of course, it is impossible to calculate the dollars and cents which any indirect source of revenue is worth to a company, but the traffic development upon the lines of the Metropolitan system has demonstrated to my mind conclusively that in its case certainly the transfer system has been a most potent factor in its enormous growth. This is, of course, a personal opinion only, and may seem highly unorthodox. Nevertheless, the experience in New York tends to show that in that city, at any rate, the liberal system of transfers adopted and in force during the last eight or nine years has increased the earning power of the company more than any other one cause, the introduction of electricity as a motive power not excepted.

When the transfer system was first introduced there was a strong opposition to it by old officials. The men who had closely identified themselves with the street railways of New York in the old companies looked upon the employment of transfers as undesirable from every point of view. While the men who are responsible for the improvement of the Metropolitan system of transfers at that time saw the conditions of the future and looked at the matter with more liberality than those who had been managing the old companies, they could not foresee the enormous extent to which the business would develop. Measures, therefore, which were considered radical and extreme in the issuing of transfers six or eight years ago would now be thought ultra conservative.

The Metropolitan Street Railway Company's system of transfers, as it exists to-day, is like many other things on the system, the result of a special study of the conditions of New York City and adaptation of methods thereto. Nine or ten years ago, before the wave of consolidation struck New York, the lines which now comprise the Metropolitan system were all being operated by horse cars as separate and individual companies. In the early nineties consolidation was begun, and the transfer privileges allowed were the product of consolidation; they were due partly to a desire to meet the competition of the elevated roads and partly to allow the people of New York to share in the benefits of the consolidation which had just been effected. Line after line was subsequently taken in by this company, until to day there is not a foot of street railway track on Manhattan Island which is not a part of the Metropolitan system. In this article, however, it is not the intention to treat of the Third Avenue system (including the Forty-Second Street, Manhattanville & St. Nicholas Avenue Railway and the Dry Dock, East Broadway & Battery Railway). As these lines have been lately acquired, they have not constituted a factor in the history and development of the Metropolitan transfer system. Moreover, before they came under the control of the Metropolitan they had made a contract for the exchange of transfers with the elevated road, which prohibited them from entering into transfer agreements with any other company. Consequently, the Third Avenue line exchanges transfers only with its own lines as mentioned above.

When the transfer privileges were first introduced on the Metropolitan system, Stedman time limit tickets of the usual form were adopted; most of them were issued by the conductors, but part were handed passengers by transfer agents on the street; these agents were placed at the heaviest transfer points, where it was considered that the work was too burdensome for the conductors. The object which the officials of the company had in view when they first established the system was to pick out certain roads over which travel was heavy and allow people, by means of a transfer, to get from certain portions of the city to other portions over two of the company's lines for a single fare.

This was primarily the idea of the transfer system, and as such it was continued for some time, but as consolidation continued, the demand for increased transfer facilities was met by constantly allowing greater privileges until a year ago, when there was practically a universal transfer between all the lines of the Metropolitan system. During this time the company had never waived its right to make certain limitations in its transfer system; nevertheless, the enormous traffic which had been developed by means of it and other improvements, such as the change from horse to mechanical power and all that goes with this change, created such a congestion of traffic that conductors were practically unable to follow the regulations as to transfers laid down by the company. The practical result of this neglect was that the owners of the system found themselves a year ago face to face with the fact that the people of New York could ride over the Metropolitan lines in any direction and practically for any length of time for a single fare, and that this was being done to a considerable extent. It was made possible by the reason that the Metropolitan Company was using a ticket which, while perfectly adequate to meet the demands of roads with a comparatively small volume of traffic, and which, in fact, met the demands of the Metropolitan roads at first, was yet inadequate for the system the Metropolitan had developed after



METROPOLITAN STREET RY.
Transfer System.
⊕=Transfer Point.

the seven or eight years of consolidation, with its improvements in motive power and in general traveling facilities.

As a result of this growth, the ordinary issue of one day now amounts to about 500,000 transfers, as against 30,000 at the time the transfer system was started nine or ten years ago. Madison Avenue, in horse-car days, just previous to electrical equipment, issued about 15,000 transfers per day. It now issues 75,000.

These statistics are given to show that the problem presented, and consequently its solution, made the question an entirely different one from that where a much smaller traffic is concerned. The minute details called for in issuing transfers and the time which would be required if they were all properly followed by the conductor, made the Stedman ticket, in my opinion, of no more value as a safeguard on the Metropolitan lines than a piece of paper with nothing printed upon it, but giving the holder an unlimited privilege of riding in any direction over all the lines of the company.

The conductors upon the Metropolitan lines were the first to appreciate this condition. The company laid down certain rules which they were supposed to follow. They were expected to punch the hour, fifteen-minute limit, month, date and the junction upon these tickets; four distinct markings in all. The imposibility of doing this properly soon became obvious. In the first place, with plenty of time and with no other exactions, it is not an easy matter to punch the ordinary time-limit transfer, and with the conditions of heavy traffic under which the Metropolitan employees had to work, such punching as was necessary to make this ticket of any value at all was practically out of the question. The consequence was that most of the transfers issued were either carelessly or improperly punched, or not punched at all. The conductors receiving such transfers had little time in which to examine them as to how they were marked, and even if this had been possible, the fact that the transfers were known to be often not correctly punched prevented the company from drawing the line closely as to the non-acceptance of transfers not presented at the proper time and place. In other words, the company had a transfer system which was perfectly correct in theory, but which it was absolutely impossible to work in practice.

One might argue that the conductors should be made to punch the transfers correctly, and should be required to accept only those presented at the hour and place indicated. The answer to this is that the chances were that for every ticket which the conductors punched properly they would miss a cash fare.

Anyone who has patronized the street railway lines of New York to any extent can appreciate how little time a conductor has to take pains in punching out a long list of items on a transfer ticket. To illustrate the conditions which existed, Fifty-Ninth Street, which is one of our busiest crosstown lines, may be taken. This line is short, but has a number of intersecting north and south lines. One conductor alone on this line would frequently issue as high as 1400 transfers a day, or 140 per hour. During the first six months of 1900 2,899,601 cash fares were paid on this division and 11,655,784 transfer passengers carried. The consequences of such a condition are easily seen. The officials could not compel the conductors to punch their tickets properly or instruct them to place any reliance upon the punching of the tickets received. The public soon became familiar with this condition, and found that any ticket could be presented upon any line, however valueless it might be, with the practical certainty that it would be accepted. We were in a position where we were dependent upon the fallibility of 4000 conductors, and the chances, instead of being against the making of mistakes, were so much in favor of it that the whole limitations intended to regulate the use of the ticket became absolutely valueless.

It might be well, before giving concrete examples of the way the old transfer system worked, to mention for the information of those who are not familiar with the Metropolitan system the unusual manner in which the street car lines in New York have been laid out. Manhattan Borough, to which this discussion is confined, is unique in that its width does not average more than about 2 miles, while its length is about 12 or 14 miles. Almost all the lines of the Metropolitan system, and all of special importance, run either north and south or east and west. The crosstown lines have from 1¼ single to 5 miles of single track, and the north or south lines from 15½ to 25 miles of single track. The north and south lines are really the main carrying trunk lines of the system, and the short crosstown lines cutting the city every few blocks from the Harlem River to South Ferry act to a large extent as feeders to the trunk lines.

Owing to the incorrect punching of the transfer tickets it was then easily possible for a person to start from downtown, go uptown in the morning, transact business and return downtown the latter part of the day for one fare by means of transfers. To illustrate the character of the greatest abuse, errand boys and others would start from the downtown end of the Fourth Avenue line, as seen by the accompanying map of our system, ask for a transfer at Fifty-Ninth Street or other crosstown line, and return down Lexington Avenue almost to the starting point. The large number of north and south lines close together which this company owns, of course, made transferring back and forth up and down town easy, as a person could go up town on one line, and, by transferring, come back on a neighboring line to the immediate vicinity of the starting point.

This condition of affairs was one which had grown gradually upon us, and was due rather to the inherent difficulty of making the old-fashioned system meet the new conditions than to any laxity or mismanagement or to intentional dishonesty on the part of the public. The expansion of the traffic and transfer system for the past fourteen years is shown by the following table:

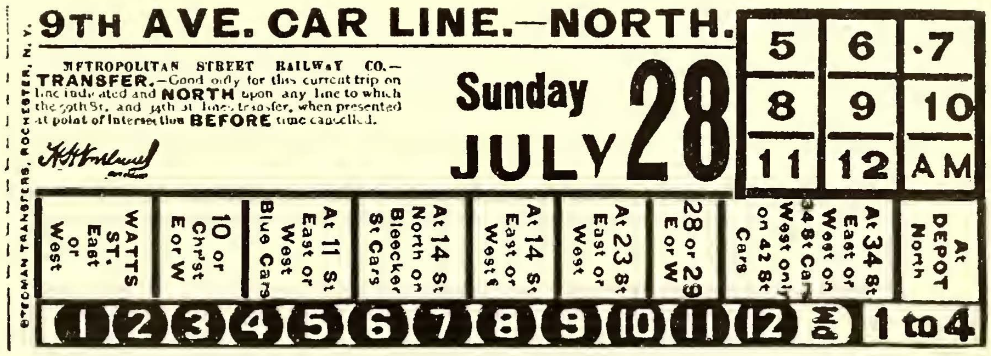
YEAR*	Paying Passengers Total Number	Transfer Passengers		Average Fare (Cents)
		Total Number	Prop. to Paying	
1900-1901	303,418,360	175,640,150	56 1%	3.16
1899-1900..	297,254,58?	155,506,578	34.34	3.28
1898-99............	266,270,268	134,868,716	33.62	3.31
1897-98............	206,940,197	90,380,411	43	3.48
1896-97............	177,338,677	56,929,611	32	3.78
1895-96............	145,965,251	28,450,996	19	4.18
1894-95..	109 686,472	9,671,697	9	4.59
1893-94..	107,036,524	5,306,654	5	4.76
1892-93............	63,011,785	3,203,832	5	4.76
1891-92...........	45,239,670	2,645,800	6	4.72
1890-91............	39,971,929	2,766,080	7	4.68
1889-90	39,571,464	2,523,239	6	4.70
1888-89............	37,386,809	2,206,866	6	4.72
1887-88............	37,318,730	1,996,871	5	4.75

* Years ending June 30th, except 1887-88 and 1888-89, which ended September 30th.

The transfer abuses which have been explained and the defects of the system in use were fully known to the officials of the company, but for reasons unnecessary to mention in this article the time did not seem to be right for a change until last spring. The problem then and the one which had been before the company for several years was how to eliminate this very apparent and growing abuse of an intended liberal system and at the same time not curtail the legitimate privileges which the company intended and desired to give to the public. After several months of close consideration of this problem, in which the situation was gone over in every detail, the men in charge of the transfer department finally developed a plan which it was considered met the demands of the situation. Experience has shown they were correct. In fact, the system has proved more successful and satisfactory to both public and company than was expected. The unusual arrangement of the Metropolitan system must be borne in mind in order to appreciate the manner in which it is operated.

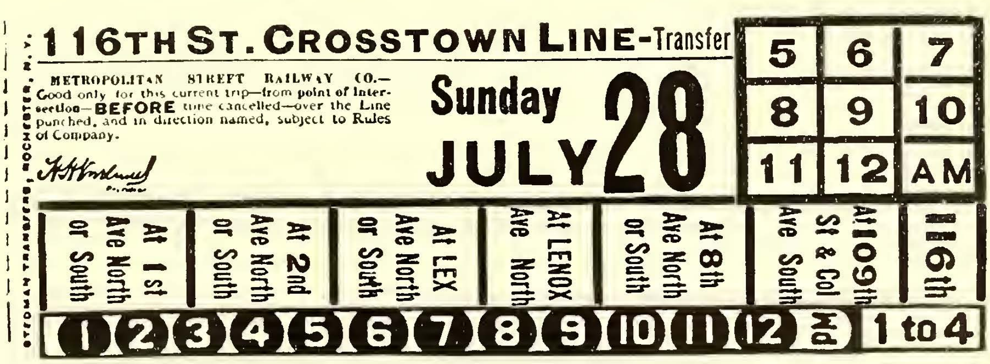
In figuring out this transfer system it was desired by the company to allow a person to go from any portion of the city to any other portion in the same general direction for a single fare, so that a person starting from, say, 194th Street and Amsterdam Avenue, the extreme northern terminus of our lines, could go from there to any other intended point in the southern portion of the city on either side of town; any person coming from a ferry could go to his place of business or any other point; any person in the residential district could get to a theater or other place of amusement, etc.; only he must not return to the starting point on one fare. This proposition was one which was eminently fair, and which could not be objected to by any fair-minded person. To accomplish it we adopted three colors of transfers—green, red and white. The green ticket is issued only by conductors upon cars going in a general northerly direction; the red ticket, by conductors in cars going in a general southerly direction, and the white ticket, by conductors on the crosstown lines, good going either north or south. In addition, a universal retransfer is allowed upon all lines, with the exception of the crosstown lines below Thirty-Fourth Street. The four crosstown lines on which this retransfer privilege was granted are, therefore, the Thirty-Fourth, Fifty-Ninth, Eighty-Sixth and 116th Street lines. In retransfering on any of the four crosstown lines just mentioned the transfer is not taken up by the conductor of the crosstown car. Supposing a person going south on Columbus Avenue wishes to transfer east on Fifty-Ninth Street, so as to be able to go south on Madison Avenue. He would be given a red transfer punched for the hour and for the intersection of Columbus Avenue and Fifty-Ninth Street. Upon presenting his transfer to the conductor on the Fifty-Ninth Street crosstown line the conductor would ask him if he wished to retransfer, in which case the conductor would simply examine the transfer and hand it back to him. He would then give it to the conductor going south on Madison Avenue, who would collect the transfer. The transfer would have been good on a southbound car on any of the north and south lines crossing Fifty-Ninth Street, as well as on Madison Avenue. This practice of not ringing up transfers would be considered with horror by some street railway superintendents, but under New York conditions it is not worth considering. The number of short riders is so large in New York that the number of people on the car and the fare register practically never correspond, and no dependence can be placed on any inspection made on that basis. Officers of this company are unanimous in the opinion that transfers should not be rung up.

On the other crosstown lines of the company, aside from the four mentioned, no retransferring is allowed. The reason for this is apparent when it is seen how near together the crosstown lines are in the southern portion of the city. Retransferring is necessary in the uptown section to allow passengers to reach any portion of the city by means of the north and south lines, but in the lower portions a passenger can be landed near to any point by a single transfer onto a crosstown line. The system of retransferring on the four crosstown lines just spoken of has reduced the number of transfers issued by the crosstown lines immensely. For example, Fifty-Ninth Street now issues 10,000 to 12,000 transfers per day, as against 70,000 under the old conditions.



GREEN TRUNK LINE TRANSFER ISSUED BY CONDUCTORS. ACTUAL SIZE

In working out this system, it was desired, and, indeed, it was absolutely essential, to lighten the work of the conductors, so that they could devote more time to their other duties. Of course, the question of direction, north and south, as indicated by the color of the ticket, was a simple one. The question of the date is almost unmistakable on the form of ticket we adopt, which is shown herewith, because this is printed in large type on every day's tickets. Consequently, the only work which the conductors on the north and south lines have to do is to punch the time and the junction. On the crosstown lines, where the largest number of transfers is issued, they have simply to punch the time, which can be done at their leisure, as an hour time limit was established. This was done because under our conditions the fifteen-minute time limit is a refinement which costs more than it comes to. All spaces to be punched are large, easily read, and can be punched rapidly without danger of mistakes. The junction point on the crosstown lines is not punched at all, because a person receiving a ticket is going to ride upon some intersecting line if he asks for a transfer, and it is immaterial to the company upon which line he rides, as he can only ride upon one line on that one ticket. It was not thought advisable to extend this privilege to the north or southbound passengers, and, as these passengers usually ride longer distances, there is not the same necessity for it, as the conductors have more time to punch the one additional space.

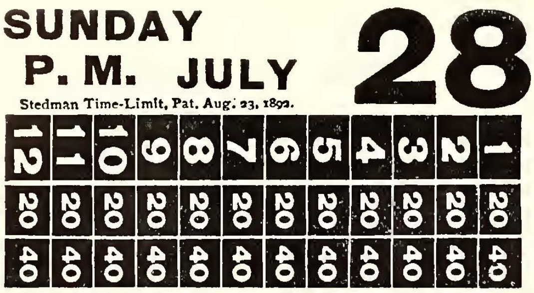


WHITE CROSSTOWN TRANSFER TICKET ISSUED BY CONDUCTORS. ACTUAL SIZE

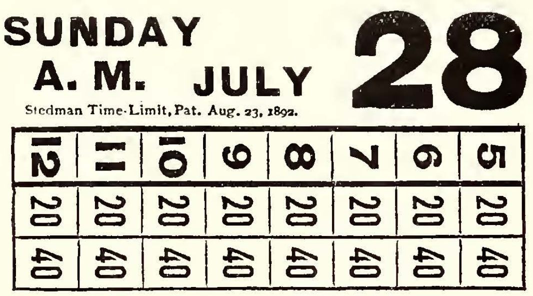
The system as described was inaugurated on the 12th of last May, and, as stated, has more than met the expectations of the company, and has proved satisfactory to the public. The change to both public and conductors was so radical that it was not without some misgivings as to its smooth working that it was started. The 4000 conductors who are employed on the Metropolitan system proper were fully instructed as to their duties, and the public was informed of their privilege through notices posted in every car of the system, with the result that upon the Sunday upon which it started there was not a single hitch. It is especially gratifying to the public, we have found, from the fact that they now understand exactly what privileges they have, and there are no disputes arising between the conductors and patrons as to whether or not they should be granted retransfers; in fact, the whole system has worked so smoothly that a great many of the points which caused disputes and complaints have been entirely eradicated.

Under the old system we had about ninety-five boys checking transfers, and, under the new system, we have about fifteen. The necessity for checking the tickets is almost entirely eliminated, as every day's tickets are absolutely distinct from those of the day before, and whatever fraud may be committed with the ticket to-day cannot be done the next day, as it is absolutely worthless after 12 midnight. The work of the boys is almost entirely that of counting tickets for information as to number issued. The question of waste is one which is of no importance, as the amount of money which the wasted tickets cost is not worth mention, considering the good which the printing of the date on the ticket accomplishes.

We still continue to have agents at our heaviest transfer points, but we have been able to do away with about twenty on account of the decrease in the work of the conductors by the simplification of the transfer system. This question as to the advisability of agents is one which is very difficult to decide, as the savings on the lines from the placing of an agent at certain points is only a matter of conjecture. We can see that it costs $4 a day to place two agents at a certain point, but we are unable to determine exactly how many fares the conductor would lose if the agents were away and they were compelled to issue the transfers. When cars are passing a given point on sixty-seconds headway, twelve hours a day, and when from 12,000 to 15,000 tickets have to be issued at that point daily, a not unusual case on our system, there is, of course, no question as to the value of the agent. The saving in immunity from missed fares and accidents in such an instance would be enough to pay the salaries of two transfer agents for a good many years.

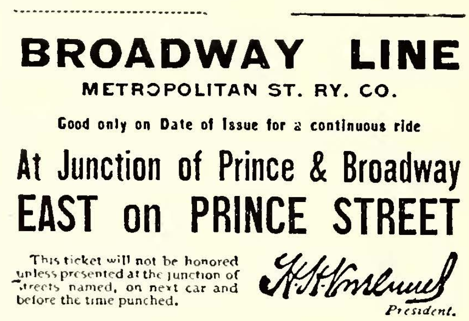


BACK OF P. M. TRANSFER ISSUED BY AGENT.
ACTUAL SIZE



BACK OF A. M. TRANSFER ISSUED BY AGENT.
ACTUAL SIZE

In case disputes arise between conductor and passenger as to the validity of a transfer, a conductor may demand fare or order a passenger off the car, but is instructed not to forcibly eject a passenger without consulting an inspector or foreman. This transfers the responsibility of forcible ejection from 4000 conductors to fifty or sixty inspectors. The company prefers to run the risk of letting a beat ride free occasionally rather than to incur the danger of having some respectable citizen put off a car because of an improperly punched ticket, with a damage suit as a result.



TRANSFER ISSUED BY AGENT (TIME LIMIT ON BACK).
ACTUAL SIZE

In closing, it is only fair to state that in this article the author has intended only to describe the conditions as they exist in New York, and makes no claim that the methods which have been found most desirable here would be applicable in any other city. The conditions on the Metropolitan system, caused by the shape of the city, the enormous traffic down town in the morning and back in the evening, and other circumstances, are in many respects peculiar, so that the same problems under other circumstances might, and probably would, have to be solved in an entirely different way.

NOTES ON THE METROPOLITAN STREET RAILWAY POWER PLANTS

BY M. G STARRETT

Chief Engineer, Metropolitan Street Railway Company

THE Ninety-Sixth Street power house, which now furnishes power for the Metropolitan Street Railway lines, was described in the March 3, 1900, issue of this journal. A number of general engineering considerations not taken up fully in that descriptive article will be here discussed, as well as some of the results obtained in practical operation. This plant being not only the largest polyphase electric railway power plant now running, but the largest electric railway power plant of any kind yet in operation, and containing the largest units, considerable interest has been manifested regarding its construction and performance as being the latest product of the evolution in power-plant construction which has been going on for the past ten years. Ten years ago electric railway practice in power house construction was just emerging from the "line-shaft" stage into direct belting. Three years later began the abandonment of direct-belted units, in favor of large slow-speed, direct-connected units. In 1893 several direct-connected units of this latter type were put in the Intramural Railway power house at the World's Fair Grounds, and also in the Cass Avenue & Fair Grounds Railway at St. Louis. When these large units were first built there was much speculation on the part of some engineers (and possibly by the manufacturers as well) as to whether there would soon be any extensive market for generators as large as 800 kw and 1500 kw. The large number of orders that were taken within six months for this type of machine settled that question very quickly. After the change to slow-speed, direct-connected units no radical move was made in electric railway power-plant construction except a gradual increase in the size of units until the use of polyphase, instead of direct-current, distribution necessitated changes in generators and switching apparatus and the addition of sub-stations. Incidentally, the change to polyphase distribution had the effect of increasing the size of the generating units employed, because the polyphase stations could feed a greater area. The total output was greater, and hence the size of the units selected to equip the power house was naturally larger.

The reasons that prevented the earlier introduction of polyphase distribution on a large scale in American railway practice were mainly commercial, because from an engineering standpoint polyphase distribution could have been employed several years before it was, as was amply demonstrated by the existence of water-power plants employing the system. Present practice seems to indicate that polyphase distribution from a steam plant for electric railways is best adapted to long suburban and interurban lines and to very large cities. In both of these cases the total amount of power generated is large, compared with that used near any one center. Hence the general statement can be made that so far practice has shown polyphase distribution for electric railway purposes to be most suitable to locations where a large amount of power is used, but where the amount needed near any one point is small, as compared with the total aggregate amount generated. In this respect the power requirements of large city systems and interurban roads are similar, although widely different in nearly every other particular. In the case of most large American cities, the adoption of polyphase distribution at any time within the last five years would have necessitated the abandonment of direct-current power houses which were already in use, and which were the result of a gradual growth of the electric railway business supplied from the stations. This commercial consideration was sufficient to prevent for several years the construction of any large polyphase electric railway steam plants in the United States. In New York the introduction of electric traction on a large scale has been recent enough so that advantage could be taken of the improvements in apparatus which made possible the erection of large polyphase plants. At the time extensive electric railway construction was started here, therefore, the owners of the Metropolitan Street Railway could consider the various types of plants on their merits without the hindrance of previous investment in power houses and feeder systems.

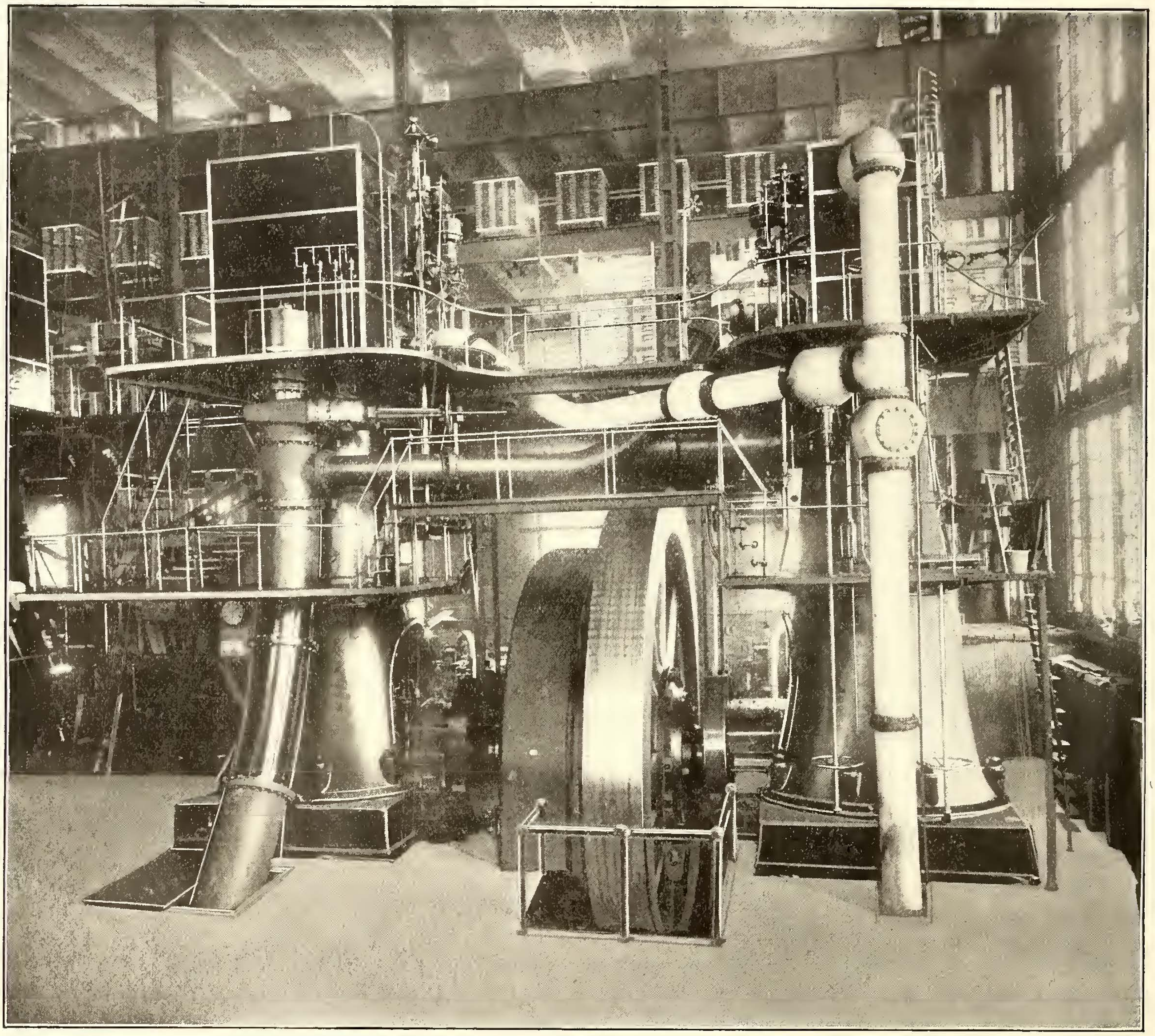
The present Ninety-Sixth Street plant of the Metropolitan Street Railway is a polyphase generating station sending out current at 6400 volts, three-phase, to seven sub-stations. It is designed for eleven 3500-kw generating units, of which eight are in operation, and the remaining three are being installed. A polyphase plant of this kind was, of course, not decided upon without much consideration of its merits as compared with a number of direct-current plants. Estimates were first made of the cost of serving the same territory from two direct-current plants, but it was found that the cost of feeders alone made this plan prohibitive. To bring the cost of direct-current feeders down to a reasonable amount it would have been necessary to build direct-current power stations at a number of centers of distribution. The price of land and cost of operation of several generating stations in the city of New York made that proposition out of the question as compared with the one alternating station, so that the one polyphase plant was easily the best solution of the problem. One of the real estate considerations that influenced us was that the company already had land enough suitable for its sub-stations at its various cable power houses and car houses, so that it did not have to go into the open market and buy land suitable for the erection of stations of this description. The cost of a generating plant of any given capacity is nearly the same for direct as for alternating current. So far as the steam plant is concerned, there is, of course, no difference if the same sized units are used. Direct-current generators cost more to build than alternating-current generators of the same capacity, on account of the commutators on the former machines, but the higher cost of the switching apparatus required for the high-tension alternating current brings the total investment to nearly the same figure.

The cost of low-tension feeders alone for supplying our system from two direct-current stations would be so much greater than that of high-tension feeders, sub-stations and direct-current feeders for one polyphase generating station that, real estate considerations aside, the polyphase plan was much superior. Omitting again the question of real estate, the economy in construction secured by the use of large units in one station instead of smaller machines, say of 1500 kw or 2400 kw, as in the direct-current plan considered, amounted to probably 10 per cent, if not more, of the total investment.

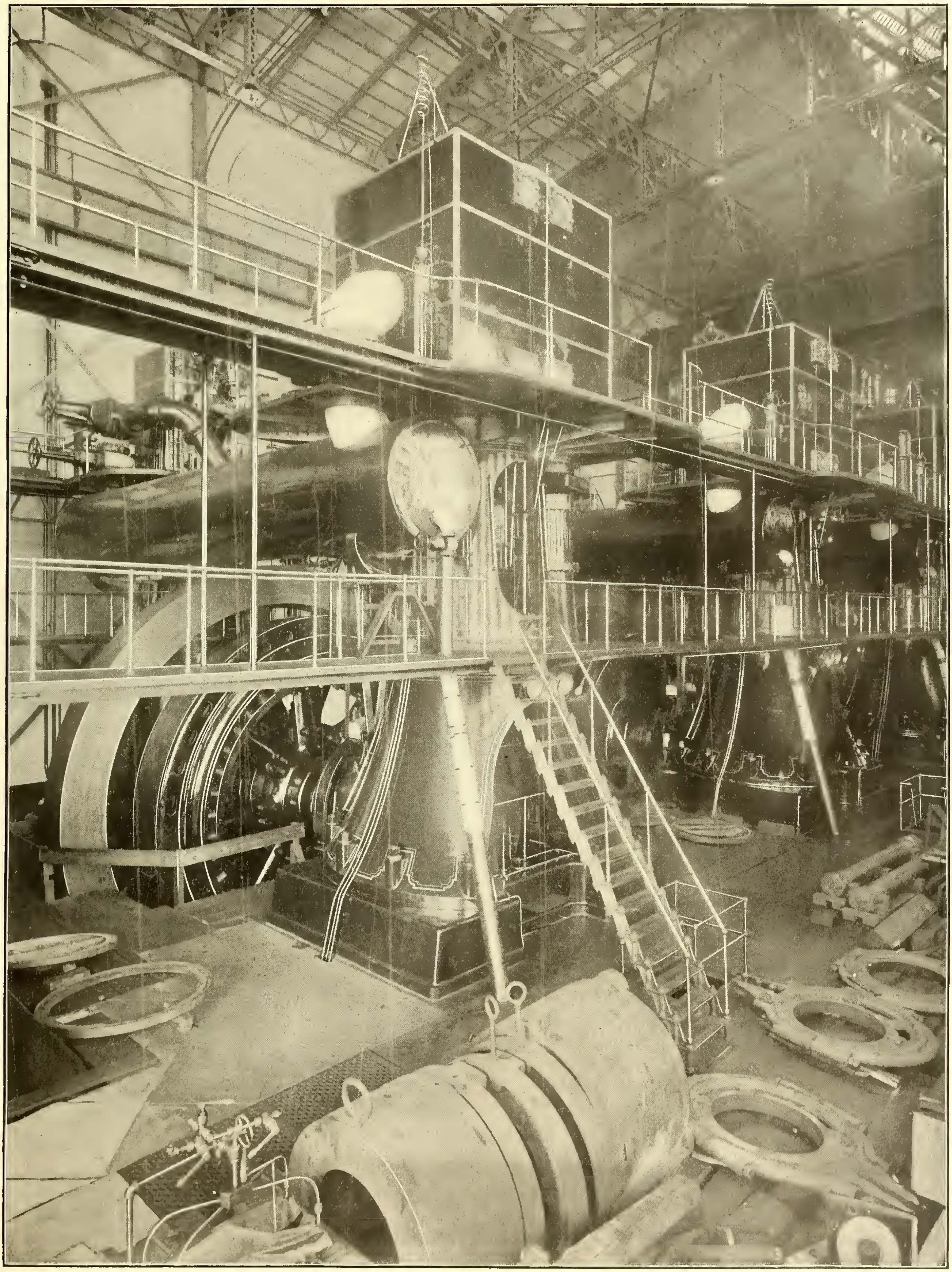
The cost of a large polyphase generating station of the type erected by the Metropolitan Company, at present figures, is about $90 per kilowatt for the power plant alone. This figure would include real estate at New York prices.

The ground space required by a power house per kilowatt of output depends on the type of apparatus employed, its arrangement and the size of the units. In the boiler room space can easily be economized by placing the boilers in tiers, as has been done in each of the stations of the Metropolitan Street Railway Company. In the engine room, however, there is no such chance to reduce ground occupied; the only two ways available are by the use of vertical engines with close spacing and by the employment of large units.

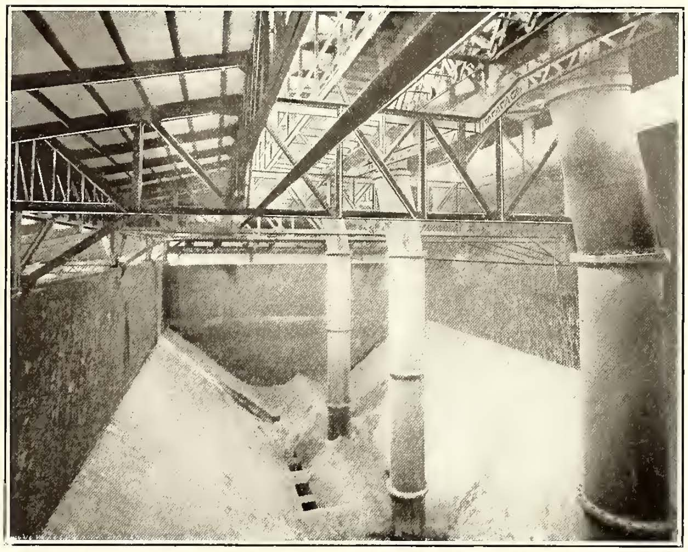
The ground space required by a power house, measured in kilowatts of total output, is much more dependent on the latter consideration than one who has never made comparative estimates would imagine. For example, the space required per kilowatt of capacity in the Ninety-Sixth Street power house of this company is 1.24 sq. ft. for boiler and engine rooms together. Of this, .68 sq. ft. is in the engine room and .56 sq. ft. in the boiler room. In the 216th Street or Kingsbridge station, which was originally designed for the Third Avenue Railroad, and is now being built for our company to one-half the capacity called for by the original plans, the boiler room takes .58 sq. ft. per kilowatt and the engine room .58, or 1.01 total for the



ONE OF THE UNITS AT THE NINETY-SIXTH STREET POWER STATION, METROPOLITAN STREET RAILWAY COMPANY. THE SWITCHBOARD GALLERIES ARE SHOWN IN THE REAR OF THE ENGINE



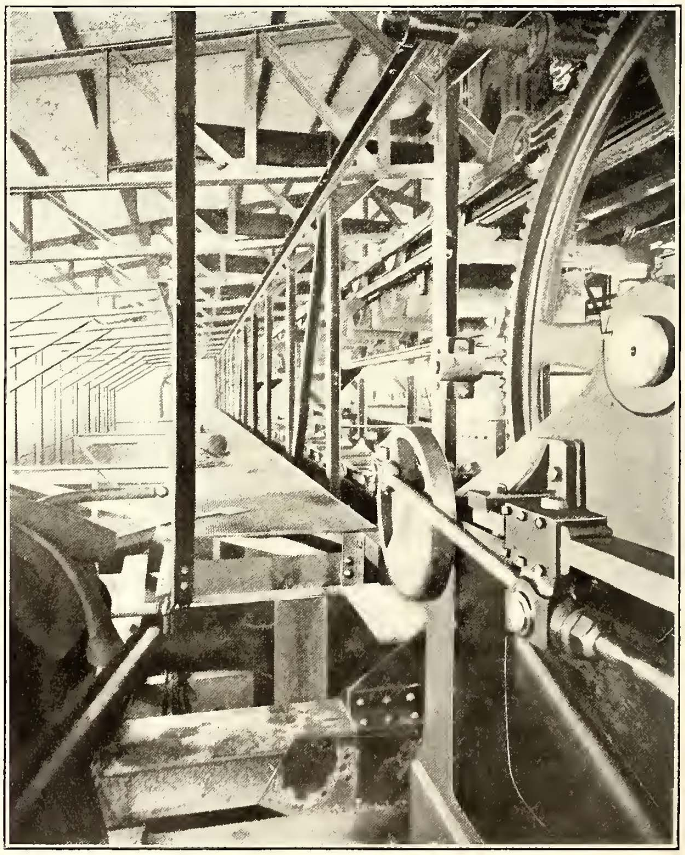
A VIEW IN THE NINETY-SIXTH STREET POWER STATION, METROPOLITAN STREET RAILWAY COMPANY entire power station. In the Ninety-Sixth Street station there is space for eleven 3500-kw units, and the plans of the other called for sixteen units of the same size. The small amount of space taken by the boiler rooms in both cases is due to placing the boilers in tiers. In the engine rooms the low figures on floor space are due mainly to the use of large units, and to what extent this influences the result can best be seen by comparing it with other large electric railway plants. It will be found by such comparison that there are very few power houses that do not take more than twice the engine-room ground space per kilowatt required by our stations, while five times as much is not uncommon. This must not be attributed to any poor design in the other power houses spoken of, or to excessive crowding in ours, but simply to the large size of the units in our stations as compared with the majority of railway plants, where 1500 kw is the largest machine used. The 3500-kw unit is in itself proportionately larger than the 1500-kw, but the passages around the latter must be as wide as around the larger machine, so that the actual space required per kilowatt is larger for the small units. Another thing conducive to a large output per square foot of ground space is the use of the same-sized units all through a power house, rather than a design which calls for several sizes. As engine rooms are usually approximately rectangular in shape, they are built wide enough to take in the largest unit, and are, consequently, wider than necessary for the smaller units. This consequently cuts down the capacity per square foot if two or more sizes of units are used.


ONE OF THE COAL POCKETS ABOVE THE BOILER ROOM

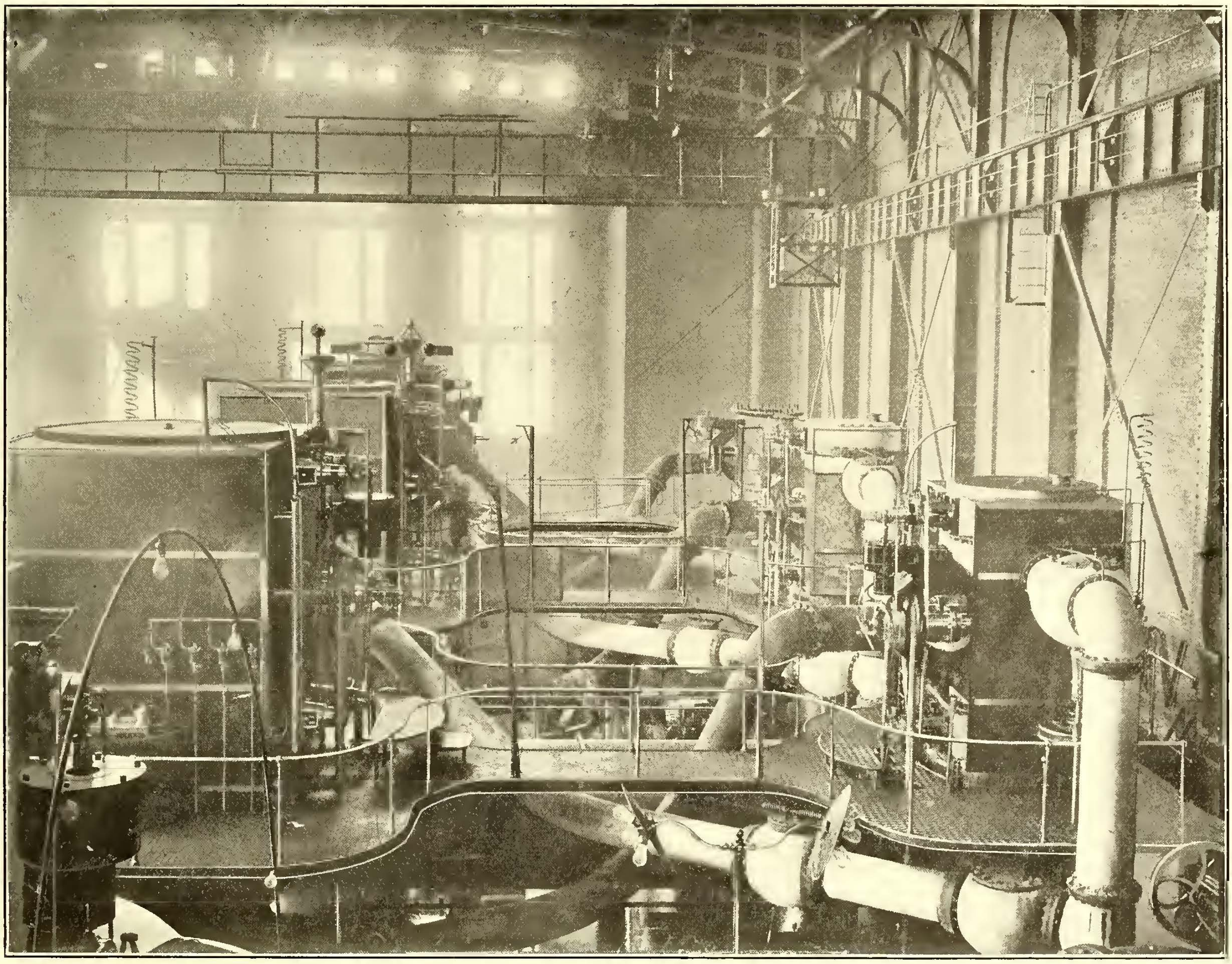
Counting the ground taken by our sub-stations as approximately 1 sq. ft. per kilowatt, and adding it to the ground occupied by the power house, it will be seen that the ground occupied by the entire generating and distributing plant still comes below the usual figures for direct-current plants using units of 1500 to 2000 kw or less. In this connection it must be remembered, as said before, that the real estate required for the sub-stations is not necessarily as high priced as that taken for power-house purposes, because a sub-station is more flexible in its location, and can be put in many places which would not be suitable for a power house. Furthermore, sub-station machinery can be put on the first floor of a building, and the upper floors can be used for other purposes. Taking all these points into consideration, it is seen that several small direct-current plants will usually cost more for real estate than one polyphase plant, because not only is less expensive land necessary for a part of the alternating-current plant, but the actual amount of land required will probably be less, because of the larger units likely to be used.

The size of unit selected for an electric railway power house is always a compromise between the wish to economize in real estate and station attendance on the one hand and the desire to keep all the machinery in operation fully loaded on the other. In building small stations the question of efficiency of large units as against small enters into the calculation, but when no unit less than 1000 kw is under consideration there is not enough difference in the efficiency of the different sizes to influence the decision. In the cost per kilowatt installed the larger units always have the advantage. When the attendance required is considered, the larger units are also at an advantage, because the number of parts that must be looked after increases, of course, with the number of machines used.

It is true, of course, that the use of large units would be disadvantageous if they were run for any considerable time under light loads. In a system like ours, however, the sub-station storage batteries can be charged or discharged so as to help in keeping the output of our machines always near their point of maximum efficiency. As a matter of fact, at the present time we have two small direct-current generating stations which are run as required so as to keep the units in operation at Ninety-Sixth Street always near their most economical load.


ONE END OF THE COAL CONVEYING MACHINERY ABOVE COAL POCKET

In considering the question of one large polyphase station *vs.* two or more direct-current stations to supply a large street railway system, it is urged by some that the liability of accident to one station is too great to admit safely of "putting all the eggs in one basket," or depending solely on one station. For this reason it is advisable, if one station only is employed, to take every precaution so that trouble at one point will not disable the whole generating or distributing outfit, and thus paralyze the whole system. In both our Ninety-Sixth Street station and Kingsbridge station the arrangement of apparatus is such that there are practically several stations under one roof. This subdivision holds from the boiler room to the switchboard. While the separation of the various groups of apparatus in the power house may be complete if necessary, in ordinary operation all are connected together. At the switchboard the generators are grouped on four sets of generator bus-bars. Each of these four sets can be thrown in multiple, and in usual operation are so connected, but a separation can be effected at any moment by opening the cross-connecting switches. The feeders are also separated into four separate groups. No sub-station is dependent on the current from any one feeder, as there is always more than one feeder connecting a sub-station with the power house. These feeders take different routes through the streets, and at the power house terminate on different sections of the feeder board. Probably the greatest point of danger is where the high-tension feeders leave the power house, for there is always the possibility that a short circuit in one of the high-tension cables (which will usually occur at a manhole) will spread so as to damage and short circuit many other cables in the same manhole. While this is not likely to happen with the precautions and construction that experience has taught us to employ, it is still probably the weakest link in the chain. To eliminate trouble of this kind, the high-tension feeders enter the Ninety-Sixth Street station from four directions, so that it is impossible for any sub-station to be shut down by trouble in any one set of conduit ducts. The station and feeders therefrom are therefore so subdivided that all the practical advantages of several stations are obtained. Any mechanical or electrical trouble with any of the power-house apparatus can hardly extend further than the group in which it originates, except temporarily. The possibility of fire is practically eliminated by the fire-proof construction employed.



TOP OF VIEW OF THREE UNITS FROM SWITCHBOARD GALLERY

The operation of our Ninety-Sixth Street power house is still somewhat in an experimental stage, because of the facts that construction is still under way and the load is constantly growing, and it is only recently that anywhere near its calculated load has been put upon the plant. Even yet the load is not such as to put us at the greatest advantage in economy of operation. This should be remembered in connection with whatever is said hereafter about the performance and attendance required in the plant. There are employed altogether in the operation of the Ninety-Sixth Street station of this company 180 men, as follows:

STEAM DEPARTMENT.

Engineer in charge of power house	1
Assistant engineers	2
Other engineers	8
Oilers	35
Wipers	5
Machinists	4
Machinists' helpers	4
Laborers	7
Rigger	1
	67

BOILER DEPARTMENT.

Water tenders	13
Stoker operators	27
Coal passers or assistant stoker operators	20
Boilermaker	1
Boilermaker helpers	2
Boiler cleaner	1
Boiler cleaner helpers	12
	76

ELECTRICAL DEPARTMENT.

Foreman (on day watch)	1
Assistant foreman (other two watches)	2
Switchboard tenders	12
Dynamo men	3
Wipers on dynamos	6
Boys	3
	28

COAL HANDLING.

Coal and ash handling force	7

MISCELLANEOUS.

Storekeeper	1
Timekeeper	1
Clerk	1
	3
Total all departments	180

Some explanation is needed with this summary. As in all New York power houses, the men work three watches, or shifts, of eight hours each. Beginning at the top of the list, the engineer in charge of the power house does no watch duty, as he has general responsible supervision. The two assistant engineers do watch duty. The oilers, who constitute the largest number of any class of employees, are kept busy seeing that all bearings are running cool, and that they are properly supplied with oil from the automatic lubrication system. In the boiler rooms each floor is divided into two nearly equal parts. One part contains fifteen boilers and the other fourteen. Each of these parts constitutes a separate boiler room, and one water tender is kept on duty for each room. The fifteen boilers in one room are as much as one water tender can look after. The stoker operators, of course, look after the rate of feeding of the stokers, the admission of air to the furnaces, and the mechanical operation of the stokers. The men rated as coal passers are called this for want of a better brief designation. Their duties are similar to those of the stoker operators. The coal and ash handling force gets the coal from the barges to the bins by the aid of conveying machinery and removes the ashes from the cellar to scows. In the electrical department the duties of all the force are plain from their designation, except the boys. Under this head come those who are learning to perform the duties in this department.

In the seven sub-stations there are sixty men employed, making in all 240 men in power house and sub-stations on all three watches. The classifications and duties of men in a large power house of this kind are considerably different from those in small stations, as can be seen from the foregoing. The division of labor, especially in the engine room, may be made in a variety of ways in a large plant. It has been argued that vertical engines require more labor to operate them than horizontal, because the attendants must go up and down stairs, and cannot watch the whole engine so well. This is not necessarily so, because, with a station ddivided into galleries, the work can be assigned by galleries rather than by units, if such an arrangement proves desirable.

The coal consumption in actual practice is 2.65 lbs. per kw-hour. The coal which we use is buckwheat anthracite under half of our boilers and run of mine bituminous under the remainder. The buckwheat anthracite is of low grade, as will be seen when it is stated that it has a heat value approximately of 12,000 British thermal units per pound, while the bituminous coal we use has a heat valne of about 14,000 British thermal units per pound. We make our own analysis of coal, oil and flue gases. Every boatload of coal that comes to the dock has samples taken from various parts of it, which are mixed and an analysis made. The following analysis illustrates approximately the kind of bituminous coal we use:

Fixed carbon	80.30%
Volatile matter	12.52
Ash	7.18
B. T. U. per lb.	13,486

The water evaporated per pound of coal as measured by water meters is about 8.4 lbs. The water required per kw-hour at the switchboard is about 22.41 lbs., including all the auxiliaries and the coal hoisting and stoking. All these figures are from the actual all-day operating reports.

The efficiency from the engine cylinders to the switchboard which gives the engine friction and generator losses has been repeatedly shown by indicator cards, taken under nearly rated load, to be above 90 per cent. That is, there is less than 10 per cent difference between the wattmeter readings and the mechanical horse-power shown by the indicator cards. As the station and distributing system is so managed, as before explained, as to keep the engines about at their most economical load, this efficiency is not far from the operating efficiency. The pounds of water per kw-hour, deducting engine friction and generator losses, would therefore be 20, which, reduced to pounds per ihp-hour, as steam engineers are accustomed to figuring, gives the water consumption of the engines as 14.9 lbs. per ihp-hour. Deducting the amount of water used by the auxiliary engines, conveyors and stokers, it is found that the water taken by the main engines per ihp-hour is between 13 and 14 lbs.

Under the conditions of a railway power station it is necessary to keep fire under a great many more boilers than are required to carry the average load. Boilers enough to carry the morning and evening peaks must be kept fired up all day. In a day's run, for example, where there were 1168 boiler hours, 679 were useful and 489 were reserve, or non-productive, the boilers lying with banked fires from one load peak until the next. The useful boiler hours were 58 per cent of the total. The boilers are in 250-hp units, and seventy-two are now installed.

Mention has been made of analysis of flue gases. A station as large as ours makes not only justifiable, but necessary, refinements which have not heretofore been considered as a regular part of station operation. The maintenance of a small chemical laboratory is one of these. We are doing business on such a large scale that such matters as the quality of the coal and the amount of good fuel that goes up the chimney, as well as the value we are getting for our money in oil, cannot profitably be neglected.

Flue-gas analysis is not worth anything unless samples are taken frequently. So far, we have confined ourselves to taking samples of flue gases from each boiler room once during each shift. The stoker operators in each room are held responsible for the quality of the flue gases coming from that room. With mechanical stokers all through, it is possible to insist on closer regulation of the quality and temperature of the flue gases than would be possible with hand firing. With mechanical stokers there is no reason why, with proper attention under ordinary running conditions, the flue gases should not show continuously approximately the same percentage of air CO_2 and CO. The proportion of the latter, which is unburned fuel, should be, of course, as low as practicable. The rate of feed, thickness of coal and amount of air admitted to the fire are all practically under the control of the stoker operators, and if the proportion is not such as to give the best results it is the fault of the stoker operators. As yet we have not attempted to set up any standard for the stoker operators to maintain. The following are figures taken at random from our flue-gas analysis record book:

Kind of coal	CO_2	O	CO	N, etc.	Temperature
Bituminous	5.6	14.4	0.1	79.9	535°
Hard buckwheat No. 1.	8.8	11.4	0.1	79.7	540°
Bituminous	11.6	7.6	1.0	80.7	525°
Hard buckwheat No. 1.	8.4	11.8	0.0	78.8	470°
Bituminous	8.5	10.7	0.1	80.7	560°

The flue gas in each case is taken from the back connection of the boilers. All of these show nearly perfect combustion.

In conclusion it may be said that the operation of a station the size of our Ninety-Sixth Street plant is such a novelty in engineering work that there are many points about which we ourselves have not reached definite conclusions. That we shall be able to improve in operating methods and reduce cost of power production as time goes on and as we get better load factor is likely. The results so far are such as to justify expectations in regard to the efficiency of large units and a large plant, operated under conditions which keep the machinery in operation well loaded. From the figures that have been given it is seen that it has been possible to come much nearer the limit of efficiency for steam engines in this plant than in the majority of power houses supplying electric railway systems.

THE ELECTRICAL DISTRIBUTION SYSTEM OF THE METROPOLITAN STREET RAILWAY COMPANY, NEW YORK

BY WALTER A. PEARSON

Electrical Engineer, Metropolitan Street Railway Company

THE electrical distribution of the Metropolitan Street Railway Company is distinctive as being the largest polyphase alternating-current distribution for railway purposes yet put in operation. It is also notable on account of the large amount of energy distributed per square mile of the territory served, due to the heavy traffic and the large number of lines in any given area. The distribution of electrical energy to large city street railway systems has in the United States heretofore been done entirely with direct current, except in a few cases where water power has made an alternating-current transmission and distribution desirable. Although the question of alternating versus direct-current distribution is still an open one in the minds of many electrical engineers the situation in New York at the time the Metropolitan station was decided upon left little doubt as to the best course to pursue. Two plans of distribution over the company's territory were considered. One of these was by direct current from two direct-current stations. The other was the alternating-current plan of distribution with sub-stations as afterward adopted and now in operation. Without going into the plans in detail it may be said that the preliminary estimates for the two direct-current plants, including the real estate and the feeder system necessary to deliver the current at the conductor rails, were $1,650,000 higher than for one alternating current plant with six sub-stations and all feeders for a capacity of 26,000 kw. The feeders for supplying the territory from the two direct-current plants were estimated to cost $835,000 more than the sub-stations and the high and low tension feeders for the polyphase distribution. The territory served is about 9 miles long and averages about 2 miles wide, or the width of Manhattan Island, as seen by the accompanying map. There was also considerable saving in real estate due to the location of sub-stations on property and in building already used by the company for other purposes.

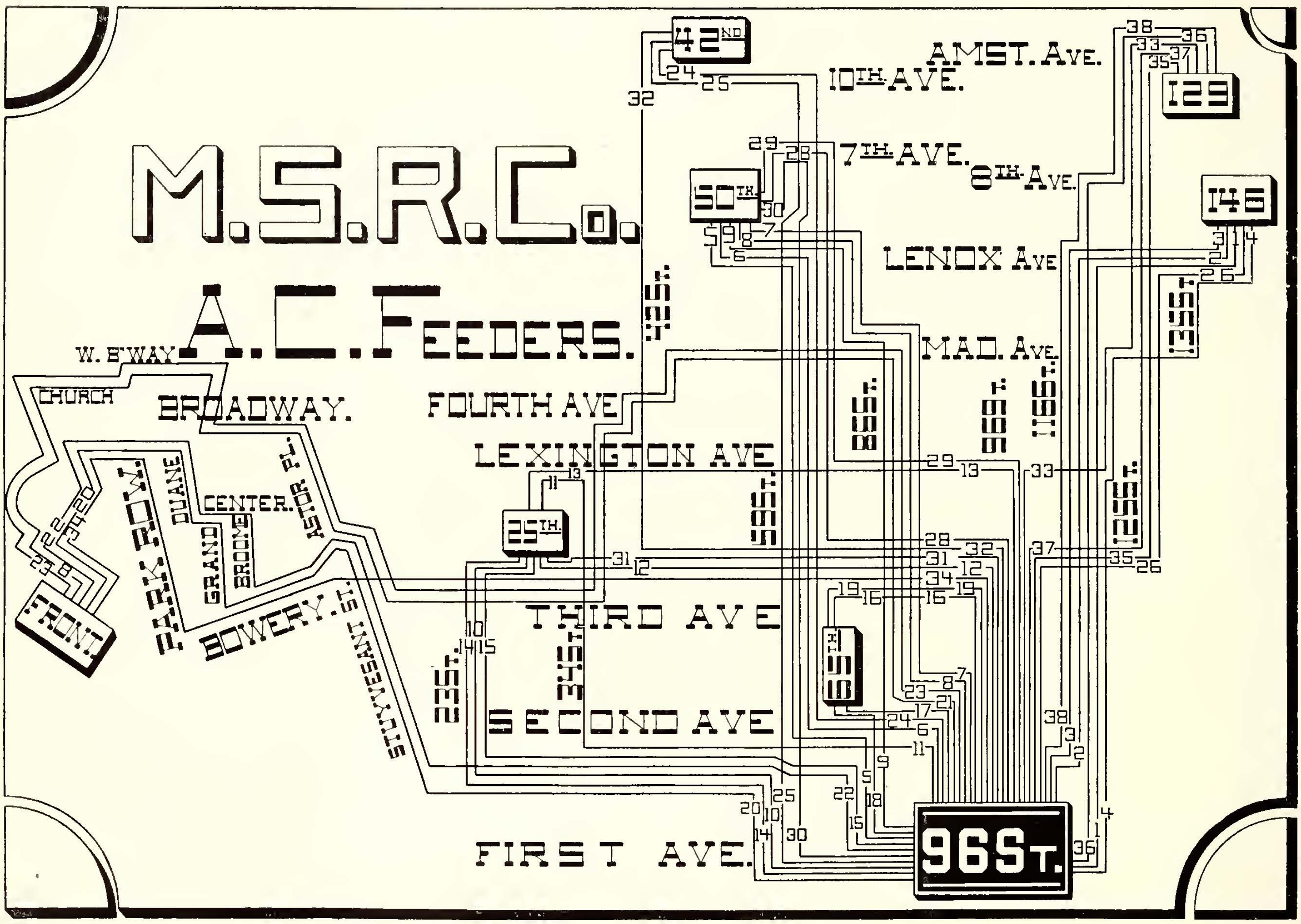
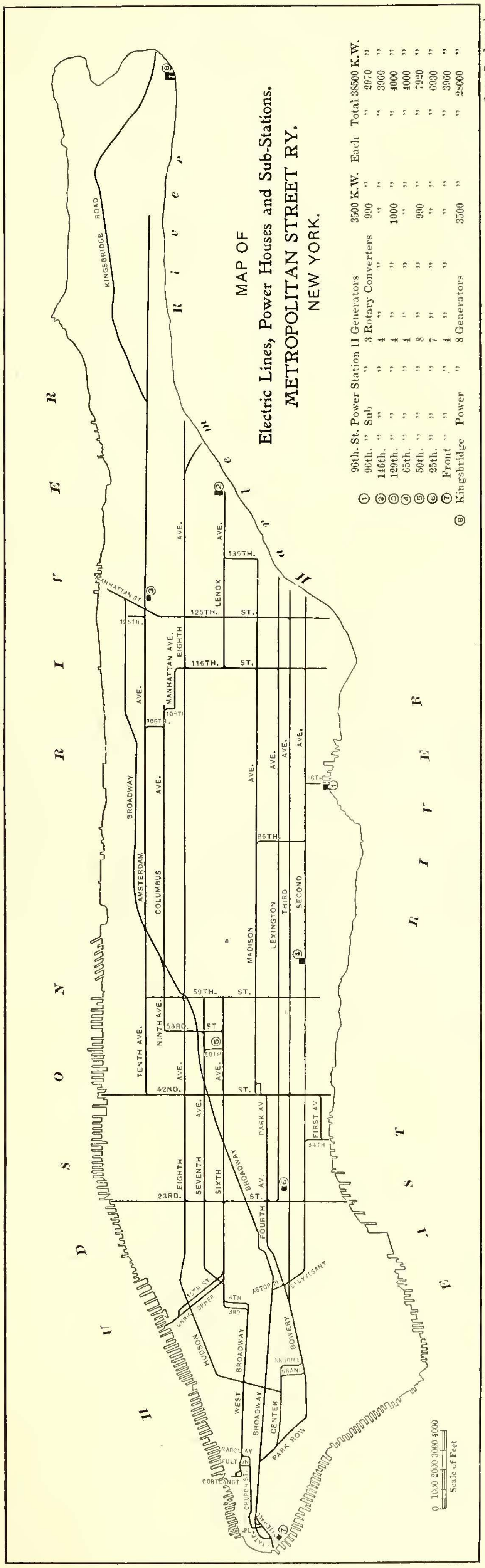


DIAGRAM OF ALTERNATING CURRENT FEEDERS TO SUB-STATIONS

The foregoing figures are sufficient to show in brief why the company adopted sub-station distribution and alternating-current transmission from one power house rather than direct-current distribution from two or more power houses.



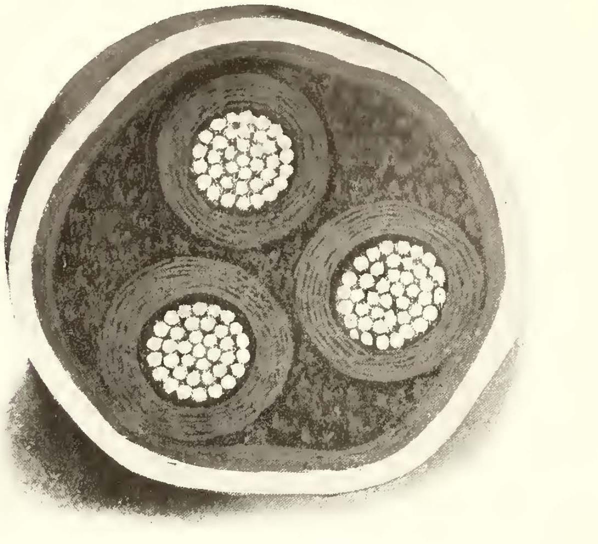
It remains now to discuss the distributing system as it exists and is operated to-day. The apparatus installed at the Ninety-Sixth Street power house and the sub-stations supplied by it were described in the STREET RAILWAY JOURNAL of March 3, 1900. Repetition of that is unnecessary except to outline our system briefly. Current is generated by 3500-kw generators, eight of which are in operation, with three more being installed. These generators give a three-phase current at 6100 volts to 6400 volts, 25 cycles. This is conducted by underground cables to seven sub-stations, as seen by the accompanying map of the system which shows the location of the power house, sub-stations and electric lines supplied. The sub-stations are of the following capacities:

Location	Present capacity	Ultimate capacity
146th St. and Lenox Ave...	4 990-kw rotaries	......
129th St. and Ams'dam Ave.	4 1000 " "	......
96th St. and 1st Ave........	3 990 " "	......
65th St. and 2d Ave........	3 1000 " "	4 1000-kw rotaries
50th St. and 6th Ave.......	6 990 " "	8 990 " "
25th St., bet. Lex. and 3d Ave.	3 990 " "	7 990 " "
15 Front St................	4 990 " "	......

At the sub-stations static transformers reduce to a proper voltage to supply rotary converters giving 550 volts on their direct-current commutators. Storage batteries are installed at the sub-stations and boosters have been put in to enable these to be charged from the rotaries in service. The direct current is taken by underground feeders and supplied to the conductor rails of the conduit system.

The first step in this distribution is, of course, the power-house switchboard, and it is a very important step where so large an amount of energy is controlled at one point. The oil break switch which was used to a limited extent before the designing of this power house, has been employed throughout for handling the 6600-volt current, and with most satisfactory results. Extraordinary precautions were taken in the design of this board to provide against extensive damage being done by the failure of any switch to break the circuit. Between each generator and the bus-bars are two three-pole oil break switches in series, which are not automatically tripped by the circuit breakers, but must be opened by hand, and are so arranged that when the circuit is opened they are both opened at once. In throwing a generator in parallel with the other generators on the bus-bars one of these two switches is closed first, leaving only one switch to be closed at the instant of synchronism. The switches are pneumatically operated by electric control. The feeder bus-bars are divided into four sections, and the generators are grouped on four sets of generator bus-bars, which can be connected to one or all of the feeder bus-bar sections. The feeders are grouped on four bus-bar sections, and not only is an oil circuit breaker put in each feeder, but another oil circuit breaker supplies each group, so that each feeder is controlled not only by the group circuit breaker, but by its own. There are thus two chances to open the circuit on each generator and on each feeder. The oil switches have each of the three legs of the circuit placed in a separate brick cell. As far as possible the feeders supplying any given sub-station are run by separate underground routes to avoid all the feeders to a sub-station being shut off by any local conduit trouble, which might cut off all the feeders in one conduit. The various feeders to a sub-station are also supplied by different sections of the feeder switchboard, so that a short circuit shutting down one section of the board could not necessarily shut down the sub-station, or, in fact, any part of the system. The oil switches and bus-bars are given plenty of room, and the switches are operated from a board which has on it only low-tension relay circuits for opening and closing the switches.

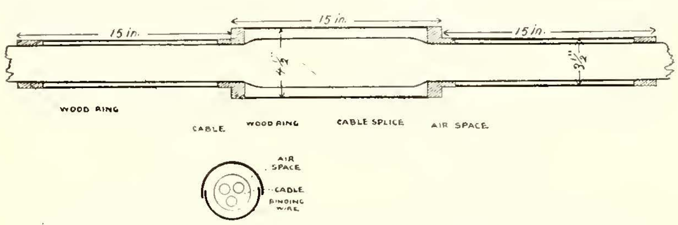
The oil switches have never failed us in any emergency



SECTION OF 6600-VOLT CABLE. ACTUAL SIZE

that has yet arisen. Several short circuits on underground feeders have been opened. In one case the current was probably not less than 2000 amps. At the sub-station ends of feeders are reverse current circuit breakers, which act in case current starts to flow back from the sub-station into a short circuit on a feeder. It was a question whether, with several feeders in parallel supplying a sub-station, a short circuit on one feeder would not cause the opening of all the circuit breakers supplying the sub-station before the circuit breakers on the short-circuited feeder would act. We have found that in some cases the feeder will be cut off before all the breakers supplying the sub-station are open. In others all will be open.

A diagram of the 6600-volt feeder system has been shown. From the power house to the sub-stations to conduct the 6600-volt current a uniform size of three-conductor lead-covered cable is employed throughout. This high-tension, lead-covered cable, a section of which is shown herewith, has

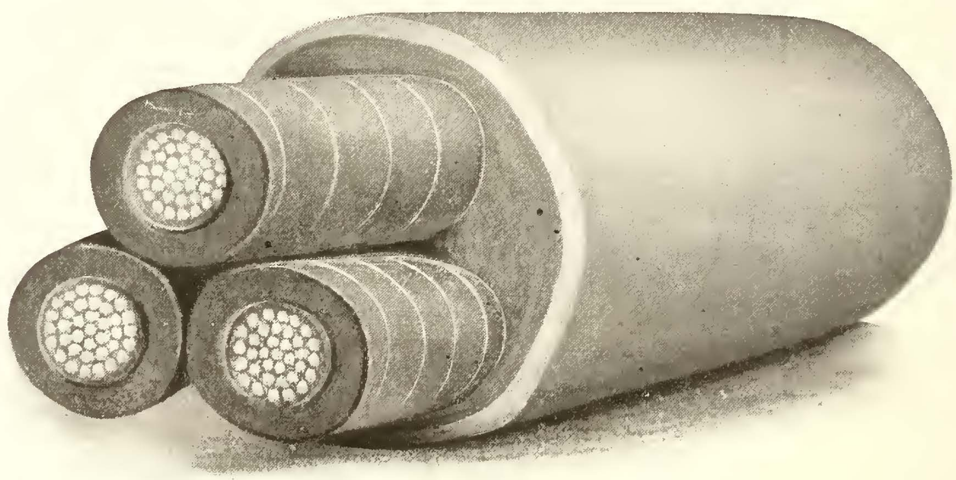


SKETCH OF SHEET STEEL SHEATH USED AT MANHOLES OVER 6600-VOLT CABLES

three stranded conductors, each equivalent to No. 0000 B. & S. gage wire, with insulation 7-32 in. thick. The first order of the company was partly for rubber insulated, and partly for paper insulated, cable. The thickness of insulation was 7-32 in. in both cases. The results with paper insulation having been the most satisfactory, the last orders placed for high-tension cable have specified paper insulation. Although the rubber cores test high in insulation at the start, the continued action of the high alternating voltage seems to cause a deterioration, though it has not been serious on our underground system. It may be well to note here that all our cables, transformers and other high-tension apparatus are tested with 25,000 volts for five minutes after being put in place, and before being put in service.

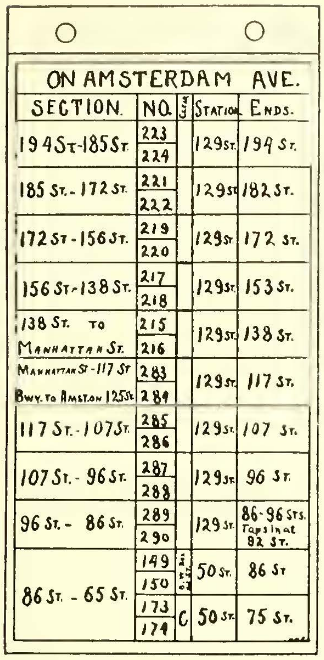
Unlike the underground cables on the direct-current feeder system, the high-tension cables are run straight through manholes whenever possible, and are covered with a sheet steel armor 1-16 in. thick, where they pass through the manholes. This tubing is made in halves, and bound over the lead covering, as shown in the accompanying sketch. A wood ring is put in between the cable and the steel armor at intervals, so as to leave an air space of one-half in. between the lead covering and the steel. This air space is not only for mechanical protection, but to prevent the spread of fire in case of short circuit. The location of defects in the great majority of cases is at the manholes. The steel covering and air space prevents the spread of damage to other cables to a large extent.

The company has installed a large amount of both vitrified conduit and iron pipe, cement lined. The vitrified conduit has a greater mass of fire resisting material, and the chemical action on the lead sheath is minimized by the in-



PERSPECTIVE VIEW OF 6600-VOLT CABLE.

sulating qualities of the vitrified surface. There is enough heat-resisting material in a vitrified conduit to confine the destruction caused by a short-circuit usually to one duct. The prevention of the spreading of a short-circuit from one duct to another is, of course, of the greatest importance. It is naturally not easy to confine a 6600-volt short-circuit with a large power house behind it. Vitrified conduit is used on all new work. Conduits are laid in concrete 15 ins. below the surface, either at the sides of the street or between the tracks, or both. In keeping track of conduit lines and feeders the engineers' office has, in addition to the diagrams of the feeder systems, a record book of many pages of blue prints, showing in diagram on each page two cross sections of the street and the location and kind of conduit thereon, at a certain point. Several of these sheets are here shown. The middle space represents the ground between the tracks and the side spaces ground at the side of

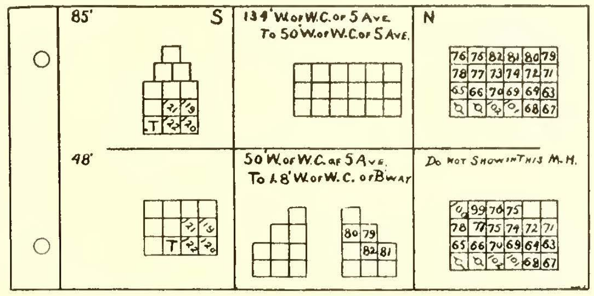


ON AMSTERDAM AVE.				
SECTION.	NO.		STATION	ENDS.
194 St-185 St.	223 / 224		129 St.	194 St.
185 St.-172 St.	221 / 222		129 St.	182 St.
172 St-156 St.	219 / 220		129 St.	172 St.
156 St-138 St.	217 / 218		129 St.	153 St.
138 St. to Manhattan St.	215 / 216		129 St.	138 St.
Manhattan St-117 St / Bwy. to Amst. on 125 St.	283 / 284		129 St.	117 St.
117 St.-107 St.	285 / 286		129 St.	107 St.
107 St.-96 St.	287 / 288		129 St.	96 St.
96 St.-86 St.	289 / 290		129 St.	86-96 Sts. Taps in at 82 St.
86 St.-65 St.	149 / 150		50 St.	86 St.
	173 / 174	C	50 St.	75 St.

PAGE FROM FEEDER RECORD BOOK. ¼ SIZE

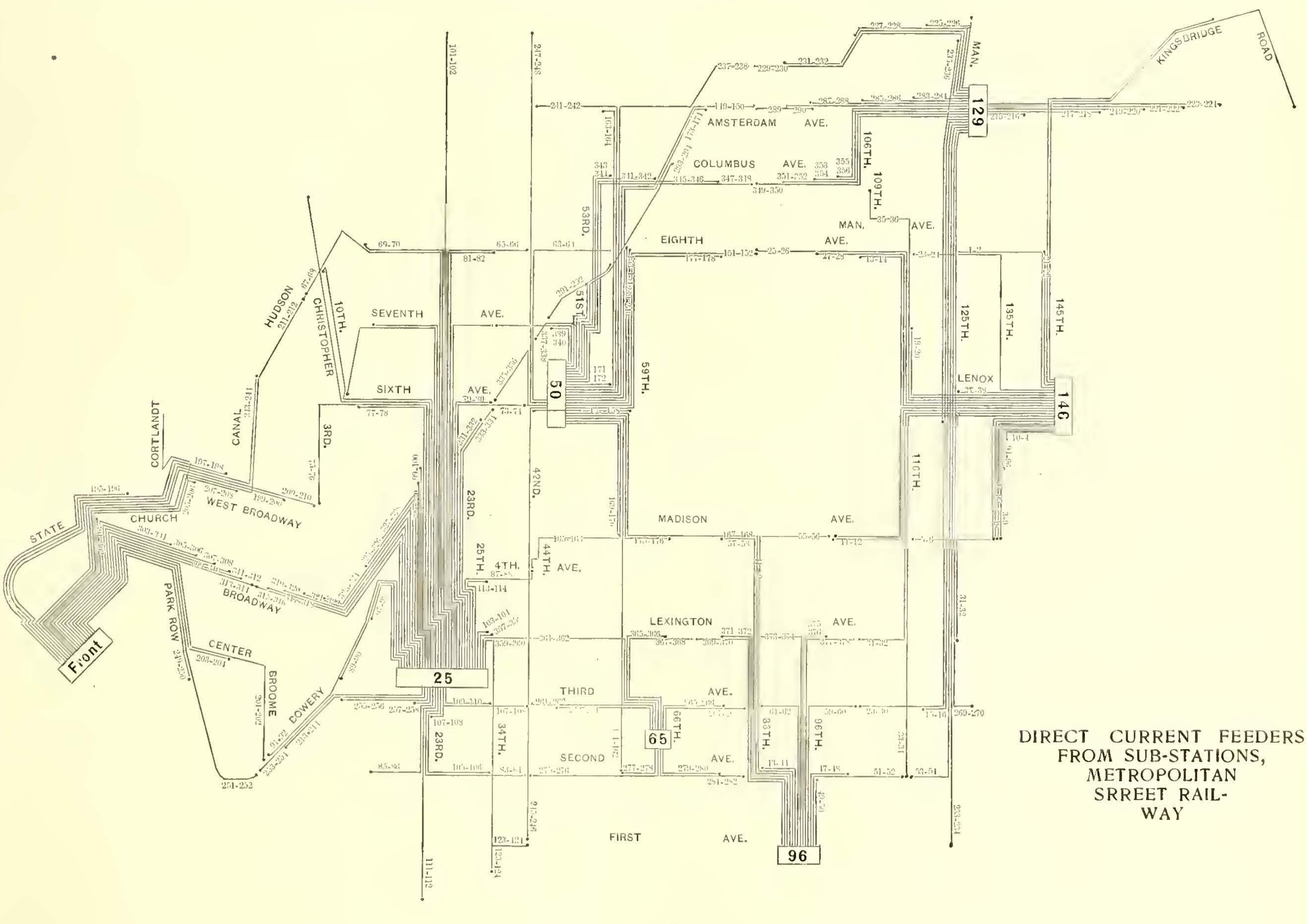
the street. There are as many sheets in the record book as there are locations on the street at which duct sections change. This record book is supplemented by a feeder book, a leaf of which is also reproduced, and which gives a key to the feeders, their place of beginning, ending and taps, if any. The standard feeder cable for direct-current distribution from the sub-stations is one of 1,000,000 circ. mils, paper insulated. This is for feeders proper. Sub-feeders running along the track to tap into the sections of conductor rail in the conduit are 500,000 circ. mil.

It sometimes happens that a ground occurs on the 6600-volt feeders, which is very small, and while it might play havoc with the service if allowed to remain in the 6600-volt lines, it is not sufficient to allow a large enough flow of current when 500-volt test current is put on the cable to be located by the repair men. For such emergencies the 300-kw, 25,000-volt testing transformer which is kept for insulation tests on newly installed apparatus is connected onto the defective cable with a water resistance in the primary. The defect will usually show up so it can be found with this treatment. In connecting in new high-tension feeders in parallel with those already supplying a sub-station, the simplest way of avoiding dangerous error in connecting up has been found to be the use of a small 6600-volt transformer, which is connected by trial between the cable conductors and the three legs of the circuit at the power house, the cable being first connected to the bus-bars at the sub-station. The terminals between which no current is obtained in the transformer are the ones connected together.



PAGE FROM CONDUIT RECORD BOOK. ¼ SIZE

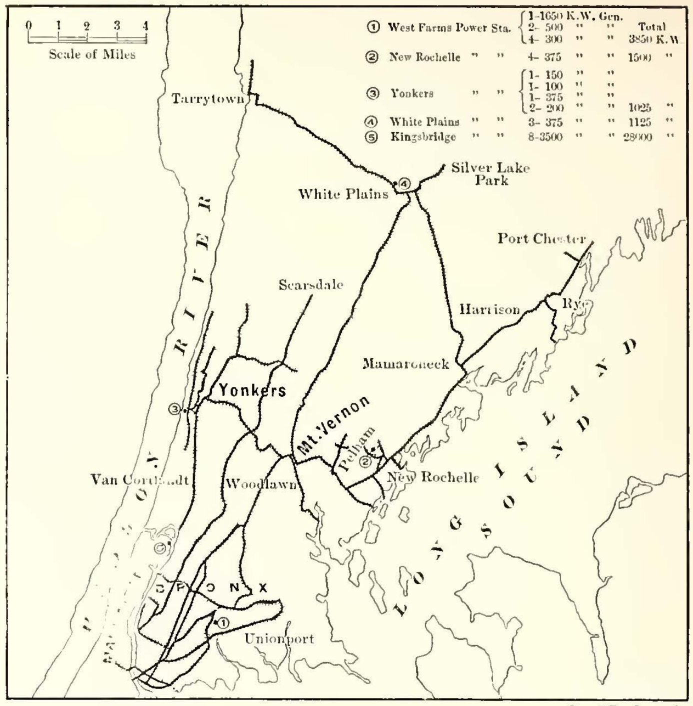
It was originally intended to run the rotary converters at the sub-stations with compound-wound fields, so as to raise the voltage automatically, as would a railway generator, as the load rises, and thereby compensate for the direct-current line loss. This plan would have necessitated the complication of safety devices to prevent the rotary converters from running away in case current was cut off the alternating-current end, and the direct-current supply was continued to them. They would, in such a case, run as



DIRECT CURRENT FEEDERS FROM SUB-STATIONS, METROPOLITAN SRREET RAILWAY direct-current motors, with the series winding opposed to the shunt, and with the very weak field that would result might reach a dangerously high speed. As a temporary expedient, the rotary converters were started with simply the shunt winding in use, and it was finally decided to do away with the complication of safety devices and the possible troubles from leading and lagging currents due to a varying field strength, and to operate all the rotary converters on the system as plain shunt machines. The line loss on the direct-current feeders is low enough, so that this is done without having an undue variation in voltage on the conductor rails, as can be seen in the accompanying voltage record taken at Madison Avenue on our system, current readings on the feeder being taken at the same time at the sub-station. This test is fairly representative of conditions over the entire system, and is as good, or better, than on most systems supplied by compound-wound generators. This is, of course, due to the installation of plenty of copper in the direct-current feeders, since the shunt-wound rotary has no ability to compensate for line drop.

In connection with each sub-station is a storage battery of a capacity of about 25 per cent. that of the rotary converter part of the plant. In charging these batteries a shunt-wound booster is used, which raises the voltage of the sub-station bus-bars a maximum of 120 volts. In discharging the batteries float on the line, discharging more or less according to requirements. Whether charging or discharging the momentary fluctuations are smoothed out by the action of the battery. In addition to taking up fluctuations the battery is useful to tide over emergencies, if there should be an interruption of the current supply from the power house, and it is also used to take the entire owl car load when the alternating current plant is shut down once every week for the cleaning of the high-tension switchboards, etc.

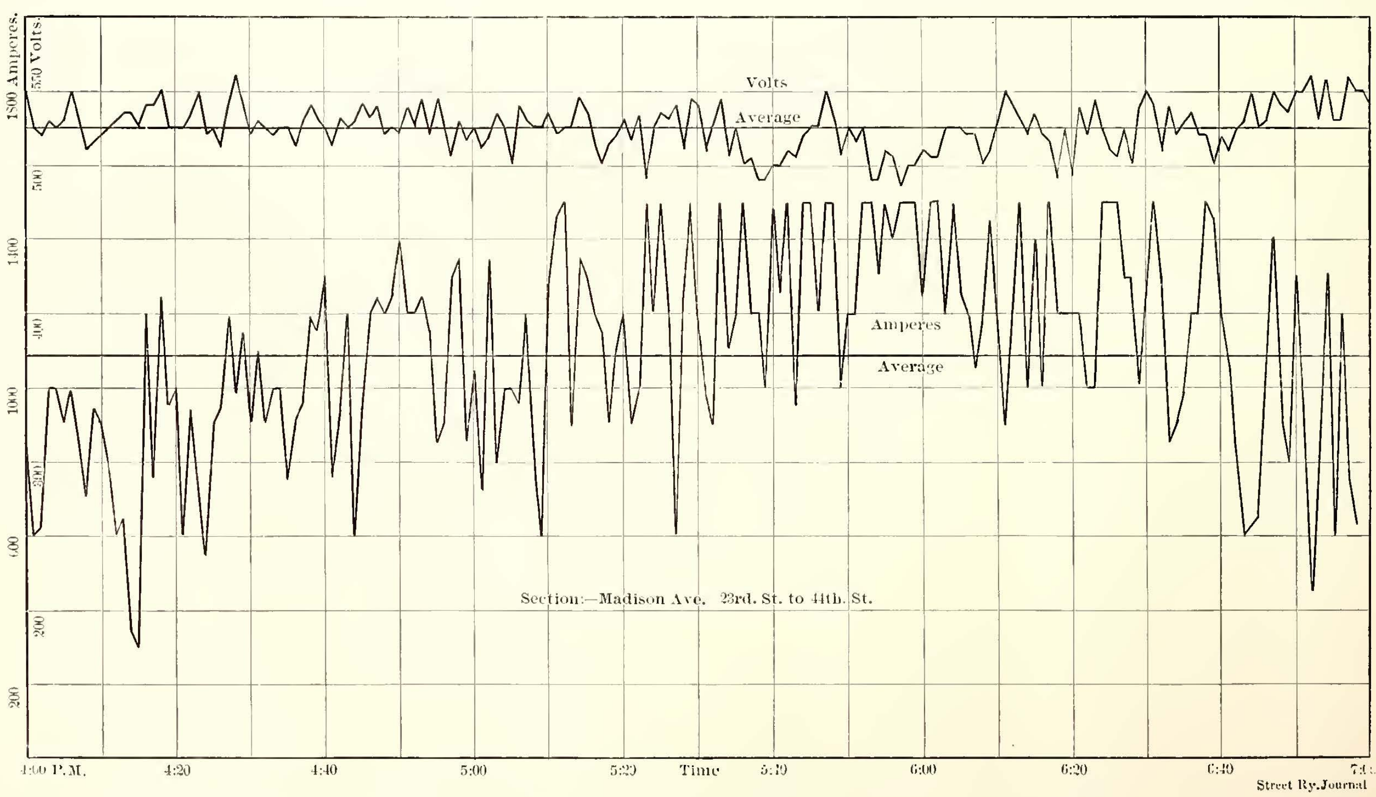
The use of a storage battery in railway work does away with an equivalent capacity of generating machinery, and



TERRITORY OF THE BRONX TO BE SERVED BY KINGSBRIDGE OR 216TH STREET POWER HOUSE

where alternating-current distribution is used, the investment in a storage battery is a special saving, because it displaces not only an equivalent generating capacity at the power house, but also the rotary converters and transformers necessary to deliver that output to the line.

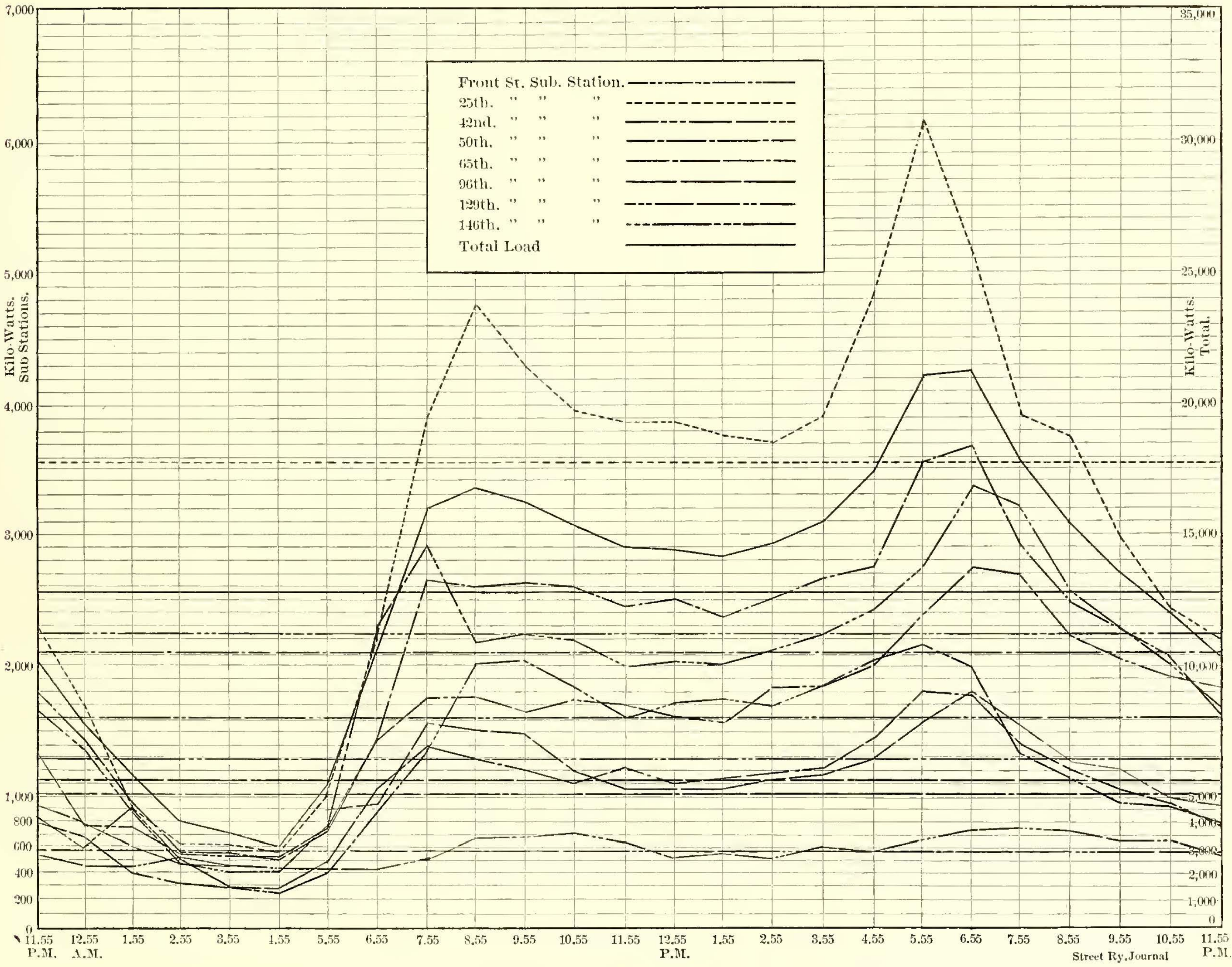
The power factor which prevails on the system is not exactly known in the absence of the power factor indicators, which we hope soon to have, but it is believed to be very near unity. When rotary converters are installed they are tested to determine at what field strength they give unity power factor, and they are then run at that field strength constantly. It is possible that at times leading or lagging currents occur at a number of sub-stations at the



VOLTAGE AND CURRENT RECORD TAKEN ON MADISON AVENUE, METROPOLITAN STREET RAILWAY same time enough to perceptibly vary the power factor from unity.

The question of the efficiency of a polyphase distribution of this kind is one that has been the source of much speculation and argument. On our system we have been able in every-day practice to come very near the rated efficiency of the apparatus, as shown by full load acceptance tests. The system being so large, it was possible to install large and efficient rotary converters (990 kw being the standard size adopted), and at the same time to have rotary-converter units in sufficient number at each sub-station, so that the number in use could be accurately adjusted to the load, and all could be kept with a full, and hence economical, load upon them. The batteries also aid in keeping an economical steady load on the rotary converters and transformers. We have recording wattmeters in all the 6600-volt three-phase feeders, leaving the power house, and in all the direct-current bus-bars at the sub-stations. The difference between the readings of these wattmeters for any given period, of course, should give the efficiency of that part of the distribution which includes the high-tension feeders, static transformers, and rotary converters, but exclusion of the storage batteries, the batteries being connected to the feeders outside the wattmeters. This efficiency is found from our records to be 90 per cent to 91 per cent. The loss in the high-tension feeders varies from 3 per cent to 7 per cent on different lines at various hours of the day.

It is the custom to read the recording wattmeters on all feeders, both alternating and direct-current, every hour. Of course efficiency figures are worthless, unless the instruments from which they are obtained are accurate. To keep as many instruments as there are in the power house and sub-stations calibrated so that their readings can be depended on, is no small task. There are about 750 switchboard instruments on the system, of which 84 are recording wattmeters, 49 are indicating wattmeters, 289 are alternating-current ammeters, 46 are alternating-current voltmeters, and 282 are direct-current ammeters. To keep these instruments correct, two men give their entire time to checking them. Especial attention is given to the recording wattmeters. The direct-current ammeters in the feeders being used merely as indicators, not much attention is paid to their accuracy. The recording wattmeters are checked by means of a portable indicating wattmeter (which is frequently standarized) and a stop watch. The standard portable wattmeter being connected in circuit, the revolutions made by the wattmeter for a definite time are noted, and, the load being known, the proper number of revolutions can be calculated and compared with those actually obtained.



TYPICAL DAILY OUTPUT CURVES, METROPOLITAN STREET RAILWAY

The load carried by the various sub-stations is indicated by the load diagram on the previous page, which shows the load on each for twenty-four hours. The maximum output is at about 6:55 p. m., and reaches 22,000kw. The amount of energy required per car on the Metropolitan lines is very high, owing to the great number of stops that must be made per mile, partly on account of the crowded condition of the city streets and partly on account of the short blocks in many parts of the town. In laying out the system a maximum of 16,500 watts, or 33 amps., at 500 volts, was allowed per car. The energy required per car mile is in the neighborhood of 2100 watt-hours at the sub-station switchboard, including lighting of car houses, etc. The schedule speed is high when the number of stops is considered, and this also tends to raise the output required to supply the system. Tests on a number of individual cars show an energy consumption as high as 1500 watt-hours per car mile. The company has 154 miles of track, supplied from the Ninety-Sixth Street power house.

To supply the overhead trolley suburban lines in the district of the Bronx, north of Manhattan Island (which lines are now being supplied by a number of direct-current plants), a large station of 28,000-kw capacity is being built at 216th Street and Ninth Avenue, on the Harlem River. This will supply sub-stations located about, as are the present direct-current generating stations, as shown by the map of this district.

The underground conduit system used on all the electric lines on Manhattan Island has been described in the technical press sufficiently, so that it need not be again described here. It is well to mention the fact, however, that in the operation of this conduit, any reports to the contrary notwithstanding, it is impossible to run cars when the conduit is filled with water above the conductor rails. The leakage of current is too large. The conduits, however, are not often flooded. The conductor rails are divided up into sections of varying length, with one or more feeders supplying each section. The ordinary leakage on the underground conduit is very small. All direct-current feeders have double-throw switches for reversing their polarity, so that if any grounds occur they can all be kept on one side of the system until they are located and removed. The system is, of course, kept normally free from grounds on both sides, no use being made of a ground return, as both positive and negative conductor rails are used in the conduit. The conduit is frequently scraped. The bottom of the conduit is smooth with catch basins at frequent intervals. In snow storms it is important to keep the snow scraped out, so that it can not wedge between the conductor rail and the shoe, which takes the current from the rail, the effect being as bad as sleet on an overhead trolley wire. There is more danger to interruption of traffic from this cause than from any other in a snow storm, but it is a matter easily guarded against by the frequent running of scrapers, so that the snow has no chance to pile up in the conduit. The conduits were, of course, constructed with a smooth bottom, with this in view.

CAR MAINTENANCE ON THE METROPOLITAN STREET RAILWAY, NEW YORK

BY THOMAS MILLEN

General Master Mechanic, Metropolitan Street Railway Company

IN the organization of the Metropolitan Street Railway Company the maintenance of the rolling stock is an entirely separate department from that of car operation. While this is a common practice, it is carried out on the Metropolitan system to a greater extent than on the majority of roads. While the cars are in the car houses they are entirely under the charge of the mechanical department, whose duty it is to deliver the cars to the operating force at the car house doors as they are required, and to receive them when they go in for the night. All inspection and repairs thus come under the mechanical department. To show the extent of our system, the maximum number of electric cars in actual operation at 6 o'clock each evening is about 1600, in which number are included a few storage battery cars. Most interest to the readers of this article, however, will center about the maintenance of the electric cars operating from the conduit lines, because they can be best compared to cars operated by the overhead trolley on other street railways.

On July 6, 1895, we put in operation on what is called the Lenox Avenue division, running from 146th Street through 109th Street to Columbus Avenue, ten closed electric cars. They were equipped with two G. E. 800 motors, were mounted on Peckham single trucks, and were the first electric cars put in operation by us on the underground conduit system. To show the rapid progress in electrical equipment made since that time the following tables are given, showing the number and kind of car equipments now in use:

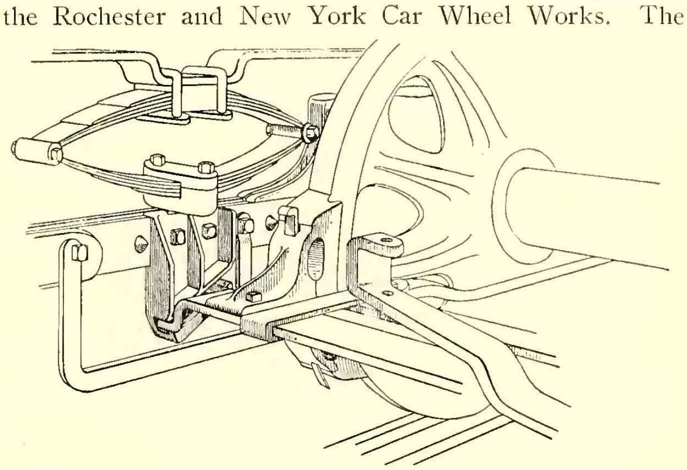
TYPES AND EQUIPMENT OF THE METROPOLITAN STREET RAILWAY CARS

Style of car	Tot. No.	Type of equipment — Gen. Elec. 800	1000	57	Westinghouse 38	56	68	69
Single-truck box	769	..	586	..	..	..	183	..
Single-truck open	331	..	331	..	..	..	..	..
Double-truck box	844	..	..	600	..	150	..	*94
Double-truck open	435	..	..	†165	..	135	..	..
Double-truck combination	200	..	..	125	60	15	..	..
	2579							
Express cars	10	..	10	..	..	..	..	..
Sweepers	58	..	46	..	..	12	..	..
Plows	12	..	12	..	..	..	..	..
Freight cars	2	..	2	..	..	..	..	..
Sand cars	16	16	..	..	..	..	..	..

* Four-motor equipments.

† One hundred and thirty-five equipments changed from box to open cars each spring. Motors and controllers only are changed. These are the only equipments changed from summer to winter cars.

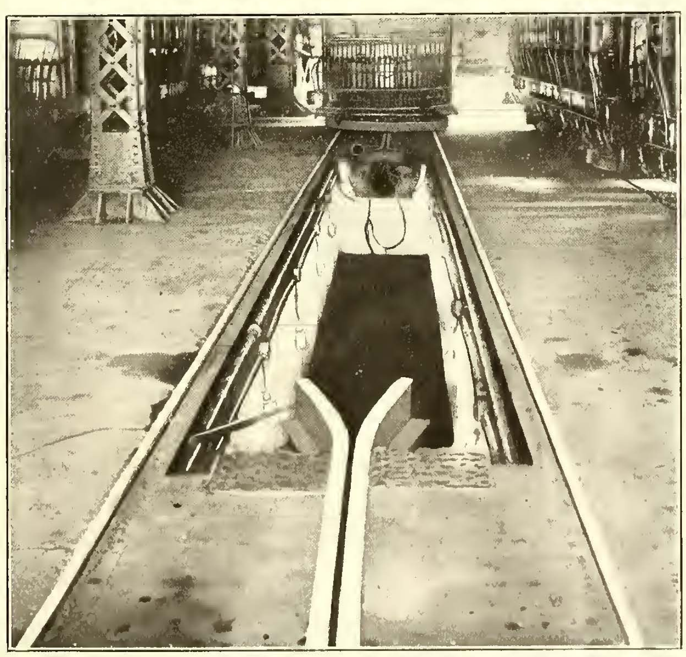
As seen by the table, the standard equipment of the cars on the Metropolitan system is two G. E. 1000 motors for short, single-truck cars, and two G. E. 57 motors for long cars, mounted on Brill maximum traction trucks, with 30-in. driving wheels in each case. The majority of the single-truck equipments are Peckham, although there are some Diamond and Brill. The Sterling brakes and fare registers are used in all the Metropolitan cars, with some New Haven registers on the Third Avenue Railroad. On the Broadway line the Sterling fender is used, and the Consolidated fender on all the other lines. The wheels are supplied by the Rochester and New York Car Wheel Works. The



GRAVITY BRAKE RELEASE

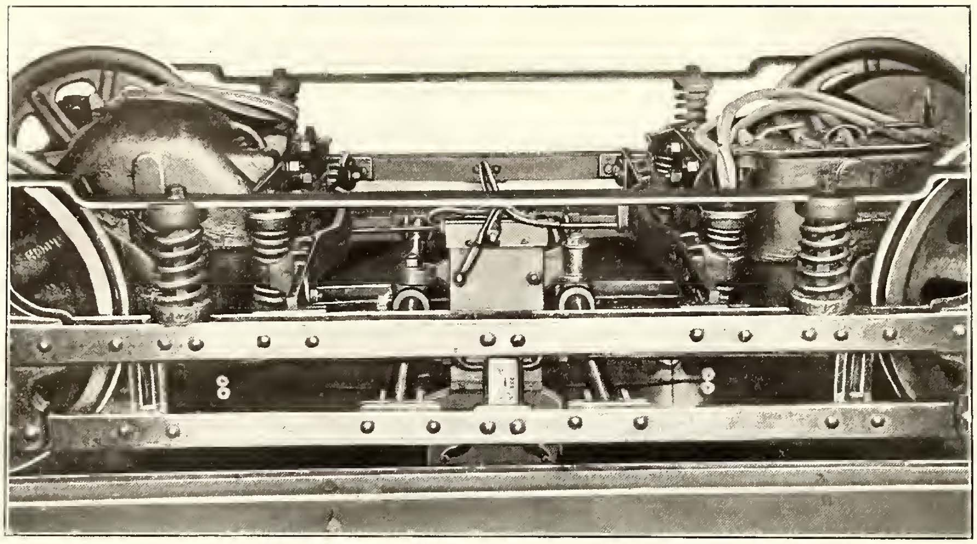
sweepers were made by the Taunton Locomotive Works. In 1897 the original G. E. 800 motors, with which the Lenox Avenue cars were equipped, were taken off, and G. E. 1000 motors substituted in their place. These cars are to-day running on the other Broadway divisions. It was found that the G. E. 800 motors were too light for the severe service in New York City.

The long cars were originally equipped with G. E 1000



INSPECTION PIT

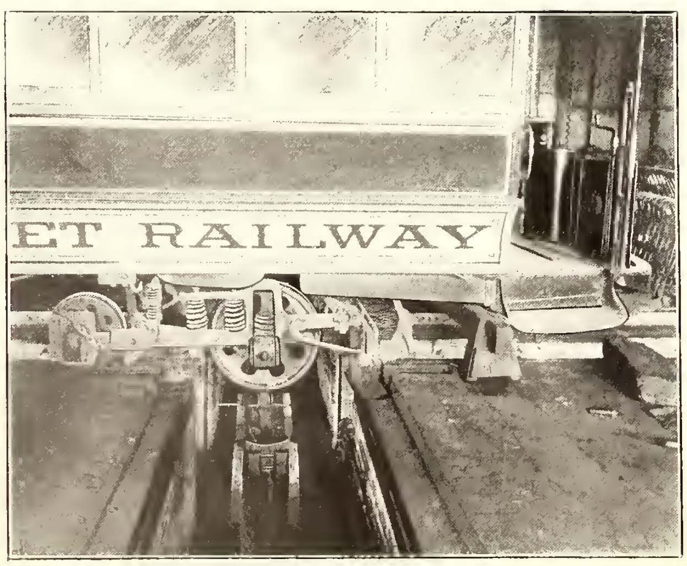
motors, and these for a time did very well, but it was found that with the increased traffic a heavier motor must be used on these cars, and for the same reason as on the shorter



METHOD OF SUPPORTING PLOW ON PECKHAM SINGLE TRUCK

cars. Owing to the short blocks and interruptions from team traffic in New York City, the number of stops made per mile by a car is very large, and the strain on the motor equipments from starting the car so many times per mile is correspondingly great. On account of this fact it was finally decided to use the G. E. 57 motor on the double-truck cars, and place the 1000 motors on the single-truck cars, which were changed from cable to electricity.

The remodeling of the cable cars formerly run on Broadway and other principal lines has been quite an undertaking. During the past winter the open cars of those lines, 210 in number, were changed over and made ready for service with the opening of the road, as an underground electric. As soon as these were ready for operation 360 box cable cars were taken into the shop to be rebuilt for electric cars to go in service the coming winter. All these are expected to be finished by about Nov. 1. These cars had first to be stripped of all the old grip mechanism, and the gas lighting and hot water heating equipment. They were then turned over to the truckmen and the brake mechanism was changed. New wheels, weighing 300 lbs., were installed in

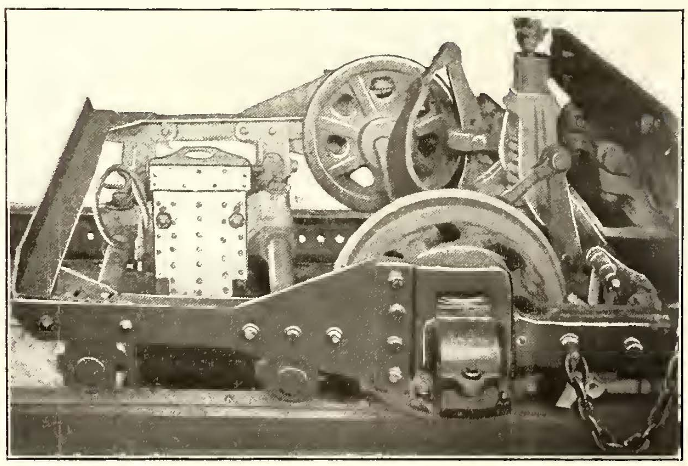


PITS FOR WHEEL RENEWAL

place of the old 290-lb. wheels, and 4-in. axles in place of the $3\frac{3}{8}$-in. The motor suspension and plow frame attachments were then put on the trucks. The car bodies were put in the carbuilding shop, where the ceilings had to be torn down for running the electric light wires, and after the former were replaced the flooring was taken up.

This part of the car had to be practically rebuilt. The cable cars had been built with one long trap door in the middle, to furnish access to the grip. In order to get in two trap doors at the ends the old cross beams and tie-rods had to be moved to make room for the three trap doors necessary. Two of these trap doors are for the motors, and the third for the plow, as we call the underground trolley of this system. The floor being completed, the car was again given over to the wireman to finish the wiring for the motor. It was then put in the paint shop.

Our standard brake mechanism may be of interest to other railway men. It requires no release springs, as the weight of the beams and shoes serves to release the brakes. A sketch of this mechanism is shown on the previous page. Guides for the brake beam, instead of being horizontal, are



PLOW MOUNTING ON MAXIMUM TRACTION TRUCKS

placed at an angle. The ends of the beams are bent correspondingly, so that when the brake is released the beam drops by its own weight down the incline of the guides, and leaves the shoes free from the wheels. The Sterling brake staff and chain is used for all our cars. This device is almost too well known to need further description. The presence of a double chain is an element of safety on all grades.

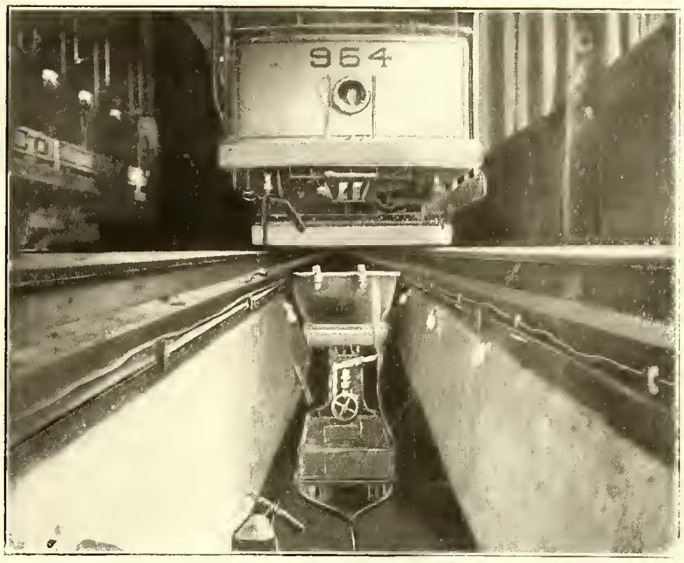
The step-lifter, with which most of our open cars are equipped, is a device peculiar to our road, but under our conditions has undoubtedly paid for itself many times over. It enables the cars to pass trucks and wagons on our crowded streets, which otherwise might have caused much delay, and, in the aggregate, much financial loss. The step can be raised or lowered at will by the motorman by means of a small chain in the front platform. On some lines this device is used frequently. We use an illuminated reversible sign, which differs from illuminated signs employed on other roads, in having its illumination from the exterior rather than from the interior. A four-side signboard is used, mounted on an axle, geared by a beveled gear to a hand wheel, as seen in the accompanying engravings. Any one of the four signs can be brought into view any time by simply turning the hand wheel. Each end sign has two lamps placed above it, with a reflector over them, so that the light is thrown down on the lettering, making it as visible by night as by day. The lamps are entirely independent of the revolving part of the sign.

When this company assumed control of the Third Avenue Railroad a new problem confronted us. We found ourselves with one hundred long box cars, with cross seats, and with car bodies 32 ft. long. These cars are equipped with four Westinghouse No. 69 motors, on Peckham center-bearing trucks, with 33-in. wheels. During the rush hours it was found, especially at transfer points and prominent streets, that much time was lost by the congestion in the narrow aisles. To overcome this we have, during the past summer, taken the three seats out of each of the four corners of the car, and in their place inserted side seats. The seating capacity is not materially lessened, while the standing room is increased about 75 per cent. This change has also had a good effect on the life of the motors and controllers, as the motormen do not abuse them as much in trying to make schedule time with them.

SIGN ON CAR

The plow, or underground trolley, of these cars is, of course, peculiar to New York. The method of supporting the plow in the trucks is shown herewith. The cast-iron shoes which we use on these plows last from ten days to two weeks. At the line of slot rails there are placed over the main plate two clips, called wearing plates, which are renewed as often as necessary. The body of the plow which passes through the slot is composed of three pieces of sheet steel, with space between them for the flat insulated wire to run down to the contact shoes. The latter are fastened directly on springs, and two flexible conductors run to each shoe, as it was found that one conductor is liable to become broken. The lower part of the plow is entirely of wood, with the exception of the contact shoes, springs and iron for spring support. The plow is taken off the car when any repairs are to be made on it. When a plow is to be inserted between the conductor rail at some point out on the road, a clip is placed over the shoes which holds them close together until the plow can be placed down between the rails.

The electric cars for our system are housed in twelve different car houses. At all of these car houses the ordinary routine of inspection and repairs is carried on. In the following list the number of cars mentioned as operated for each car house is the number operated out of the house each day, and does not include the number stored. When special mention is made of the work done at a car house it is where facilities exist for doing more than the ordinary routine of work. The electric car houses are as follows:



REPAIR PIT AND HYDRAULIC JACK

One Hundred and Forty-Sixth Street and Lenox Avenue. Paint shop, armature winding and plow repairs; total capacity of the house 460 cars; 200 cars operated.

Ninety-Sixth Street and Second Avenue. Paint shop; total capacity 400 cars; 220 cars operated.

Ninety-Sixth Street and Lexington Avenue. Paint shop; total capacity 255 cars; 175 cars operated.

Eighty-Sixth Street and Madison Avenue. Inspection and storage only; repairs at Thirty-Second Street; 50 cars operated.

Thirty-second Street and Fourth Avenue. Repairs for Eighty-Sixth Street and heavy work for Twenty-Third Street. Ninety cars operated.

Fiftieth Street and Sixth Avenue. Total capacity 530 cars; 400 cars operated.

Fiftieth Street and Eighth Avenue. Seventy-five cars operated.

SIGN TIPPED TO SHOW LAMPS AND MECHANISM

Twenty-Third Street and North River. Fifty cars operated.

Forty-Second Street and North River. Storage battery car house; 50 cars operated.

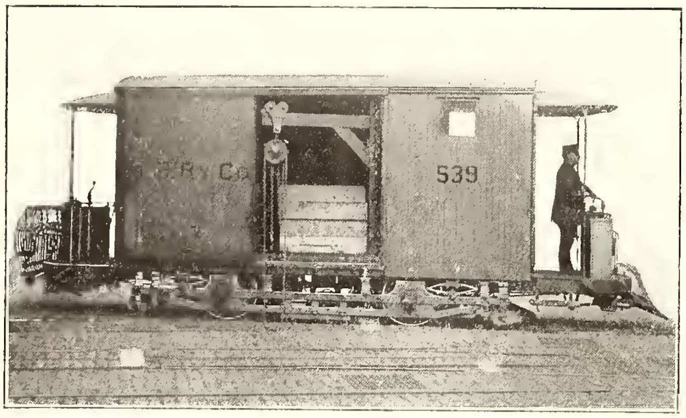
One Hundred and Twenty-Ninth Street and Third Avenue. Does all heavy work for Sixty-Fifth Street and Amsterdam Avenue car houses. Total capacity 300 cars; 100 cars operated.

Sixty-Fifth Street and Third Avenue. Carpenter shop. Total capacity 150 cars; 100 cars operated.

One Hundred and Twenty-Ninth Street and Amsterdam Avenue. Seventy-five cars operated.

At Fifty-Fourth Street and Tenth Avenue is also a car shop, at which some of the work on electric cars is repaired, and also all the horse cars.

Every car is given a general inspection each night. As far as possible this inspection is given as the cars are run into the car house. That is, they are first run over the inspection pit, and if found all right are run back into the car house for storage, or, if in need of repairs, are run over a repair pit. Three men are placed in an inspection pit of this kind. In case cars come in very rapidly it is sometimes necessary to set aside some of the cars to give the men time for inspection. The latter consists in examining the wearing plates, springs and shoes of plows, washing the plow bars with kerosene and greasing them, examining the motors for loose bolts and hot boxes, and the cars for damaged wheels, defective gong or loose truck bolts. An inspection pit is the length of one car. No repair work is done in the inspection pit. If any work is needed the cars are run over a long repair pit in the back of the house.



FREIGHT CAR LOADED WITH ARMATURES

Every two months cars are taken in for general overhauling. At this time the armature bearings are usually renewed, and sometimes the axle bearings. The good results which we have obtained with armature bearings where the babbitt has been compressed with a hydraulic broach, which is passed through the bearing after it is cast, and which puts a hard polished surface on the babbitt, has led the company to put in a machine for this purpose. Some of the trials made on bearings so treated have resulted in a run of one year for an armature bearing without excessive wear. The results are, no doubt, due to the compression and polishing of the wearing surface of the babbitt by the passage through the bearing of the broach, which is a small fraction of an inch larger than the bearing as cast.

All overhauling and inspection in all our car houses is done from the pit. Wheels are also renewed from below, and cars are never taken off of single trucks, though cars on maximum traction trucks are sometimes lifted free of the trucks. The arrangement of the pits for wheel renewal in our car house at Ninety-Sixth Street and Second Avenue is shown in one of the accompanying photographs. The track has removable sections, according to the usual custom, and wheels are taken out by a jack, which is on a truck, as seen. The pit through which the wheels are removed lies at right angles to the regular inspection pit. The pits in all our car houses are 5 ft. deep in the clear, and in a majority of cases are equipped with hydraulic jacks. All electric light wiring in the pits is in iron conduit.

This department passes over to the electrical engineer's department all armatures and fields which need to be rewound, as well as controllers and plows which need any extensive repairs. Armatures, fields, plows and controllers which go to the electrical department are collected from the various car houses by a freight car which has a crane on each side. Armatures are placed in boxes for such shipment. One of these cars is shown herewith.

THE NEW YORK RAPID TRANSIT SUBWAY

THE Rapid Transit subway, now under construction in New York City, is the result of a long demand on the part of the public for more and better rapid transit facilities for the long distances that must be traveled by those going from the downtown or southern end of the island to Harlem and the Bronx to the north. The transit facilities in New York have never been able to keep pace with the needs of the city. Although the improvements have been rapid in the surface lines the last few years and the Manhattan Elevated has extended its lines and is now equipping electrically in order better to handle its business, the physical limitations under which both surface and elevated lines must necessarily labor in New York City make them inadequate to the growing demands made upon them as the population increases and the number of long-haul passengers becomes greater.

A review of all the schemes for underground and elevated roads that have ever been proposed would require several volumes. Agitation for more rapid transit lines has been more or less violent for many years. The first movement of the kind that amounted to anything, exclusive of the street railway lines, was the passage of the elevated railway act of 1875. Under this law the present elevated roads were completed in 1878 and 1879. It is questionable whether New York will ever see again the inauguration of a rapid transit system that will be such a marked improvement over previous methods as were the elevated roads at the time they were started. That the present subway system, when completed, will offer much faster service than anything now available is, however, certain. The island of Manhattan is so long and narrow that the building of a new rapid transit line of any kind is by no means the simple matter it would be in many large

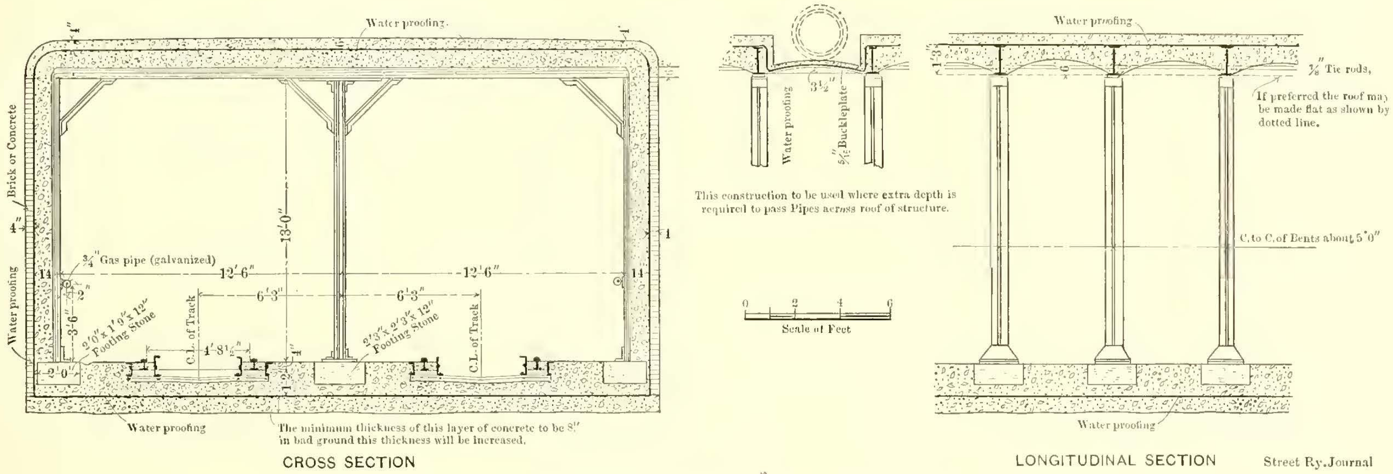


FIG. 2.—STANDARD CONSTRUCTION FOR DOUBLE-TRACK SUBWAY

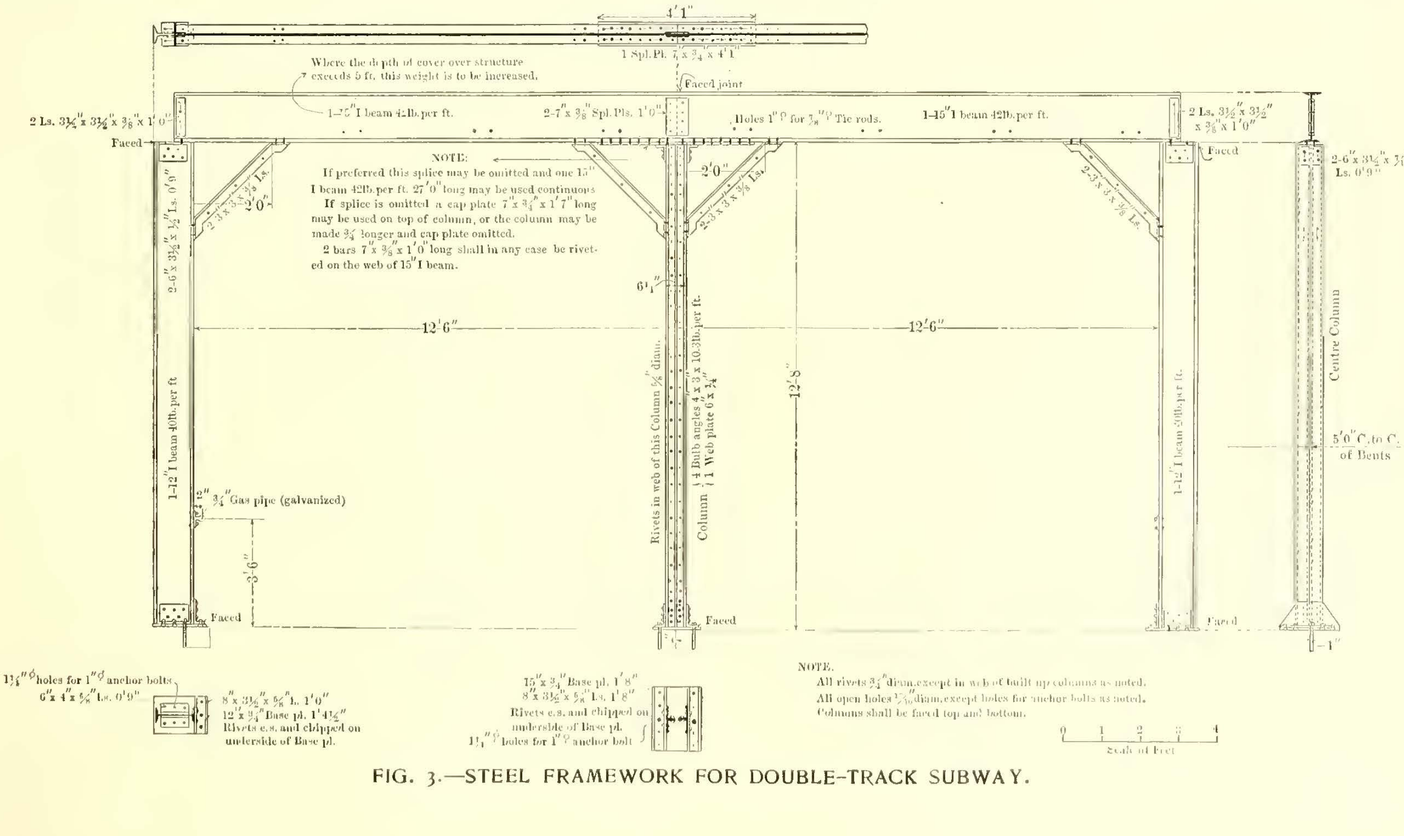


FIG. 3.—STEEL FRAMEWORK FOR DOUBLE-TRACK SUBWAY.

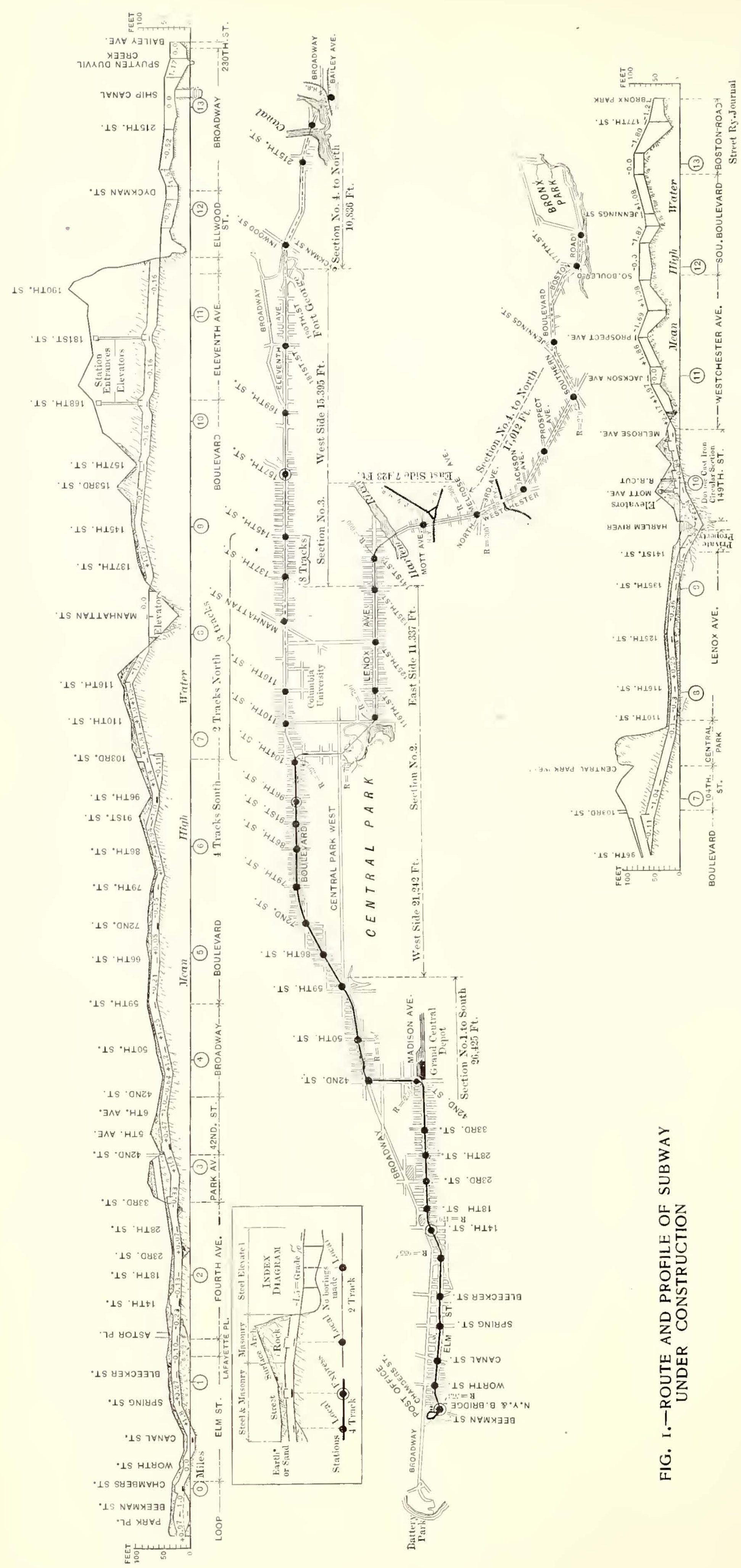
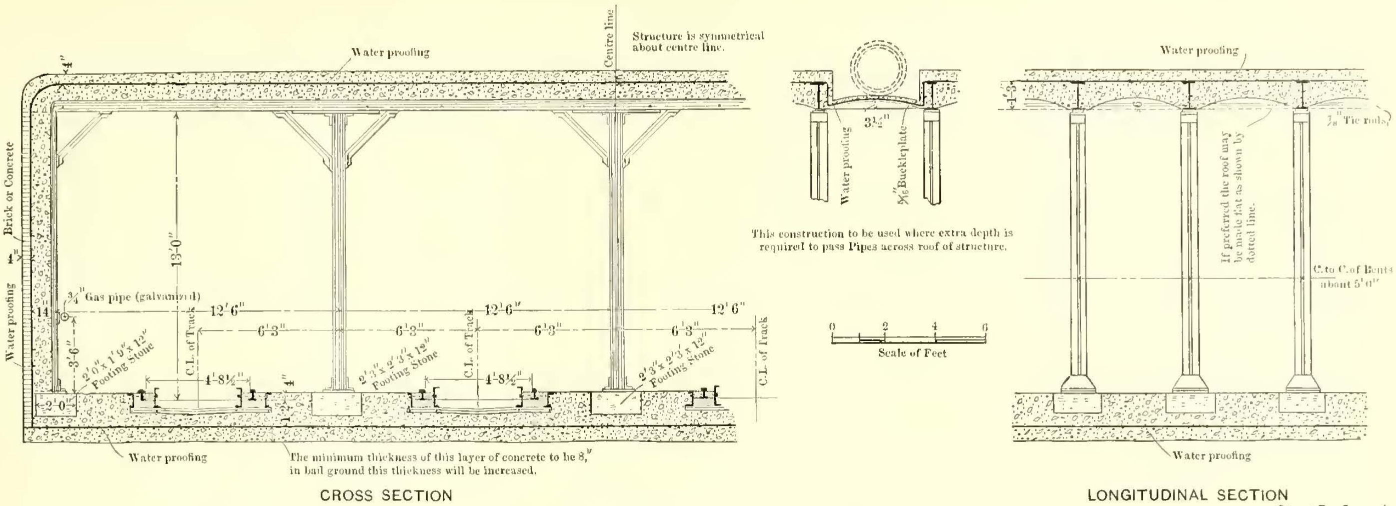


FIG. 1.—ROUTE AND PROFILE OF SUBWAY UNDER CONSTRUCTION

cities, owing to the congestion of buildings, the narrowness of streets and the necessary conflict of any subway or tunnel with building foundations and with underground pipes and structures. As said before, underground schemes without number have been proposed.

In April, 1890, Mayor Hugh J. Grant appointed a commission to select rapid transit routes for the city. This commission consisted of Orlando B. Potter, William Steinway, Charles Stewart Smith, John H. Starin and August Belmont, chairman. This commission did a great deal of work and considered many different routes and tunnel schemes. In July of the same year it made a final report to the Mayor, in which a four-track underground road was recommended. This ended the work of that commission, and, in formal compliance with the statute, fifty reputable householders made application to the Mayor, reciting the need of such a railway in New York City. The Mayor then appointed as commissioners William Steinway, John H. Starin, Samuel Spencer, Eugene S. Bushe and John H. Inman. The Council selected as a sixth member John N. Bowers. This commission drew up definite plans, which were adopted by the Board of Aldermen. The franchise for the road was then offered for sale, but capital was afraid of the enterprise under the conditions offered, and no bids were received. The work of the commission, therefore, came to nothing.

The subway now under construction is the outcome of the work of a commission appointed in 1894, and still in existence. This commission was the result of action by the Chamber of Commerce, which body held frequent meetings to discuss the subject and outlined several feasible plans for the financing of a rapid transit subway system. A bill was prepared under the direction of a committee of the Chamber of Commerce, and was passed by the Legislature May 22, 1894. This bill provided for the Rapid Transit Commission, which is responsible for the present undertaking. This commission consists by law of the Mayor and Comptroller of the city of New York, the president of the Chamber of Commerce and the five members named in the bill. Any vacancies are filled by the vote of the



FIGS. 4 AND 5.—STANDARD CONSTRUCTION FOR FOUR-TRACK SUBWAY

members of the board. No city or State officer has any power of removal. The commission was authorized either to sell the franchise or to provide for ownership by the city. The latter question was submitted to the voters in November, 1894, and resulted in a great majority for municipal ownership. The commission originally consisted of John H. Starin, William Steinway, John H. Inman, Seth Low, John Claflin and, *ex-officio*, Mayor Thomas E. Gilroy, Comptroller Ashbel P. Fitch and Alexander E. Orr, president of the Chamber of Commerce. There have been various changes, and the board now consists of Alexander E. Orr, George L. Rives, John H. Starin, Woodbury E. Langdon, Charles Stewart Smith and Mayor Van Wyck, Comptroller Coler and President Morris K. Jesup of the Chamber of Commerce.

The commission decided upon routes and definite engineering plans for the subway system, and Nov. 13, 1899, called for bids for its construction. All these engineering features were the work of the chief engineer of the Rapid Transit Commission, William Barclay Parsons, and an able corps of assistants. The plan under which bids were requested provided for the building of the subway according to the plans by the contractor and its operation for a period of fifty years. The contractor receives his pay in long-term bonds issued by the city of New York. In addition to constructing the subway, the contractor is to operate it for fifty years, must provide the rolling stock and motive power himself, and pay a rental to the city of an amount equal to the interest on the bonds plus 1 per cent for a sinking fund to be used to retire the bonds. At the end of forty-five years it is calculated the bonds will have been paid off. When the contract expires at the end of fifty years the city agrees to buy the rolling stock and other equipment from the contractor at a price to be agreed upon by arbitration. By this plan the city in fifty years becomes the owner of a rapid transit subway without any cash outlay, and assumes no financial burden except that it stands behind the bonds in case the contractor fails and is unable to pay the interest on them. The contractor is thus able to secure money at a lower rate than if

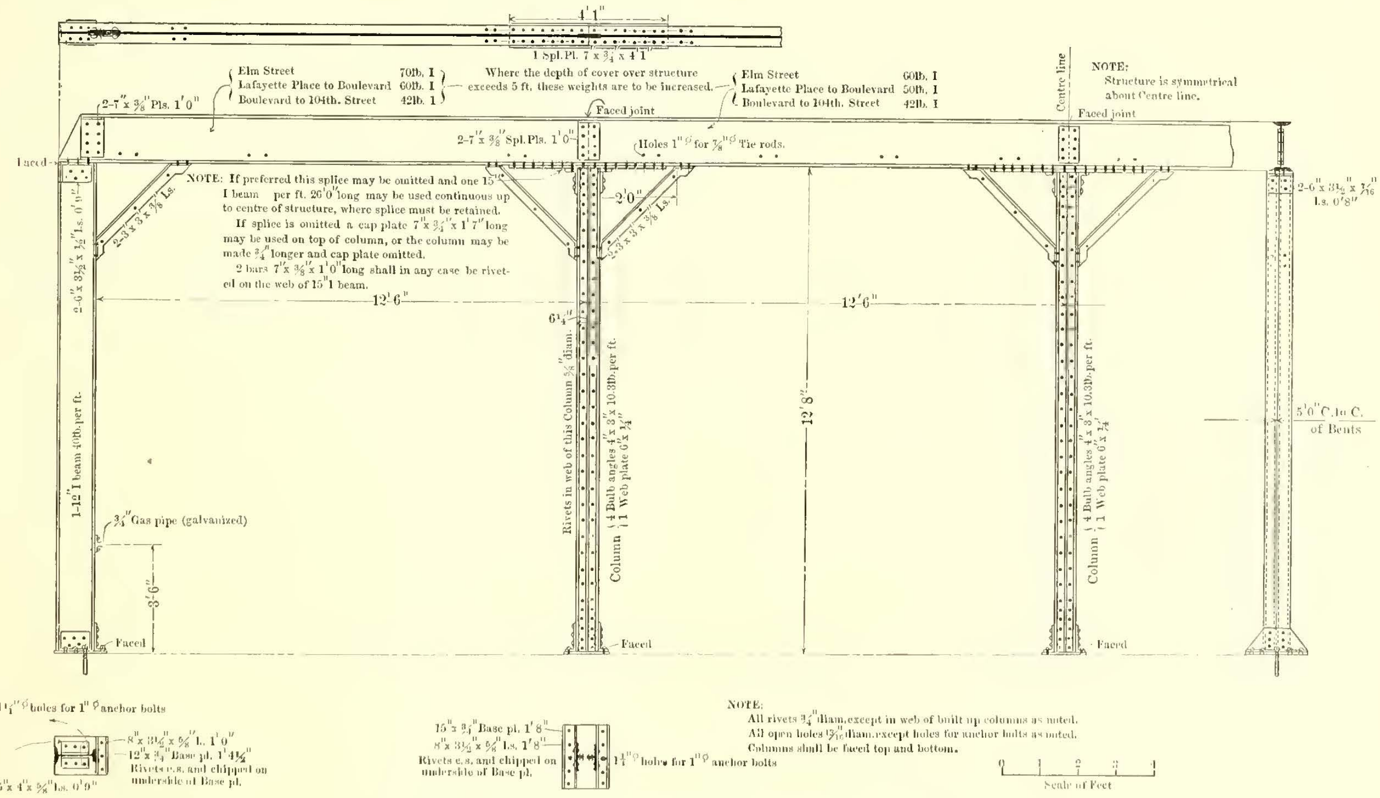


FIG. 6.—STEEL FRAMEWORK FOR FOUR-TRACK SUBWAY

he used his own credit to issue bonds and stock. He is saved the expense of financing the scheme, and, furthermore, he is operating, not under a franchise which can be altered by municipal and State legislative bodies, but under a definite contract, which can not be broken by any laws that may be passed.

Two bids were received. One was by Andrew Onderdonk; the other by John B. McDonald. Mr. McDonald's bid was for $35,000,000, and was $4,300,000 lower than Mr. Onderdonk's. The commission met and decided to award the contract to Mr. McDonald, Jan. 16, 1900. The contract was signed Feb. 24, 1900. It was an impressive event, second only in that respect to the formal beginning of work, which took place March 24, 1900.

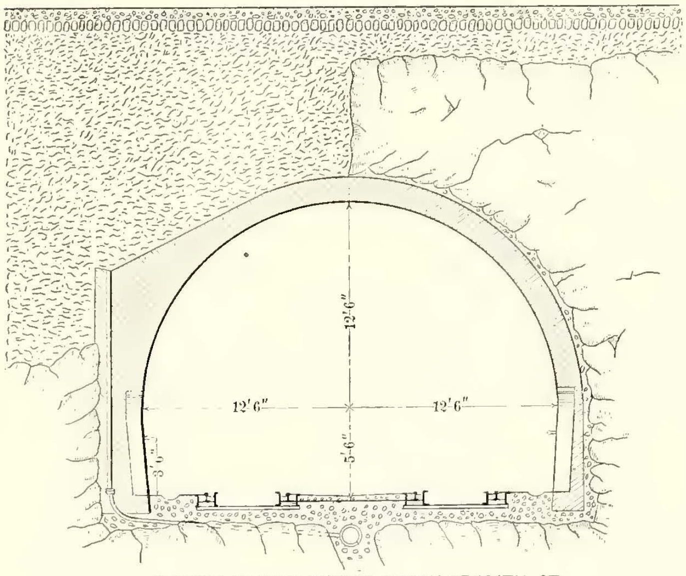


FIG. 7.—DEEP TUNNEL WORK

John B. McDonald is a well-known contractor, who had the backing of the banking house of August Belmont & Company. August Belmont & Company organized a company to furnish the necessary bonds for the faithful performance of the work. The city now has in cash and securities $8,000,000 for that purpose.

The Rapid Transit Subway Construction Company was formed by August Belmont & Company to finance the construction of the Rapid Transit subway under John B. McDonald's contract. It also will, it is understood, operate the system when it is completed. The president of the company is August Belmont, son of the August Belmont who was on the Rapid Transit Commission of 1890. The family has been prominent in New York banking circles since 1837. Walter G. Oakman, vice-president of the company, is president of the Guaranty Trust Company; John F. Buck is treasurer and Frederick Evans, secretary. The capital stock of the company is $6,000,000. The equipment of the road comes under General Manager E. P. Bryan, formerly vice-president and general manager of the Terminal Railway Association of St. Louis. S. L. F. Deyo is chief engineer, and has charge of the construction of the subway. John Van Vleck is mechanical engineer. L. B. Stillwell, who is also consulting electrical engineer of the Manhattan Railway Company, and had charge of the electrical installation of the Cataract Construction Company, was selected as electrical director, and acts in an engineering capacity with Mr. Bryan in the equipment of the road. All the work done by the contracting company is subject to the approval of the engineer of the Rapid Transit Commission, William Barclay Parsons. Associated with Mr. Parsons as consultants upon electrical matters are Dr. Louis Duncan and Cary T. Hutchinson.

The route of the subway now under contract, its profile, grades and distance below the surface are shown in Fig. 1. Its downtown terminus is at the City Hall, from whence it proceeds north under Park Row, and then under Elm Street (which is a new thoroughfare which the city is opening up parallel with Broadway) as far north as Union Square. From Union Square it runs north under Fourth Avenue to the Grand Central Depot at Forty-Second Street, west under Forty-Second Street to Broadway, and north under Broadway and the Boulevard. As far north as 104th Street there are to be four tracks, two for express and two for local trains. At 104th Street the routes branch into two two-track routes, one of which continues straight up to Ft. George, and the other runs northeast to Bronx Park. There are, however, three tracks on the Ft. George line from 104th Street to 145th Street, and from 137th Street to 145th Street there will be eight tracks, five of which are for storage. Between the City Hall and 104th Street there are twenty-two stations, five of which are express stations. It is expected that the express trains making the five stops will make this run in seventeen minutes. This distance is over 6¾ miles. On the two branches all stations will be local except that there will be an express station at 157th Street. In laying out the road as to grades it has been the general rule to have the stations at high points to aid trains in accelerating and stopping. The greater portion of the way the subways are immediately under the surface of the street. In a few

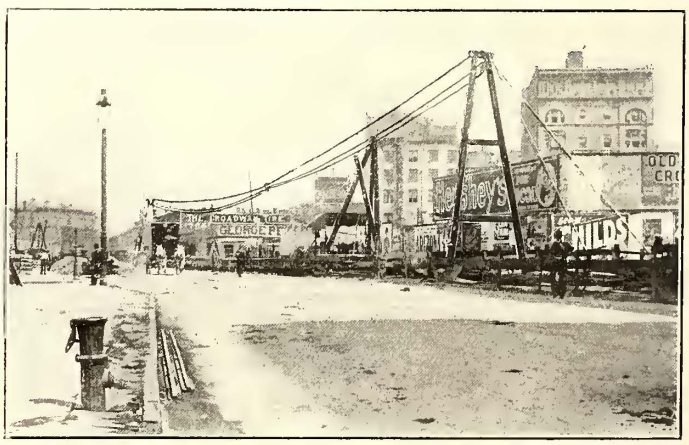


FIG. 8.—A COMMON METHOD OF WORK. ONE SIDE OF STREET OPEN. OVERHEAD ROPEWAY

places a deep tunnel construction had to be employed, notably between 150th Street and 200th Street. Here two stations are over 100 ft. below the surface, and at the station a tunnel, with a 50-ft. diameter arch, is being made in the solid rock. The rock is granite, and the arch needs no artificial support, though masonry will be put in. An arch of this size in the solid rock, unsupported, is said to be unprecedented in underground work.

Fig. 2 shows the standard construction for the double-track subway when but a short distance under the street, where concrete arches with steel girder framework are used. Fig. 3 shows the steel part of the structure. The weight of the street and street traffic is taken by 15-in.

I-beams weighing 42 lbs. per ft. The track construction is not decided upon as yet, but will be of some form similar to that shown, with steel ties in the concrete, and the rails resting on a wood cushion, from which they can be easily removed for renewal.

No special provision is being made to deaden sound and vibration, as with the construction employed and spring-supported motors it is not expected that vibration will be troublesome. Experiments are now going on upon a section of the Long Island Railroad to determine the track construction that will finally be adopted.

FIG. 9.—STREET RAILWAY TRACK ON TEMPORARY SUPPORTS

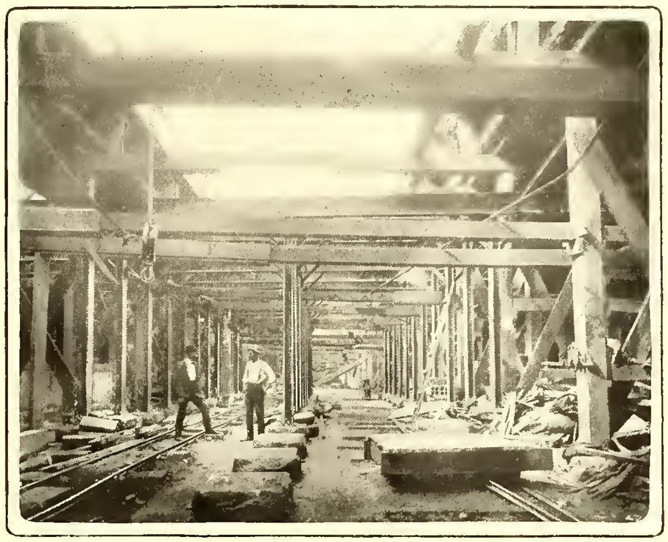


FIG. 10.—STRUCTURE IN MIDDLE OF STREET UNDER BOTH STREET RAILWAY TRACKS

The standard steel and masonry construction for four tracks is shown in Figs. 4, 5 and 6. In all cases there is no partition between tracks. The whole subway is open, save for the lines of supporting columns. This is an important consideration where trains are to be run at such a high speed. As electricity will be the motive power, the question of ventilation is not considered important. It is not expected that the air in the subway will be damp and cellarlike, because of the precautions that are being taken to exclude moisture.

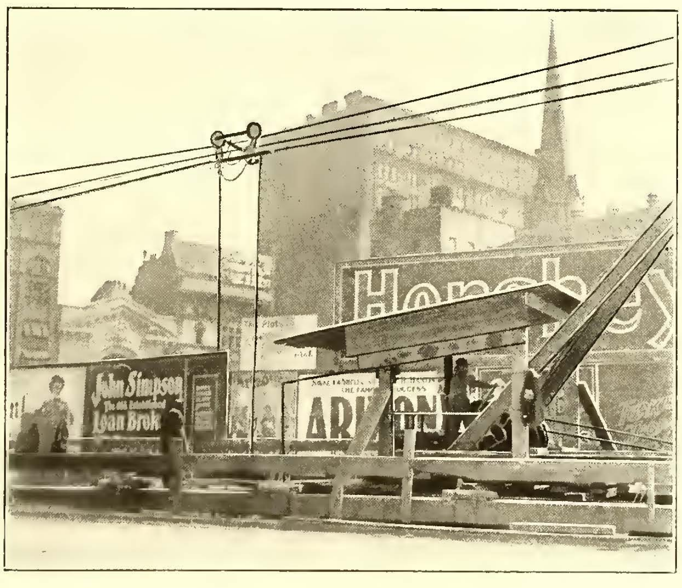


FIG. 11.—COMPRESSED AIR HOISTING ENGINE FOR OVERHEAD ROPEWAY

The construction where there is a deep tunnel is shown in Fig. 7. This is a plain masonry arch. Under the Harlem River two tubes, one for each track, are being built.

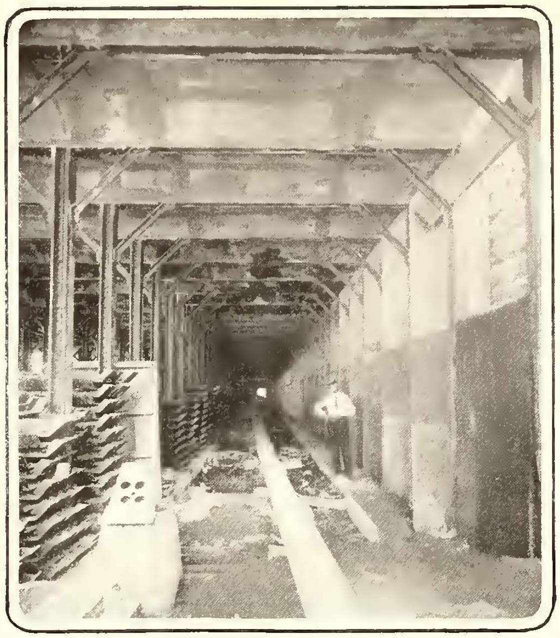
In addition to the route shown in Fig. 1, on which construction work is now under way at numerous points, an extension is to be made south from Park Row on Broadway to Battery Park, and thence under the East River to Brooklyn City Hall. From Brooklyn City Hall the extension runs to the terminus of the Long Island Railroad at Flatbush Avenue. These new lines are shown by the inset map in this issue. There will be loops at Battery Park and Brooklyn City Hall. As some trains will run clear through to Brooklyn, the loop facilities at any one point need not be as great as if the cars all terminated at one loop at Park Row, as formerly intended.

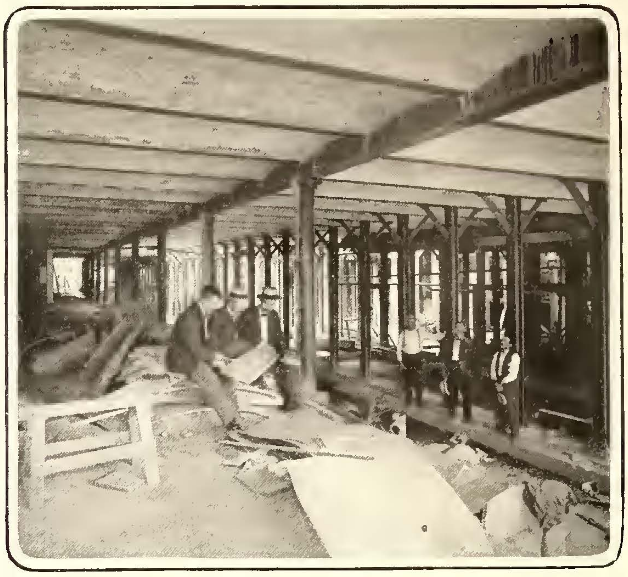
With the express service which the construction of four tracks south of 104th Street makes possible, the reduction of schedule time under that of any existing route will be considerable. The tunnel to Brooklyn is also greatly needed, as the present bridge and ferry facilities are entirely inadequate to handle the future traffic to Long Island.

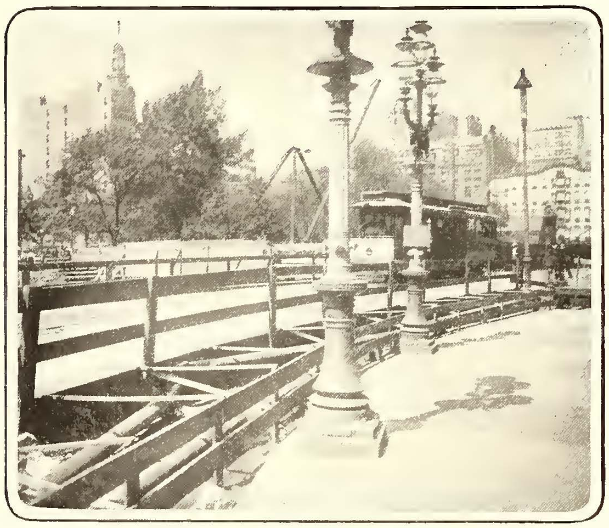
In nearly all cases the work is being carried on without interrupting street railway traffic and by closing only one side of the street to team traffic, as in Fig. 8, which also shows the overhead ropeway for handling material. There are a few places where both sides of a street are opened at once, and the street railway tracks are supported in the middle by a temporary structure. Fig. 9 is a view at Sixty-Second Street and Broadway at the bottom of the subway, showing a street railway track on temporary supports. Fig. 10 is another view at the same place, showing both tracks and the steel structure.

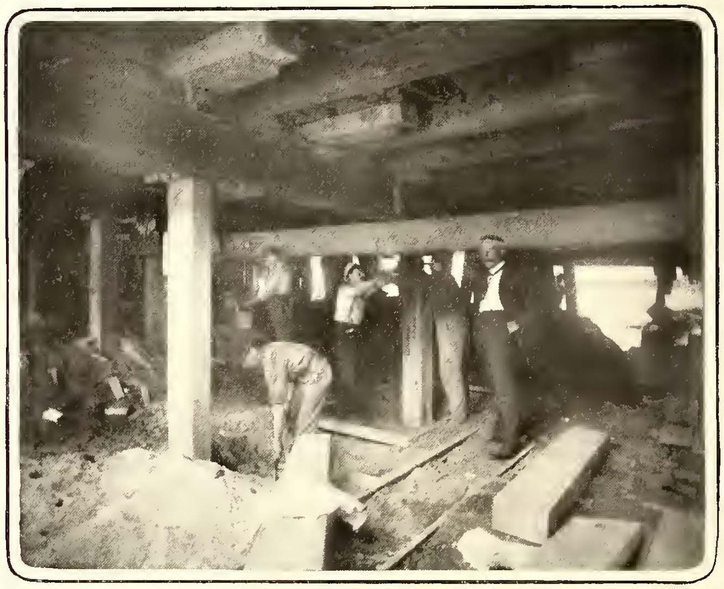
One of the first things to be done was the removal of all the sewers which would interfere with the work, and the building of such new sewers as were necessary to take care of the sewage left unprovided for by the change. Work is being pushed all along the route of the subway by various sub-contractors, and a visit to the places where work is in progress is most interesting. Different modes of procedure are adopted in various places.

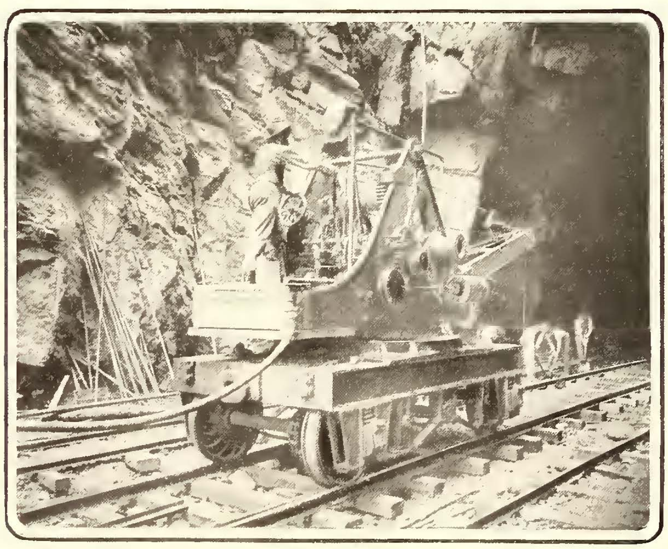
The method most frequently used in the ordinary subway work is to open up one side of the street for a dis-











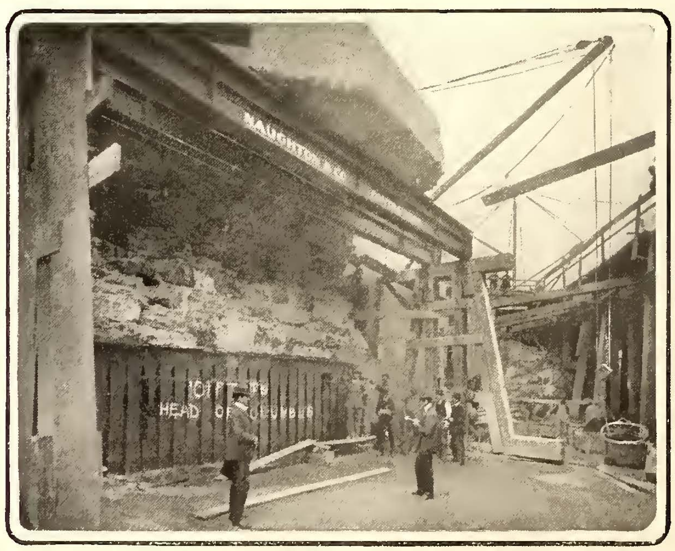


FIG. 13.—IN THE SUBWAY. STEEL AND MASONARY FINISHED

FIG. 15.—TEMPORARY TRACKS AND CONDUIT RAISED ABOVE SURFACE OF STREET

FIG. 17.—COMPRESSED AIR SELF-PROPELLING CRANE

FIG. 14.—AT SIXTIETH STREET STATION

FIG. 16.—DRIFTING UNDER PARK ROW

FIG. 18.—UNDER COLUMBUS MONUMENT

tance of about 400 ft. Excavation is made to the depth of the subway. The numerous pipes that are always encountered are suspended by chains from beams placed across the excavations. The workmen then drift under the street railway tracks in the middle of the street, using the same tactics as in drift work in a mine, and follow the excavation up with supporting timbers. When the drifting has reached half-way under the tracks the subway steel work and masonry are put in under the half of the street that has been excavated, and the surface of the street is restored to its original condition. Then the other half of the street is excavated and the drift work carried under the other street railway tracks to meet the subway already finished under the other half of the street. The second half of the subway at that point is then completed and the street filled in and paved. All this time street railway traffic is not interrupted. Material is handled in and out of the long excavations by an overhead wire rope tramway stretched over the length of the excavation, Figs. 7 and 11. This and its hoist are operated from one end by a compressed-air hoisting engine. A number of stationary derricks, run by compressed air, are also in use. As solid rock is encountered in numerous places, extensive use is made of compressed-air drills. Compressing plants for supplying hoists and drills are housed in temporary structures placed on vacant property along the line. When rock is to be blasted, mats, woven from large hemp rope, are put down to catch as much of the rock loosened by the blast as possible. Although the blasts make little disturbance, every precaution is taken with them. Boards are put over the excavation. Pedestrians and street cars are kept off that part of the street when a blast is fired.

On Elm Street (Fig. 12), which is a new street which is being opened by the city to parallel Broadway from Park Row to Union Square, the contractors have had full swing. The street having never been opened for traffic, it could be given for the time being entirely to the subway contractors. On portions of Elm Street the subway is completed so far as the steel and masonry work is concerned. The appearance of the finished subway plus considerable rubbish is shown in Fig. 13. The station at Sixtieth Street and Broadway is far enough advanced so that Official Photographer Pullis was able to get the view from one of the platforms shown in Fig. 14.

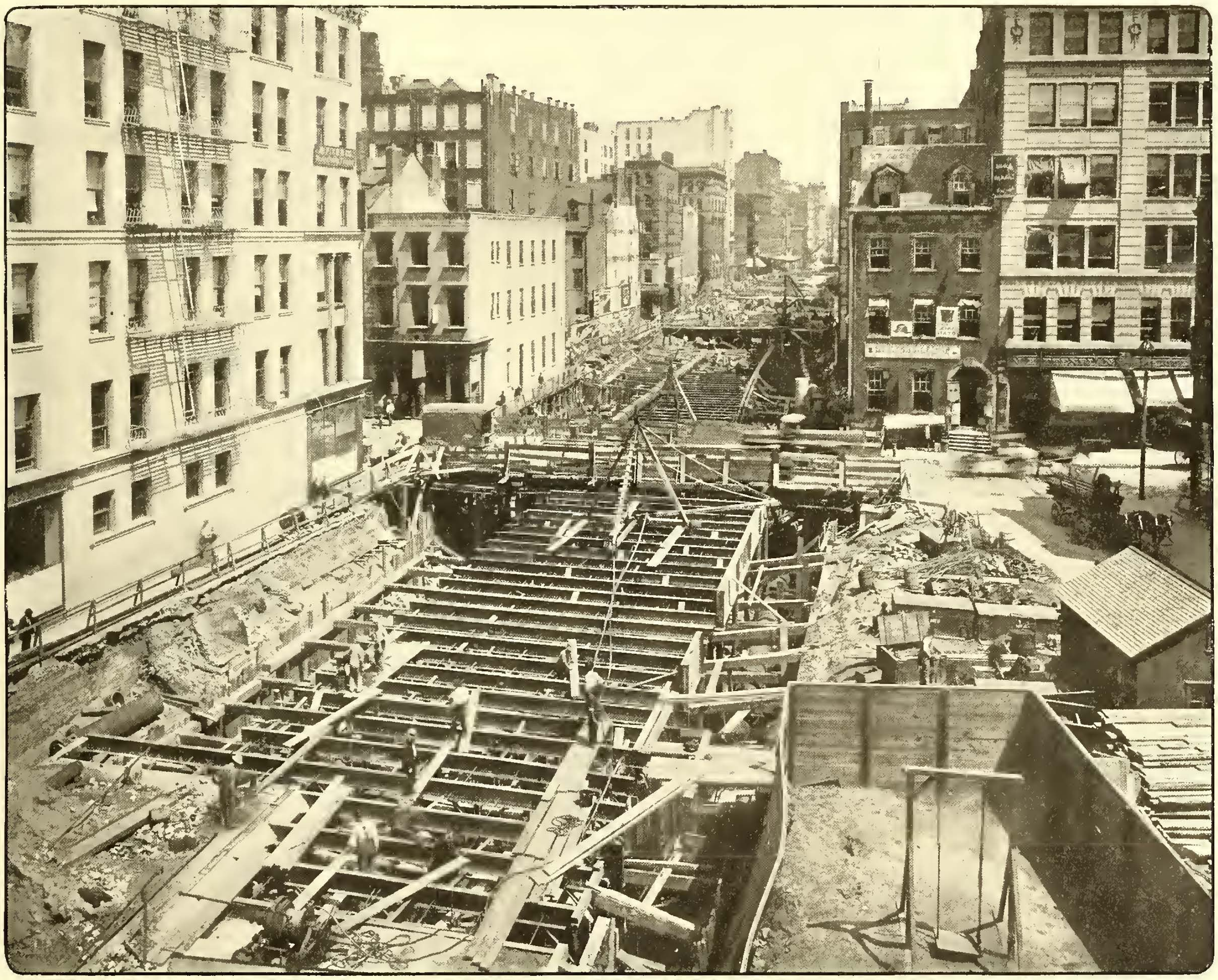


FIG. 12.—ON ELM STREET

On Fourth Avenue, near Seventeenth Street, and at a few other places, instead of drifting under the tracks and leaving them and the pavement surrounding them intact, the contractors have put down a temporary street railway track, conduit and all, and supported it by a wooden framework covered with plank (Fig. 15). This brings the track slightly above the grade line of the street, so that the entire street can be removed from underneath it.

Fig. 16 is a piece of work that appeals strongly to the popular imagination, though it is simply doing on a large scale what has been done at many other places along the line. It illustrates the work of drifting under Park Row, one of the most crowded streets of the city. The street is being opened only at one side on Park Row, and space for both tracks and station is being made under the street without disturbing traffic on the south side.

Another means of handling material is the compressed air derrick, self-propelled, which is used in the rock tunnel under Central Park, and shown in Fig. 17.

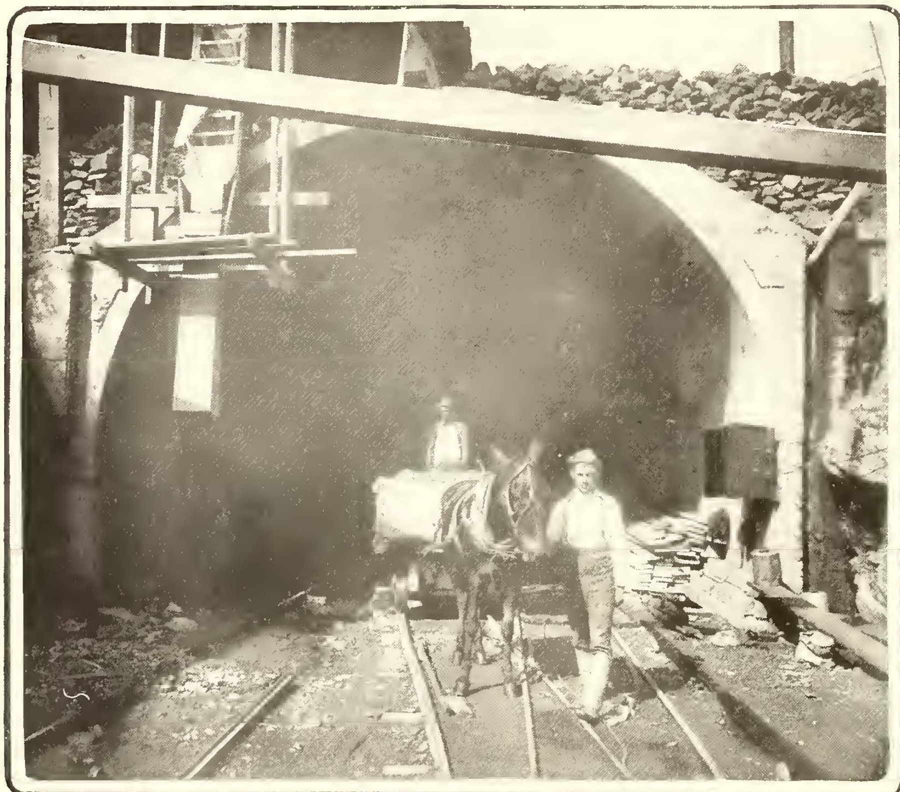


FIG. 19.—AT THE ENTRANCE TO A TUNNEL

A spectacular feature of the work is the supporting of one side of the Columbus monument at Fifty-Ninth Street and Broadway, of which Fig. 18 gives a good idea.

The masonry tunnel work as it appears when finished is seen in Fig. 19, which is at one end of one of the tunnels.

On Lenox Avenue a balanced overhead wire-rope tramway is in operation on a system owned by the W. F. Brothers Company, of New York. The cable which takes the weight, instead of being fastened to a "dead man" at the ends, is counterbalanced, and the end supports are on pivots. In this way the grade which the load must ascend is kept approximately the same from end to end, instead of increasing near the ends, as in an ordinary cable tramway. An electric crane (Fig. 20) is used on this cableway. The operator, being directly over the bucket, no signal men are needed to direct the movement of the bucket, as where there is a power house at the end. The tramway must, of course, be heavier and stronger to support the additional weight of the crane mechanism and operator than if the motive power and engineer were at one end.

The construction work has been divided among the following six sub-contractors: The Degnon-McLean Construction Company, 21 Park Row, New York; L. B. McCabe, Broadway and 156th Street, New York; E. J. Farrell, 215 West 125th Street, New York; John Shields, Hamilton Bank Building, New York; John C. Rodgers, 21 Park Row, New York; Holbrook, Cabot & Daly, 44 Union Square, New York.

The steel work is being furnished by the American Bridge Company. Of this, over 75,000 tons will be used. The waterproofing material is supplied by the Sicilian Asphalt Company, and 775,795 cu. yds. are required.

The cost of the subway, according to the contract price, is $35,000,000. Its entire length is about 21 miles, which makes the cost $1,666,666 per mile. There are, however, 55.5 miles of single track, exclusive of storage, which makes the cost per mile of single track $630,630. This, of course, does not include the cost of rolling stock and power houses. The fixed charges will not, however, probably be much greater per mile of single track operated than it was on the Manhattan Railway (elevated) of New York, which, previous to a recent $18,000,000 bond issue for electrical equipment and improvements, had 109.5 miles of track and an issue of stock and bonds amounting in round numbers to $802,000 per mile of single track. Its structure covered 36.19 miles.

FIG. 20.—ELECTRIC CRANE ON BALANCED CABLEWAY

The construction practically began Sept. 1, 1900, and Sept. 1, 1901, about $8,000,000 worth of work had been done. From now on it is expected and practically assured that $1,000,000 worth of work will be done each month, as work is now in progress practically all along the route of the subway except at such places as an elevated structure is required, and where it is not necessary to begin work for some time yet. The time named in the contract for the completion of the subway was August, 1904, but the engineers calculate that the work will be completed nine months sooner than this. Payment is made to the contractors each month for the amount of work accomplished as estimated by the engineering department of the Rapid Transit Commission. The Rapid Transit Commission has over 150 engineers at work on estimates and inspection. All engineers entering this department must pass a very rigid civil service examination, and are retained upon their merits only. A definite price was agreed upon by the contractor for excavations in soil, excavations in rock, replacement of pavement and all other items going into the construction of the subway. The amount of such work accomplished each month is measured by the engineers of the Rapid Transit Commission, and the estimates according to schedule agreed upon are sent in to the chief engineer's office. The total amount is then estimated, and the City Controller, upon the order of the Rapid Transit Commission, issues bonds to the contractor for the amount of work accomplished according to the engineer's estimates. The work is divided into five engineering divisions, four of which are on the subway, and one has only to do with sewers.

The power house for the subway lines will be built to contain twelve engines of a rated capacity of 7500 hp each, at best efficiency, with a maximum capacity of 11,000 hp each. Eight of these engines have been contracted for, and will be built by the Allis-Chalmers Company. They will be of the same general type as those being put in the Manhattan Elevated Railway power plant. Each engine consists of two component engines, operating on one shaft, with a 5000-kw alternator between the engines. Each of these component engines will have a vertical low-pressure and horizontal high-pressure cylinder acting on the same crank.

The high-pressure cylinders are to be 42 ins. in diameter and 60 ins. stroke, and the low-pressure cylinders, 86 ins. in diameter by 60 ins. stroke. The engines will operate with 175 lbs. to 200 lbs. initial pressure, and at 75 r. p. m. The high-pressure cylinders will have poppet valves, and the low-pressure cylinders, Corliss valves. The object of the poppet valves in the high-pressure cylinders is to insure the successful operation of the valves without excessive use of oil at high steam temperatures. It is expected that they will operate successfully with steam at 500 degs. to 550 degs. F.

The matter of speeds and schedules is something which has not been fully decided, nor can it be decided entirely until the road is in operation. It is stipulated in the contract that local trains making all stops must not have a schedule speed of less than 14 miles per hour. The maximum speed for which the track is being laid out is about 40 miles per hour. It is expected that considerably higher speeds than those named in the contract will be attained. This will depend largely on the nature of the equipment to be adopted and the rate of acceleration. It is expected that express trains can be operated two minutes apart and local trains one minute apart. The local service will not differ materially in number of stops and spacing of stations from the Manhattan Elevated service, so that to make higher schedule speeds than the elevated some radical steps in the way of high acceleration and rapid braking will be necessary.

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In publishing this, our souvenir issue of the twentieth annual convention of the American Street Railway Association, we think that no apology is due our readers for devoting so much space to the street railway situation in Greater New York. America is justly regarded as representing the latest developments in modern methods of transportation, and its electric railway apparatus and steam locomotives are being adopted as standard in all parts of the globe. Moreover, it so happens that its commercial metropolis, New York City, not only contains the most complex problem in transportation, but is also the scene of the greatest activity in electric railway construction in the world. This is due partly to the configuration of the city and its relations to the water courses which surround it. Manhattan Borough, which contains the most important business districts and most densely inhabited portions of the greater city, is situated on a long and narrow island, and is connected by only one bridge to the next most populous borough, Brooklyn, often called the dormitory of New York. These conditions make the number of rides per capita on the different transportation systems within the city reach between 350 and 400 annually, a figure largely in excess of that in any other city.

* * *

The other principal reason which makes the New York traffic situation of particular interest at the present time is that, owing to local circumstances, the introduction by the companies in the city of modern traction methods has been until recently very much delayed, so that the improvements now being made are more extensive than they otherwise would be, because they represent the accumulation of years of comparative inactivity. Thus the metropolitan railways, being prohibited the use of the trolley, have installed the conduit system so recently that the company's power station is entirely modern in its equipment, and represents not only the latest engineering practice, but what may fairly be considered as an advance on present practice, inasmuch as it is still the pioneer in the distribution of large currents for railways at high potential. The elevated railway system is also now in process of transformation to electric power, and the work is so far advanced that the power station building is completely erected, part of the machinery is installed, and all the rolling stock is under contract. In addition, the Rapid Transit Subway, so long discussed and the subject of so much contention, has now been in the hands of the contractor for about a year and a half, and most of the excavation has been completed. It is eminently true, therefore, to say that the eyes of the world, so far as transportation is concerned, are on New York City, because it presents not only the largest and most complicated urban traffic problems in existence, but also the most advanced steps made to solve them by modern transportation methods. The readers of this number are fortunate in having these problems discussed by the leading officials of the companies interested in their solution, and by experts on the allied topics also treated in this issue. A few words of comment on each of these articles will assist, we believe, to a better understanding of them.

* * *

In the first article Mr. Ford reviews the general urban transportation problem. He shows how, with a population second only to London, the physical configuration of New York City is such as to confine the travel into certain definite congested lines, making the traffic on them the heaviest of any in the world. In the case of New York City, also, the local surface and elevated passenger lines are not relieved to any great extent of the long-distance suburban riders traveling on the steam railroad suburban systems, as is the case in London. The three important characteristics of the surface and elevated railroad transportation problem of New York City are the enormous traffic north and south on Manhattan Island, both long haul and short haul; the great congestion of Brooklyn traffic at its one Manhattan terminal across the Brooklyn Bridge, and the immense summer resort traffic to Coney Island and other beaches. Another feature of especial interest in connection with the New York City railway systems results from the fact that the principal surface system, the Metropolitan Street Railway, and the principal elevated system, the Manhattan Railway Company, are probably the most successful enterprises of their kind in the world. Their equipment, their operating methods, and their financial success have been such as to mark them as standards for future practice. The tables and diagrams collected and presented by Mr. Ford have been prepared through the courtesy of the managements of the different companies interested, and comprise what is undoubtedly the most complete set of data ever presented on the transportation system of any city in the world. In addition, the maps, covering a period of years, will be of considerable historical value, and have been compiled here for the entire city for the first time. In view of the many consolidations which have occurred during the past ten years, it does not seem beyond the bounds of possibility that all of these transportation systems will ultimately become parts of one consolidated system, and the figures here combined enable one to form an opinion of such a condition, together with an estimate of the probable increased business to be done by such a corporation.

* * *

Following this article is a series of five by officers of the Metropolitan Street Railway Company. Messrs. Vreeland and Root take up subjects connected with the operation of the road. The foundation for success in railway service, as in practically any other industry involving the employment of a large amount of labor, is undoubtedly that of the upbuilding of an effective working organization. This problem includes not only the direction of the train crews, the part of the force which directly represents the company so far as the public is concerned, but also the division of responsibility throughout all the subdivisions of the company. It is an undertaking which has been forced upon large corporations recently by the vast consolidations, which have become so common, and whose ultimate success depends almost entirely upon the possibility of so arranging the duties of each department head and worker as to secure their maximum efficiency. In the street railway field the problem is perhaps more complicated than in any other because by far the greatest expense in railway operation is that for labor, and in that service it has a dominating importance to a greater extent probably than in most other branches of industrial activity. Not only is this phase of the subject discussed by Mr. Vreeland, but he points out the effect of the recent railway consolidations on the operating force. This is not, as is popularly supposed, to effect a reduction in the number of workingmen. The number on the Metropolitan system, on a mileage basis, is twenty-five times that employed in the old horse-car days, but there has been an elimination of a large number of high-priced officials and ornamental heads. The duties of the active manager of a large railway system has in recent years become entirely different from that of his predecessor on the small road. Instead of carrying on individually the detail of each department, he selects his division chiefs, on whom rest the responsibility for his portion of the work. This, on a large road, requires executive ability of the highest order, as well as practical knowledge of the details of every department, and in this direction Mr. Vreeland has established a record second to no other "captain of industry" in the country.

* * *

For many years it has been the custom among operating officers to consider transfers and the transfer problem an unavoidable evil; something which has grown on the street railway systems of this country against the will of the directors, and which all would do away with were it possible. Indeed it at one time came to be so much the fashion to refer to transfers as an objectionable necessity that no one dared lift his voice in contradiction. Mr. Root, in his discussion of this subject, gives a decided jar to these old orthodox views on the transfer question. In view of his position in the active management of the New York City street railways for a number of years past, his opinions are certainly entitled to the highest consideration, even if all do not fully agree with him. His position, briefly stated, is that the introduction of an extensive transfer system is as much, if not more, responsible for the increased dividend earning power of the Metropolitan Street Railway during the past ten years as is the introduction of mechanical traction, with its increase of speed and comfortable cars. Perhaps if many other broad-gage street railway managers expressed their real convictions about the transfer matter it would be along the same line, though perhaps not so pronounced. Certain it is that, as Mr. Root says, it is easy to let the difficulties and abuses of the transfer system so fill one's mental horizon when dealing with the difficulties encountered in connection with it every day that sight is lost of the great gains secured by it. And right here is a valuable lesson which should not be forgotten in all matters pertaining to the management of large corporations, as well as small ones. It is that in the management of large enterprises of this kind small abuses and petty drawbacks often disappear from vision when a broad survey is taken of a question of policy, and the final objects to be obtained are considered.

* * *

The articles by Messrs. Starrett and Pearson on the power house and distribution system of the Metropolitan Street Railway Company are of more than ordinary interest because they give the actual results attained in the operation of the largest electric railway power house in the world, as well as of the largest generating units and the largest polyphase system of power distribution in use for electric railway purposes. The statements are of importance, not because of any idle curiosity that attaches to the "biggest" things, but because it is of value to know how far engineering is correct in its present tendency to concentrate generating machinery at single points and distribute over large areas by polyphase current. The articles referred to comprise the first authentic published information on the performance of this mammoth plant. The Ninety-Sixth Street power house of this company, which is the one under consideration, marked a radical change in electric railway generating and distributing methods on this side of the Atlantic at the time it was designed. Some polyphase distribution work had been done in Europe, but in neither continent had a steam plant on such a large scale been erected. The results of the operation of both the power plant and distributing system are very satisfactory, both as to economy and reliability, and justify all the reasonable expectations which the engineering world had concerning them. A coal consumption of 2.65 lbs. per kw-hour and a water consumption of between 13 and 14 lbs. per ihp in everyday practice, as announced by Mr. Starrett, would have been startling in electric railway circles a few years ago and is a surprisingly low figure now, even in the light of modern experience with large generating plants. It is sometimes customary to calculate the difference in efficiency between a large and a small power house simply on the basis of the difference in the full-load test efficiency of the generating units, with possibly some allowance for difference in cost of superintendence of one station *vs.* two or more. Practice seems to have demonstrated, however, that this method of reckoning leaves out of account numerous other economical possibilities in the large plant not available for the smaller one, These are too numerous to discuss here at length, but a few examples may be cited. The size of the Metropolitan system, together with the use of storage batteries at the sub-stations, makes possible a fairly steady, economical load on the large units running in the power house. Another refinement possible in a large plant of this kind is the maintenance of a laboratory and the analysis of coal, lubricating oil and flue gases, a work not heretofore systematically attempted. Flue gas analysis is only valuable, as Mr. Starrett says, when samples can be taken frequently, and it is possible to insist upon uniformity in flue gases only when mechanical stokers are used. The article seems to show that in the Metropolitan power house excellent combustion is being secured. How easy it is to obtain imperfect combustion probably no one knows better than the stoker operators, although better work can, of course, be done with mechanical stokers than with hand firing.

* * *

Considering now the distribution system as taken up in Mr. Pearson's paper, it is interesting to note that the efficiency of the polyphase distribution from the switchboard of the generating station to the direct-current bus-bars of the sub-stations is 90 to 91 per cent, or fully as high as was expected from calculations based on the commercial efficiency of the apparatus. This figure, however, does not include what may be lost in charging and discharging the storage batteries, but this, on the Metropolitan system, would be but a small per cent of the total, as the principal function of the battery in each sub-station is to take care of the smaller momentary fluctuations, though it can be used to take a considerable load for a short period. As a matter of fact, the efficiency of the Metropolitan system from the coal pile to the conductor rails is probably higher than on the majority of large direct-current railway plants and distribution systems. On this point data for comparison are difficult to obtain, for few railway companies know more than approximately the amount of the loss in their direct-current feeders, and it is probably much larger than commonly supposed. There is usually a constant tendency to deterioration in the ordinary ground return circuit and often, as well, a gradual increase in the line loss, caused in the latter case by deterioration in insulation and heat losses where cars are added without increasing the feeder capacity. Indeed, when a road is operating with but 20 per cent loss between its power station bus-bars and the cars, as the Metropolitan seems to be, it is probably doing far better than the average. Of course, the question of loss in distribution is entirely one of investment, but the point we wish to make is that before any engineers mentally compare the loss in distribution on the Metropolitan system with the losses that are common on direct-current railway distributors to the detriment of the Metropolitan, they would do well to inform themselves thoroughly on the direct-current distribution losses that are usual, and then determine the cost of copper necessary to bring these losses within 15 per cent. This may well apply to the other figures on the performance of the Metropolitan generating and distribution system as well. It is one thing to criticise performances in the abstract, but quite another to compare with actual commercial results elsewhere.

* * *

The lessons to be learned from these power station articles are entirely encouraging to those working toward the consolidation of power houses into large polyphase generating plants. Incidentally, they should throw some light on the engineering questions that come up in connection with the equipment of suburban steam railroads with electricity, for it is the size and type of unit that must be built for such service. The satisfactory working of the plant and successful control of such large amounts of electrical energy are also matters which should afford much satisfaction to all interested in heavy electric railway work. While larger power houses than the Metropolitan will soon be in operation in New York, the publication of the results attained in this, the first of its type, are certainly worth the considerable amount of space which has been allotted to them in this issue.

* * *

In the comparative review of the steam plants of the three large electric traction stations in New York City Mr. Kent criticises somewhat the conservative lines which have been followed in the design of the engines employed in all the stations in Manhattan Borough, and believes that if higher pressures, superheated steam, triple expansion, piston and poppet valves and higher rotative speed had been employed, a considerable economy would have been effected. He quotes extensively from modern marine engine practice, and makes an interesting plea for this design of machine. He also favors larger engines, to secure the maximum benefits. In view of Mr. Kent's standing as an authority on steam practice, these suggestions, as well as those on other parts of the equipment, are certainly worthy of consideration, and we should be glad to see a trial made of the type of engine used in marine service and to which reference in the article is made. But it should be remembered that railway work is extremely exacting, that an interruption to the distribution through any trouble with the power-generating plant means a stoppage of traffic, entailing loss of revenue and other serious troubles. While, therefore, it is of course possible to carry conservatism too far, we believe that the directors of most railway companies do not view with much disfavor all reasonable precautions which their engineers may adopt to insure the certainty of station operation.

* * *

The situation on the east side of the East River is at present of as great, if not greater, interest as in Manhattan Borough. The four articles which discuss the railway conditions in Brooklyn give in detail the policy and practice of the Brooklyn Heights Railroad Company as they now are, at the same time indicating the future possibilities awaiting the system. The physical union of the two boroughs is rapidly following their political consolidation, and the many contemplated Manhattan-Brooklyn bonds, both above the water and below it, will shortly necessitate an entire rearrangement of the traffic and the increased accessibility which will make the two boroughs practically one will solve the most difficult problem confronting President Greatsinger. Until such relief is provided for the congestion at the Manhattan end of all lines, it hardly seems possible that the remarkable yearly growth shown in General Manager Brackenridge's article can be maintained.

* * *

In the technical articles by Messrs. Chamberlin and Roehl two important subjects are taken up—the power supply and the rolling stock. The difference in service in the two boroughs necessitates in general only slight modifications in the standard cars, but it is interesting to note that the half-open, half-closed cars that have proved so popular in Manhattan seem to be in small favor in Brooklyn. The somewhat meager description of the new type of combination summer and winter car which has been in experimental use for some months in Brooklyn, receiving great approbation from the company's patrons, will be enlarged upon, we understand, in Mr. Chamberlin's paper before the American Street Railway Association, and will be reprinted in these pages later.

* * *

In Mr. Roehl's article is given for the first time a comprehensive account of his railway's proposed power development. The greater distribution economy resulting from the adoption of the high-tension system will be supplemented by the additional advantage of offering opportunities to buy or sell alternating current, the same three-phase, 6500-volt current being in use by the lighting company. The omission of storage batteries may, perhaps, be criticised by some, but it gives Mr. Roehl an ever-ready means of increasing the capacity of his system. The remarkable growth in the demands of the Brooklyn Heights Railroad Company has temporarily somewhat limited its resources, but one can not read of the contemplated eradication of the present impediments to expansion without acquiring the same optimistic spirit which prevails in the articles.

* * *

Passing now to the Borough of the Bronx, we find railway conditions more closely approximating those on the average city and interurban electric railway in other parts of the country. As in Brooklyn, the overhead trolley is used, and the railway reaches out into suburban territory where high speeds and long rides are the rule, not the exception. Mr. Maher's article shows, however, that the tide of population is rapidly pushing its way northward, and this annual growth, already great, will, of course, be enormously accentuated when the rapid transit tunnel is completed. Within ten years, therefore, it is not too much to expect that a greater part of the Bronx Borough will present traffic conditions similar to those existing in the uptown residential sections on Manhattan Island, except that to them will be added the natural flow to and from the great park systems, which will always make the Bronx the principal pleasure ground of the greater city.

* * *

The article giving the programme to be followed by the American Street Railway Association and the Street Railway Accountants' Association of America at their New York conventions shows that a great deal of valuable information is to be presented to the consideration of the attendants to both conventions. In the case of the American Street Railway Association the list of papers is considerably longer than that at the last convention, and it is understood that all the papers will be presented without question. All the authors have won a prominent place as authorities in electric railway railroading, and speak with knowledge on the topics which will be treated by them. The same is true of the papers to be read before the Accountants' Association, and we feel confident that no one who attends either convention at the Madison Square Garden this month will leave with a feeling of regret that any portion of the programme has been slighted. The facilities at the Madison Square Garden for the exposition of exhibits are probably unrivaled in this country, and from the preparations already made by the manufacturers, the exhibition there will undoubtedly be without parallel for completeness in the history of electric railroading. The entertainments will also, it is needless to say, be very complete, and with the attractions which New York affords for sightseeing and entertainments to visitors, and the hospitality for which Mr. Vreeland and his confreres are noted, it may safely be said that the 1901 convention will ever be one of the most cherished memories in the minds of the members of the Street Railway Association and of all others who attend the New York convention.

* * *

It is impossible in the space available in this issue even briefly to discuss all of the papers published therewith. We think it only fair, however, to express in public our thanks to our contributors for the time which they have given in the preparation of these articles. They are extremely busy men, especially so at this time, as all are taking an active part in the preparations for the entertainment of the American Street Railway Association at its annual convention. They have, nevertheless, taken up each subject with great thoroughness, with the result that this number is not only the most complete single publication on the transportation systems of any city in the world, but contains information which is of the greatest value in solving the transportation problems presented in other commercial capitals, as well as to a large extent those presented on electric systems in every city in the country. Nor can we close without a possibly pardonable word in regard to the Street Railway Journal itself. Our readers are so familiar with our special souvenir issues that perhaps they are not acquainted with the fact that each of these numbers for the last five years has been the largest engineering or technical paper ever published up to the time it was issued, and has been exceeded only by our own succeeding numbers. Each contains as many pages and represents as much labor and expense in its compilation as nearly any treatise extant on an electrical engineering subject, and each would require, if published in book form in the usual way, some six or eight months in its preparation. We have endeavored in this issue to surpass even our former records in value of contents, typographical appearance and artistic effect, not only in the reading, but in the advertising pages as well, and have aimed to present to our readers an issue which would be worthy of the American Street Railway Association and of the principal topic treated, the street railway situation in New York City.

THE COMING CONVENTIONS AT NEW YORK CITY

THE AMERICAN STREET RAILWAY ASSOCIATION

THE twentieth convention of the American Street Railway Association will be held, as announced, Oct. 9-11, in the Madison Square Garden. There will be two business sessions on Wednesday, Oct. 9, and on Friday, Oct. 11. Thursday, Oct. 10, has been set apart exclusively as Exhibitors' day, and it is supposed that most of the delegates will devote that day to an examination of the exhibits.

The papers to be presented have been assigned as follows:

"Street Railways: A Review of the Past and a Forecast of the Future"—Robert McCulloch, general manager Chicago City Railway Company.

"The Adoption of Electric Signals on Suburban and Interurban Railways, Single or Double Track, and Their Economy of Operation"—William Pestell, superintendent of motive power, Worcester Consolidated Street Railway Company.

"The Value of Storage Batteries as Auxiliaries to Power Plants"—W. E. Harrington, vice-president and general manager, Camden & Suburban Railway Company, Camden, N. J.

"The Public, the Operator and the Company"—C. S. Sergeant, vice-president, Boston Elevated Railway Company, Boston.

"The Best Manner and Mode of Conducting the Return Circuit to the Power House"—E. G. Connette, general manager, Syracuse Rapid Transit Company, Syracuse.

"The American Street Railway Association: The Purpose of Its Organization and the Benefits Accruing to Investors in and Operators of Street Railway Properties by Membership Therein"—G. W. Baumhoff, St. Louis.

"The Best Form of Car for City Service: A Consideration of the Various Types of Car as to Size of Car and Arrangement of Seats, Including Best Types of Brakes and Wheels"—Eugene Chamberlin, superintendent of equipment, Brooklyn Heights Railroad Company.

"Relations of Interurban and City Railways"—Ira A. McCormack, general manager, Cleveland Electric Railway Company, Cleveland.

"Alternating and Direct-Current Transmission on City Lines"—M. S. Hopkins, general manager, Columbus Railway Company, Columbus, Ohio.

"The Modern Power House, Including the Use of Cooling Towers for Condensing Purposes"—J. H. Vail, consulting engineer, Philadelphia.

Also papers on the following subjects: "The Economies Resulting from the Use of Four Motors Instead of Two on Double-Motor Equipments," and "The Practical Results Obtained from Three-Phase Transmission and Rotary Transformers or Motor Generators in Transmitting Power on Railway Lines."

THE EXHIBITS

The exhibits at the New York convention, as has already been announced, will be contained in the Madison Square Garden, one of the largest covered amphitheaters in the country. This building occupies the square bounded by Madison Avenue, Fourth Avenue, Twenty-Sixth and Twenty-Seventh Streets, and is close to all of the principal hotels in the city. Not only will the main arena be occupied with exhibits, but others will be located in the large hall to the right of the entrance, usually used for restaurant purposes. No better place could have been selected for exhibition purposes, and none, it is safe to say, has ever been so replete with interest to the street railway visitor as that which will be seen at New York this month.

THE STREET RAILWAY ACCOUNTANTS' ASSOCIATION OF AMERICA

The programme of the above association, which will also hold its convention at the Madison Square Garden Oct. 9-11, is as follows:

Wednesday, Oct. 9, Madison Square Garden, 10 a. m.—Address of welcome by Hon. Bird S. Coler, Comptroller of the City of New York. Annual address of the president. Annual report of the executive committee. Annual report of the secretary and treasurer. Appointment of convention committees, resolutions and nominations. Paper—"Car Mileage and How to Arrive at It Easily," by J. M. Smith, comptroller Toronto Railway, Toronto, Canada; 2:30 p. m.—Paper—"Capital Accounts from the Viewpoint of the Investor and the Public," by Col. T. S. Williams, vice-president Brooklyn Rapid Transit Company, Brooklyn, N. Y. Report—"Standard Blanks and Accounting for Material and Supplies," by F. E. Smith, auditor Chicago Union Traction Company, Chicago, Ill., chairman.

Friday, Oct. 11, Madison Square Garden, 10 a. m.—Paper—"Consumers' Accounts, Electric Lighting Companies," by S. E. Moore, comptroller United Traction Company, Pittsburgh, Pa. Report—"Standard System of Accounting for Electric Light Companies," by G. E. Tripp, general auditor Stone & Webster's Companies, Boston, Mass., chairman. Annual Report—"Standard System of Street Railway Accounting," by C. N. Duffy, auditor Chicago City Railway, Chicago, Ill., chairman; 2:30 p. m.—Paper—"Conductors' Accounts," by Elmer M. White, cashier Hartford Street Railway, Hartford, Conn. Report—"Standard Unit of Comparison," by H. C. Mackay, comptroller Milwaukee Electric Railway & Light Company, Milwaukee, Wis., chairman. Reports of convention committees. Election of officers.

TRANSPORTATION TO NEW YORK

The passenger associations have granted the usual rates of one fare and one-third for the round trip, on the certificate plan. To secure this reduction it is necessary to obtain a certificate from the agent when the railroad ticket is purchased, in the usual way. No stopover is allowed on return tickets except at Buffalo, where stopover of ten days will be allowed on tickets from New York. A fee of $1 is charged for this by the Joint Ticket Agent in Buffalo.

H. H. VREELAND

N. H. HEFT

JOHN HARRIS

W. H. HOLMES

J. B. McCLARY

F. L. FULLER

OFFICERS AND EXECUTIVE COMMITTEE, AMERICAN STREET RAILWAY ASSOCIATION

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J. A. HARDER

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C. N. DUFFY

W. F. HAM

C. S. MITCHELL

W. G. McDOLE

OFFICERS AND EXECUTIVE COMMITTEE, STREET RAILWAY ACCOUNTANTS' ASSOCIATION OF AMERICA

C. M. HEMINWAY

W. B. BROCKWAY

G. E. TRIPP

COMPARATIVE REVIEW OF THE STEAM PLANTS OF THREE LARGE ELECTRIC TRACTION MAIN STATIONS IN NEW YORK CITY

BY WILLIAM KENT, M. E.

THE three plants referred to in this article are those of the Metropolitan Street Railway Company, Ninety-Sixth Street and East River; the Third Avenue Railway Company at Kingsbridge, 216th Street and Harlem River; and the Manhattan Railway Company (elevated railway), Seventy-Fourth Street and East River—all of them on Manhattan Island. Each one of these stations has already been described and illustrated in considerable detail in the STREET RAILWAY JOURNAL, the first named in the issue of March, 1900; the second, in that of January, 1900, and the third in that of January, 1901; and descriptions, more or less complete, have also appeared in several other engineering journals.

Each of the plants is a representative of the most advanced American practice in both steam and electrical engineering in central station plants, and each of them is far in advance of any stations furnishing power for electric traction previously built anywhere in the world, both in the magnitude of the total power developed and in the magnitude of the steam and electrical units. It is intended in this article to review the principal features of the steam portion of each of these plants, comparing the points in which they are similar and contrasting their differences.

The general engineering problem to be solved in each of these three plants is practically the same. It is to furnish electric current for moving cars on street or elevated railways extending the whole length of Manhattan Island, and also over a large extent of territory north and east of the Harlem River, in the borough of the Bronx. The maximum quantity of steam power estimated to be capable of being furnished by the stations is 66,000 hp by the Metropolitan, and 100,000 hp each by the Kingsbridge and Manhattan stations, and provision has been made for a future enlargement by 50 per cent of the size of the Manhattan station when the demand for power shall make it advisable.

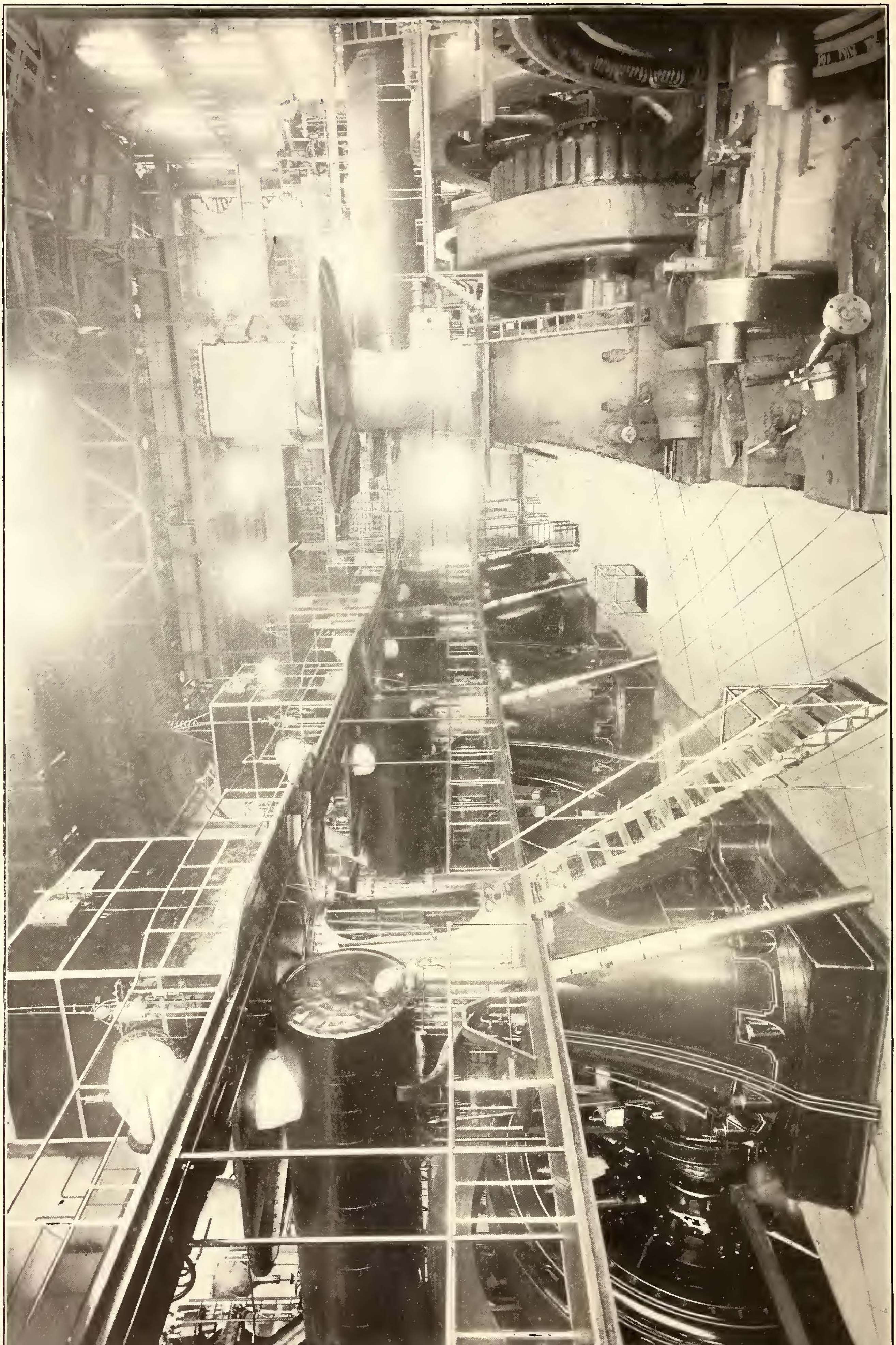
The solution of the electrical problem reached by the engineers of each of the three companies is practically identical. It involves the generation at one point, on tide water, of the electrical current required for the whole railway system, the current being three-phase alternating, of a frequency of 25 cycles per second, the potential in the Metropolitan and Kingsbridge stations being 6600 volts, and in the Manhattan station 11,000 volts. These currents are carried in each case to six or more sub-stations, located at convenient points on the lines of the respective railways, where they are converted by means of transformers and rotary converters into direct currents for delivery to the third rail or to the underground conduit conductors, as the case may be. The location of the main stations on the river front is for the purpose of securing water transportation for coal and ashes and an abundant supply of water for the condensers.

The conclusion to adopt a three-phase alternating-current generated at a single station was reached by the engineers of each company only after a careful study of a great number of other proposed plans and a comparison of their advantages and disadvantages, both from a standpoint of finance and that of certainty of continuous operation of every part of the railway system. A statement of the controlling reasons in favor of the method of electrical distribution adopted is given in an article by L. B. Stillwell, electrical engineer, published in the STREET RAILWAY JOURNAL of Jan. 5, 1901. The reason given for the adoption of 11,000 volts by the Manhattan Company instead of 6600 volts, adopted by the other companies, is that the cost of copper for 11,000 volts is 40 per cent less than for 6600 volts. The cost of insulation is greater for the higher voltage, but the net saving is considerable.

Each of the three companies having decided upon having its main station furnish three-phase alternating current of a frequency of 25 cycles per second, each also decided upon alternators of similar construction, viz., a stationary armature and a revolving field of 40 poles, with a speed of 75 r. p. m. The size of these alternators differed in the different stations, but the shafts upon which the armatures are keyed are of nearly the same dimensions, all being hollow-forged shafts of fluid-compressed steel, made by the Bethlehem Steel Company, and all having main bearings of the same size, viz., 34 ins. in diameter and 60 ins. in length. The shafts are all driven through single fantail cranks at each end, with overhung crankpins, no double cranks being used, and they are all driven by compound condensing engines of 60-in. stroke, fitted with Corliss drop cut-off valves. The similarity of dimensions of the shafts and their bearings is somewhat remarkable, in view of the fact that the size of the alternators and engines, the power transmitted through the shafts and the total weight upon the shafts are not the same in all the stations.

The adoption of the moderate rotative speed of 75 r. p. m. is one of the evidences of safe conservatism which seems to characterize the designs of all three stations. Corliss engines have run successfully at 100 revolutions and upward, and piston and slide valves at much higher speeds, and higher speeds would greatly decrease the size and cost of engines and alternators for a given power, but it has seemed wise to the engineers intrusted with the designs to keep well within safe limits of speed in order to insure greater durability of the valve mechanism and lessen the danger of breakdowns and the inconvenience of stoppages for repairs.

In the general design of a whole system of electrical generation and distribution for traction purposes the work of the electrical engineer may be said to begin at the third rail or underground conduit rail and to proceed backward



GENERAL VIEW OF THE NINETY-SIXTH STREET POWER STATION, METROPOLITAN STREET RAILWAY COMPANY to the rotating part of the alternator which is keyed to the engine shaft. The design of the steam engineer begins at the shaft, which is to turn a given number of revolutions per minute, which is to transmit a given horsepower to the alternator, and which is to be of such proportions that it will not appreciably deflect under the load it carries, and proceeds backward to the coal pile. The size of the combined unit of alternator and engine may be limited by the state of the art of engine building and armature building. It is also limited by the facts that the station as a whole has to be designed with reference to fluctuating loads, the total power during the period of "peak of the load" being ten or more times as great as that required during four or five hours after midnight, that one or more units may at any time be out of service for repairs, and that the efficiency of alternators decreases with light loads, while that of engines decreases both with light loads and with overloads. While it might be possible, therefore, to build a station for a maximum capacity of 100,000 hp with only five units of 20,000 maximum hp each, it would not be a good design, for it would not provide for one of the units being out of repair during the time of the peak of the load, and during the time of lightest load, when only 10,000 hp is required, the one unit furnishing it would be running at low efficiency.

The prime consideration in the design of such a large station is certainly of continuous operation; that no accident, short of an earthquake or a bombardment, shall prevent the station furnishing the full quantity of current desired during the hours of heaviest traffic. A secondary consideration is that at all times the station shall be run at the highest economy of fuel and labor. The question of first cost of plant is of minor importance, since the station is paid for by issues of stock and not of bonds, and even some extravagance is pardonable if it tends to certainty of operation, to economy of running, to durability of buildings and machinery, and to fine architectural effect.

The questions of size and number of units and their arrangement are capable of any number of different solutions, and it is not surprising that the engineers of the several plants came to different conclusions concerning them. The following are the sizes and the numbers of units designed for the three stations:

	Units	Kw each	Engines, hp	Total hp
Metropolitan ...	11	3,500 normal	4,500 rated	49,500
		4,700 maximum	6,000 max.	66,000
Kingsbridge	16	3,500 normal	4,500 rated	72,000
		5,000 maximum	6,250 max.	100,000
Manhattan	8	5,000 normal	8,000 rated	64,000
		7,500 maximum	12,500 max.	100,000

The engines selected for the Metropolitan and the Kingsbridge stations are of the same type and the same general dimensions, viz., vertical cross-compound, cylinders 46 and 86 ins. x 60 ins. stroke. Those of the Metropolitan station are designed by the Allis-Chalmers Company, those of the Kingsbridge station by the Westinghouse Machine Company, but they are identical in type and are similar in all their principal features. In each engine the shaft is of practically the same dimensions, about 27 ft. long, with a 16-in. hole through it; the bearings are 34 ins. x 60 ins., and the diameter in the middle is 37 ins. in the Metropolitan and 39 ins. in the Kingsbridge engine. The shaft carries the revolving field of the alternator, 16 ft. 8 ins diameter, and also a fly-wheel 28 ft. diameter with a rim weighing 100 tons, between the high and low pressure cylinders. At each end of the shaft there is a single fantail crank with an overhung crankpin, 14 ins. x 14 ins., the cranks being set at 90 degs. The wristpins are also 14 ins. x 14 ins. The connecting rods are 12 ft. 6 ins. in length, or 2½ times the stroke. The valves are all of the Corliss type, with the usual releasing gear, with separate eccentrics for steam and exhaust, and are all set in the heads of the cylinders. The cylinders are entirely unjacketed, except that there is a slight jacketing effect due to the steam valves being in the heads of the cylinders. The governors are of the ordinary weighted pendulum type. A separate governor operates a safety stop-valve in the steam pipe, shutting off the steam when the speed of the engine exceeds the proper rate.

In the Manhattan station the engines are of a different type from those adopted in the other stations, and from those hitherto used in any railway power plants. They are built by the Allis-Chalmers Company.

Each unit of 8000 rated horse-power consists of two compound condensing engines, one at each end of the shaft, with horizontal high-pressure and vertical low-pressure cylinders. The two connecting rods of each compound engine take hold of a single overhung crankpin. The two cranks, one for each engine, are set at an angle of 135 degs. with each other. The principal advantage of this arrangement is that the four cylinders give eight impulses to the shaft at equal intervals of time in each revolution, instead of four impulses, which would be given if the cranks were at 90 degs. or 180 degs. The uniformity of angular velocity of rotation produced by this arrangement of cylinders, together with the fly-wheel effect of the revolving field of the alternator is such that no separate fly-wheel is needed. The principal dimensions of the engines are:

Cylinders, 44 and 88 ins. diameters and 60 ins. stroke; shaft, length 25 ft. 3 ins., diameter at hub of alternator 37 ins., at bearings 34 ins., length of bearings 60 ins., hole through shaft 16 ins.; cranks, fantail, 20 ins. thick; crankpin fit, 18 ins. x 20 ins.; crankpins, 18 ins. x 18 ins.; crosshead pins, 12 ins. x 12 ins. Connecting rods, 5.4 cranks in length; bearing of connecting-rod brasses on crankpin, 18 ins. diameter, 9 ins. in length; piston rods, 8 ins. diameter; distances between center lines of main-shaft bearings, 16 ft. 9 ins., of vertical low-pressure cylinders 26 ft., of horizontal high-pressure cylinders 27 ft. 6 ins.; clearance, 3 per cent in the high-pressure cylinder, 4 per cent in the low; receiver volume for each engine of the pair, 310 cu. ft.; reheating surface in each receiver, 773 sq. ft. of 2-in. copper pipe. At the rating of 8000 hp for the engine unit of four cylinders and an estimated steam consumption of 13 lbs. per hp-hour, there are 1.93 sq. ft. of reheating surface per hp and 1.12 lbs. of steam reheated per minute per square foot of reheating surface. There is .0775 cu. ft. of receiver volume per hp, and the volume is 5.87 times that of the high-pressure cylinder. The cylinders are not steam-jacketed.

The valves are double-ported Corliss, driven by the ordinary Reynolds-Corliss gear, with a single eccentric on each high-pressure cylinder and separate eccentrics for the steam and exhaust valves of the low-pressure. The dimensions of the valves are as follows:

	Diam., ins.	Length, ins.	Port width, ins.	Port area, sq. ins.
High-pressure steam.......	10	44	2	176
High-pressure exhaust......	10	44	2¾	242
Low-pressure steam........	14	83	4	664
Low-pressure exhaust......	16	83	4½	747

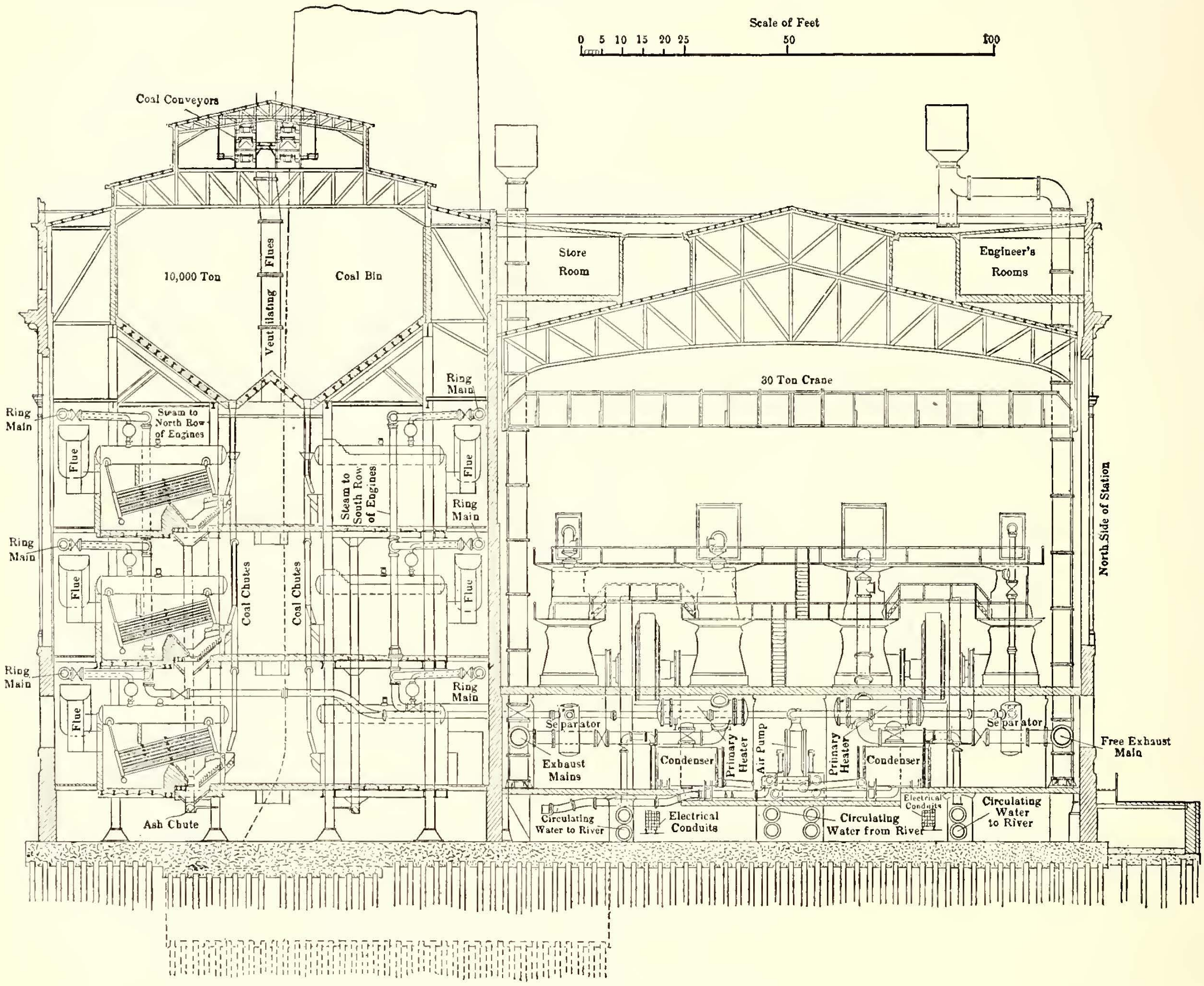
The governor will control the point of cut-off on both cylinders. An auxiliary governor operates a safety-stop steam valve. Both governors are driven by belts. The frame of the engine is massive, and is designed so that the compressive stress does not exceed 400 lbs. per sq. in. The maximum stress on other parts of the engine when working at 8000 hp with 150 lbs. steam-gage pressure and 30 lbs absolute receiver pressure are as follows: high-pressure cylinder, 1320 lbs.; low-pressure cylinder, 310 lbs.; high-pressure piston, 2500 lbs.; low-pressure piston, 2400 lbs; cross-head, 2200 lbs.; connecting rod, 3500 lbs. at neck; piston rod, 3600 lbs. at root of thread.

The power capable of being developed by this double engine is calculated as follows, the revolutions being 75 per minute: Displacement of two low-pressure cylinders, 63,094 cu. ft. per minute. Horse-power per pound mean effective pressure, referred to the two low-pressure cylinders, 275.32.

Horse-power	Displacement per hp low-pres. cyls. cu. ft. per mm	M. E. P. referred to low-pres. cyls.
7,500	8.41	27.24
8,000	7.89	29.06
9,000	7.01	32.69
10,000	6.31	36.32
12,000	5.26	43.57

The guaranteed economy is a consumption of not over 13 lbs. of steam per ihp per hour when developing 8000 hp with steam of 150-lbs. gage pressure, 26 ins. vacuum and 75 r. p. m.

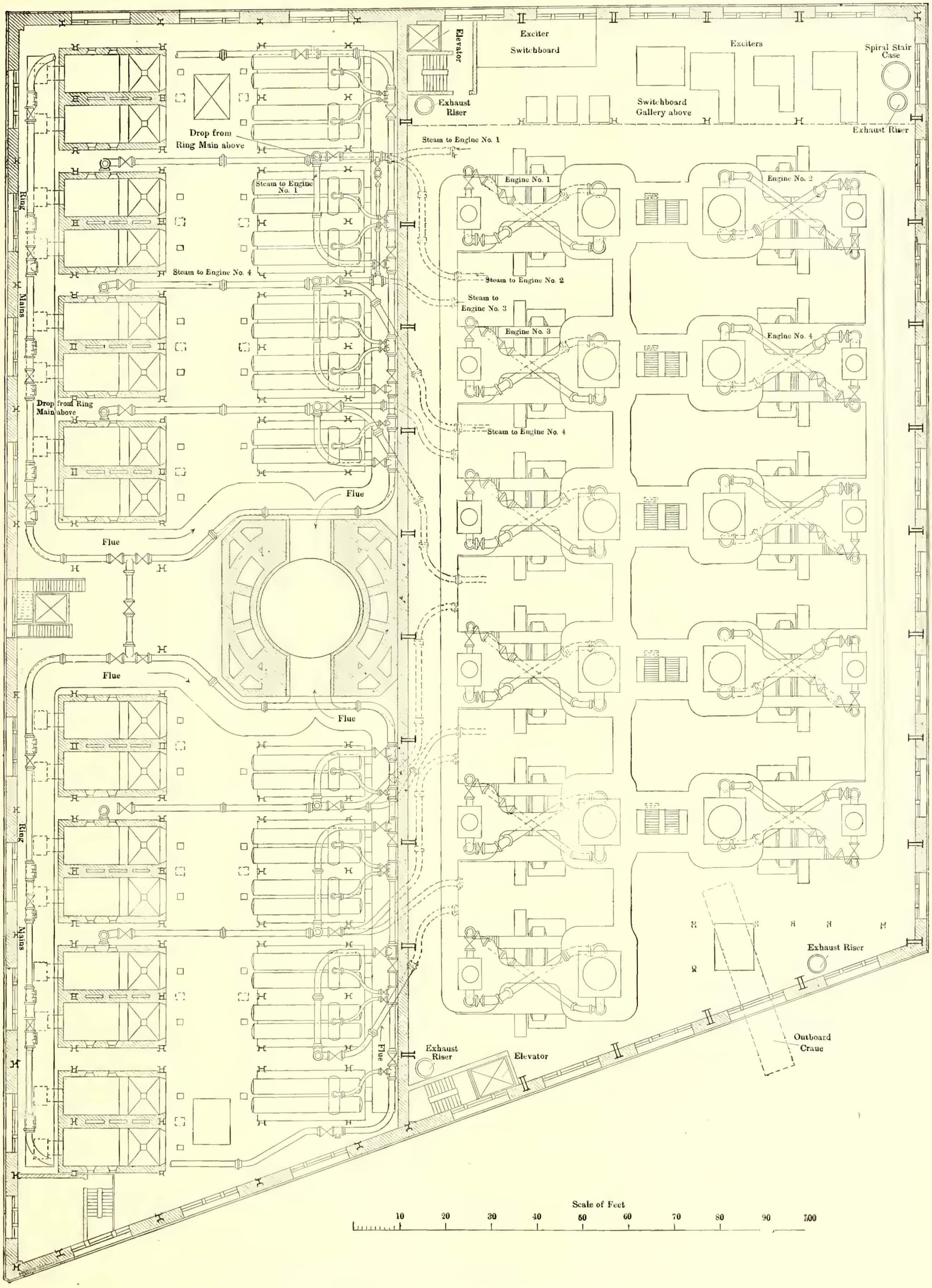
The calculated weights on the main bearings are: shaft, 65,000 lbs.; revolving part of alternator, 332,000 lbs.; two cranks, 42,000 lbs.; total, 439,000 lbs., or 107 lbs. per sq. in. of projected area of the shaft journals. The rubbing speed is 607 ft. per minute. The revolving field of the alternator is 32 ft. diameter. The distribution of material is such that its fly-wheel effect is equivalent to a weight of 370,000 lbs. rotating in a circle 23.4 ft. diameter. With this fly-wheel effect, together with the uniformity of crank effort produced by eight impulses per revolution, it is calculated that the extreme variation in speed shall not be greater than three-fifths of one degree per revolution; in other words, the amount that a point on the rotating field lags behind plus the amount which it forges ahead of the position of uniform rotation shall not exceed 3-5 of 1-360 of the circumference.



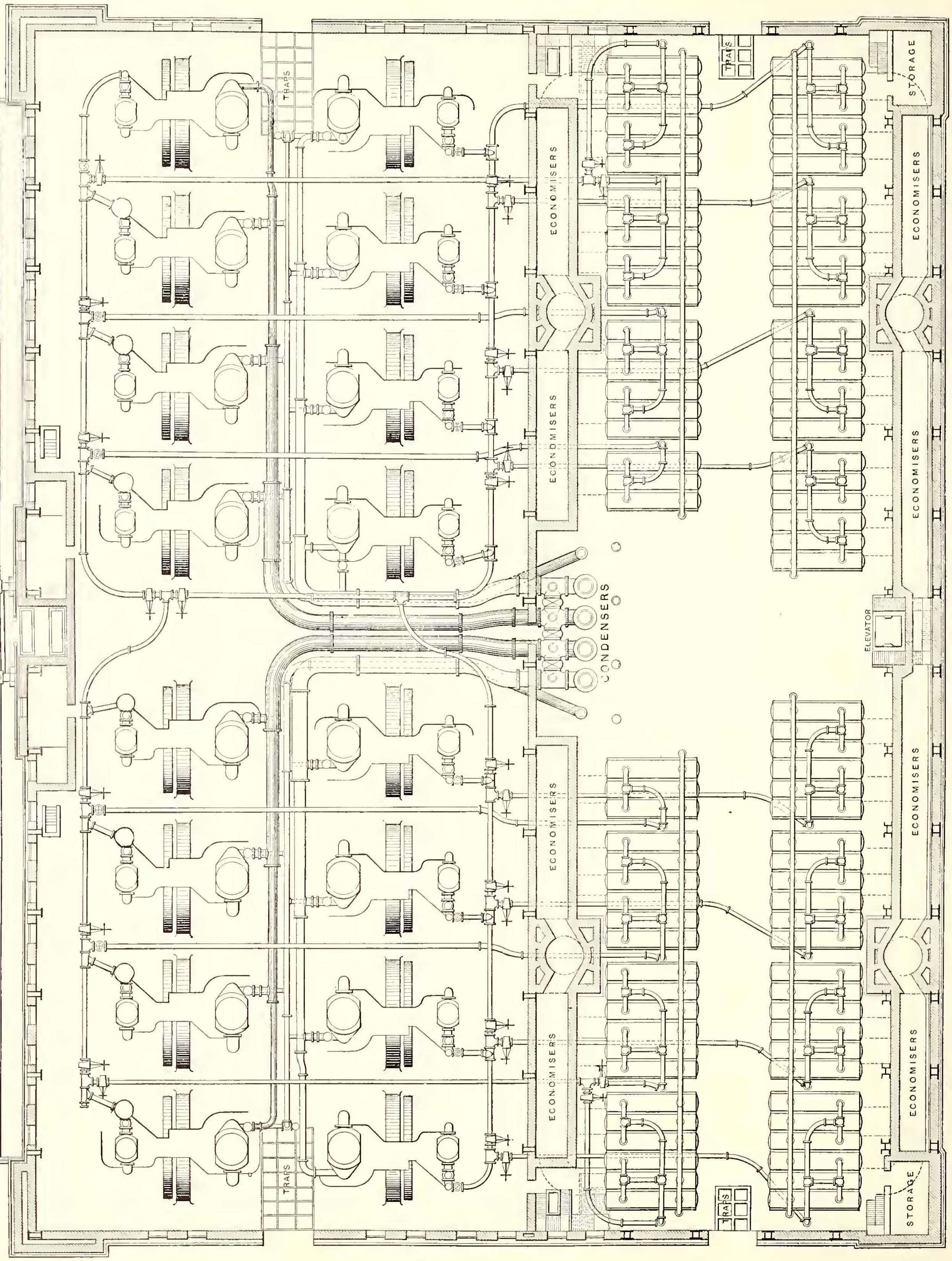
CROSS SECTION OF NINETY-SIXTH STREET POWER STATION, METROPOLITAN STREET RAILWAY COMPANY

The shipping weight of each pair of engines is about 1,440,000 lbs., or 180 lbs, per rated horse-power. Each pair occupies about 2000 sq. ft. of floor space, and stands 38.3 ft. above the floor level. The foundations are of concrete, 40 ft. square and 21 ft. high, with an archway 4 ft. 6 ins. through the middle.

The number and size of the engine units constitute the



GENERAL PLAN OF NINETY-SIXTH STREET POWER STATION AT ENGINE ROOM FLOOR principal feature which distinguishes the Manhattan from the other two stations. If we rate the engines on the same basis, say 30 lbs. mean effective pressure referred to the low-presure cylinders, the Manhattan engines are 8260 hp and the engines of the other two stations are only 3933 hp, although their rating in the published descriptions is given as 4500 hp. The power of compound engines at normal loads, other conditions being equal, depends on the size of the low-pressure cylinders. The Manhattan engines, with two low-pressure cylinders 88 ins. diameter, are 2.1 times the power of the engines of the other two stations, with one low-pressure cylinder 86 ins. diameter.



ORIGINAL PLAN OF 216TH STREET POWER STATION, METROPOLITAN STREET RAILWAY COMPANY. ONE-HALF OF THIS STATION IS NOW UNDER CONSTRUCTION

Comparing the Kingsbridge and the Manhattan stations, which are of practically the same capacity, the former has sixteen of the smaller units and the latter eight of the larger units. The Metropolitan station, of smaller capacity than the others, has eleven of the smaller units.

There does not seem to be any good reason for subdividing the total engine power of a large station into any greater number of units than eight, providing that the size of the unit thus obtained does not lead to objectionable structural difficulties in either the engine or the electrical generator. The Kingsbridge and the Metropolitan stations being designed some time earlier than the Manhattan, it is probable that the size of the unit was determined with reference to the largest size of alternator which the manufacturers at that time were prepared to build, viz., 3500 kw, with one-third overload capacity, and the engines were designed to suit this alternator. When the Manhattan station was designed it was found possible to construct an alternator of 5000 kw normal and 7500 kw ultimate capacity, with a rotating part 32 ft. diameter, giving a circumferential speed, at 75 revolutions, of 7540 ft. per minute, and it was not difficult to design an engine to drive such an alternator. A two-cylinder engine of the power required would have cylinders 62 and 124 ins. diameter, the latter being an objectionable size for many reasons, and it was therefore decided to build a duplex engine, with cylinders 44 and 88 ins. diameter.

The subdivision of the Manhattan station into eight instead of sixteen units has many advantages. It makes fewer units to be taken care of, economizes floor space and foundations, and simplifies the steam piping. The particular type of engine chosen, with two horizontal and two vertical engines, has some advantages besides the one of giving eight impulses per revolution, already mentioned. It has a shaft of less length even than that of the engines of less than half the power, adopted for the other stations, and it has only half the number of bearings, cranks and crankpins that are required for two smaller engines aggregating the same power. It has the apparent disadvantage of larger crankpins with two connecting rods taking hold of one pin. Whether this is a real disadvantage can be learned only by experience.

There are some peculiarities in the dimensions of certain details of the several engines that are worthy of notice. The piston rods of the Manhattan engines are 8 ins. diameter for both cylinders, those of the other engines are 9 and 10 ins. for the high and low pressure cylinders respectively. The main bearings of all the engines are exactly alike, viz., 34 ins. x 60 ins. The weight on the two bearings of the Kingsbridge engines, due to shaft, cranks, fly-wheel and alternator, is about 507,000 lbs., or about 124 lbs. per sq. in. of projected area, while that on the bearings of the Manhattan engines is 439,000 lbs., or 107 lbs. per sq. in. of projected area, the effort of the single cylinder of the other engines. The wristpins of the Manhattan engines are 12 ins. x 12 ins., and those of the other engines are 14 ins. x 14 ins. Taking the maximum thrust due to the full steam pressure of 150 lbs. on the piston of the high-pressure cylinder, minus, say, 30 lbs. back pressure, gives a pressure per sq. in. of projected area of 1267 lbs. on the wristpins of the Manhattan engines and 1017 lbs. on the pins of the other engines. The crankpins of the Manhattan engines are 18 ins. x 18 ins., giving 9 ins. x 18 ins. for each connecting rod, and those of the other engines are 14 ins. x 14 ins., giving a maximum pressure of 1200 lbs. per sq. in. of projected area on the crankpins of the Manhattan engines and 1017 lbs. on those of the other engines. The speed of rubbing on the crankpin bearing of the Manhattan engines is 353 ft. per minute, and that of the other engines 275 ft. per minute.

The ratio of cylinder volumes is 4 for the Manhattan, and only 3.5 for the other engines. Even the highest of these ratios is very conservative in view of recent experiments, which indicate that a much higher ratio, that is, a much smaller high-pressure cylinder for a given low-pressure cylinder, giving a large terminal drop in the high-pressure cylinder, conduces to economy of steam. The Manhattan engines being the latest design, they show some progress in the direction of high ratios, although the ratio is much lower than that advocated by some engineers, viz., 7 to 1.

While there are many admirable features in the engines of the Manhattan station, it is not to be expected that they will be largely copied in the future and become the standard American type of engine for large plants. Their guaranteed steam consumption of 13 lbs. per ihp per hour is too high to be permanently accepted in electric stations, when American pumping engines have given a figure below 11 lbs., and when engines in Europe, with superheated steam, have given below 10 lbs. The difference between 11 and 13 lbs. is sufficient to warrant a considerable increase in the first cost of an engine in order to secure it when coal is as high priced as it is likely to be in New York City when the impending consolidation of coal companies is effected.

It may be said that high first cost of engine, with consequent high cost of interest on investment, is not justified when the load is very variable, when maximum loads are expected only a few hours in the day, and when perhaps half of the engines will be idle the greater part of the 24-hour day; but when half of the engines are to be run 18 hours out of the 24 and one or two engines during the whole 24 hours, it would appear desirable to design half of the engines for the maximum possible economy, and to have the other half of cheaper design and lower economy, to run during the times of peak of the load.

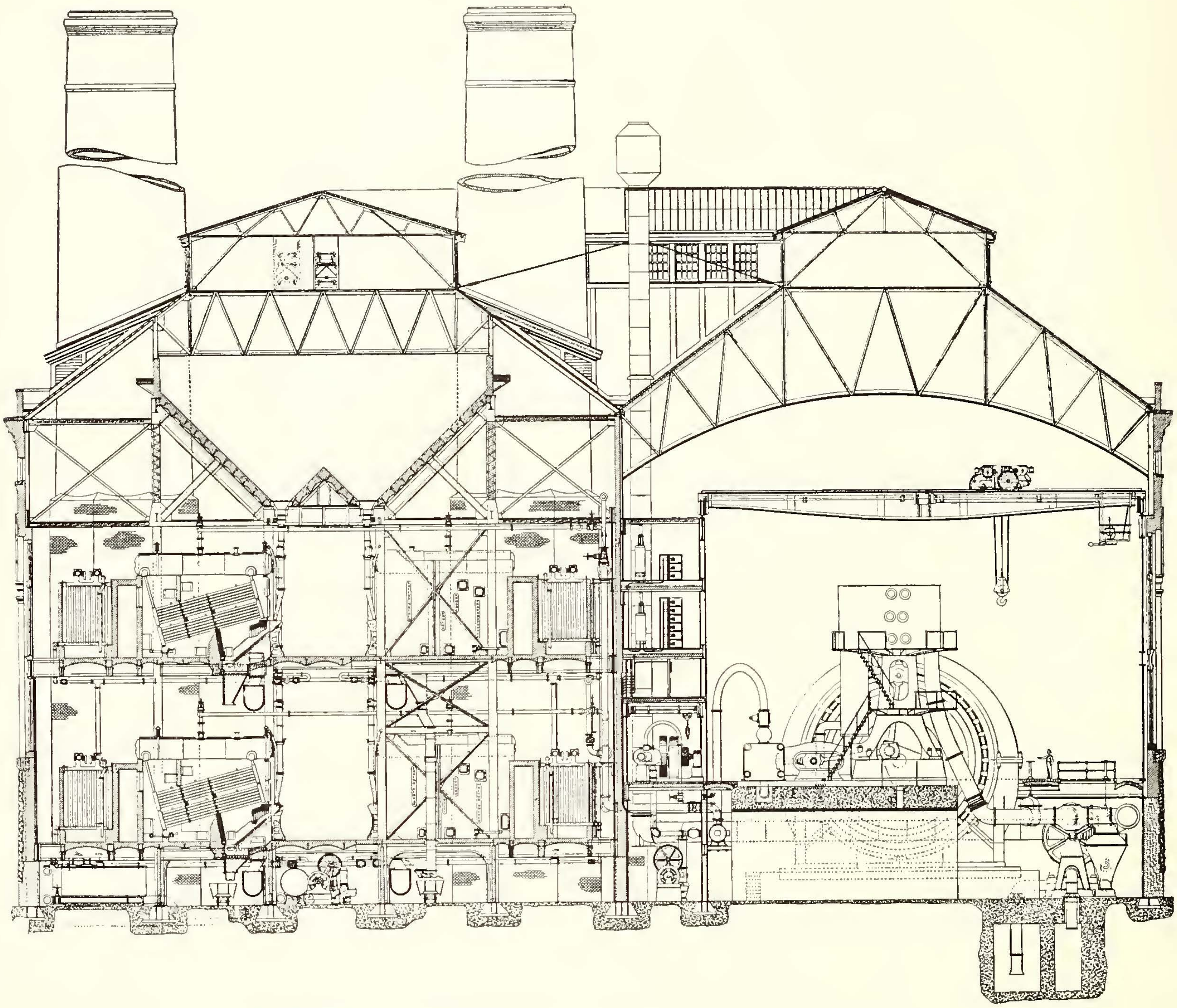
Certain features of the Manhattan engines which are open to criticism, besides the comparatively low economy, are the use of horizontal high-pressure cylinders, which entail greater wear and the use of more oil than vertical cylinders, besides increased labor of engine tenders due to having the valve mechanism of the high-pressure cylinders at the floor level and that of the low-pressure on an elevated gallery; the use of Corliss valves, those of the high-pressure cylinder being unsuited to the use of superheated steam and those of the low-pressure cylinders being of enormous size, difficult to lubricate properly, and, being unbalanced, probably requiring considerable power to operate them; and the use of two connecting rods on the same overhung crankpins, with consequent high pressure per unit of area and high speed of rubbing surface. Another feature which may be objected to is the use of belts to drive both the main governor and the governor of the safety stop valve.

The important advantage of the Manhattan engines is the giving of eight impulses of the shaft in each revolution, due to setting the cranks at 135 degs., but this advantage can be obtained also by an engine with four vertical cylinders, with four cranks, two of them double and two single. The use of two single cranks only, as in the Manhattan engines, has in its favor simplicity and low first cost, but otherwise the double cranks would seem to be unobjectionable. They are universally used in marine practice, in which the whole power of the engine with four cylinders in line is transmitted in one direction to the tail shaft through either four double cranks or one single and three double cranks. If this can be done on a steamship, with its unstable foundation for the main bearings, there would seem to be no objection in an engine on land, with solid foundations, to transmitting the power to an alternator on the middle of the main shaft from the two cylinders at each end, through one overhung crank for the high-pressure cylinder and a double crank for the low-pressure cylinder.

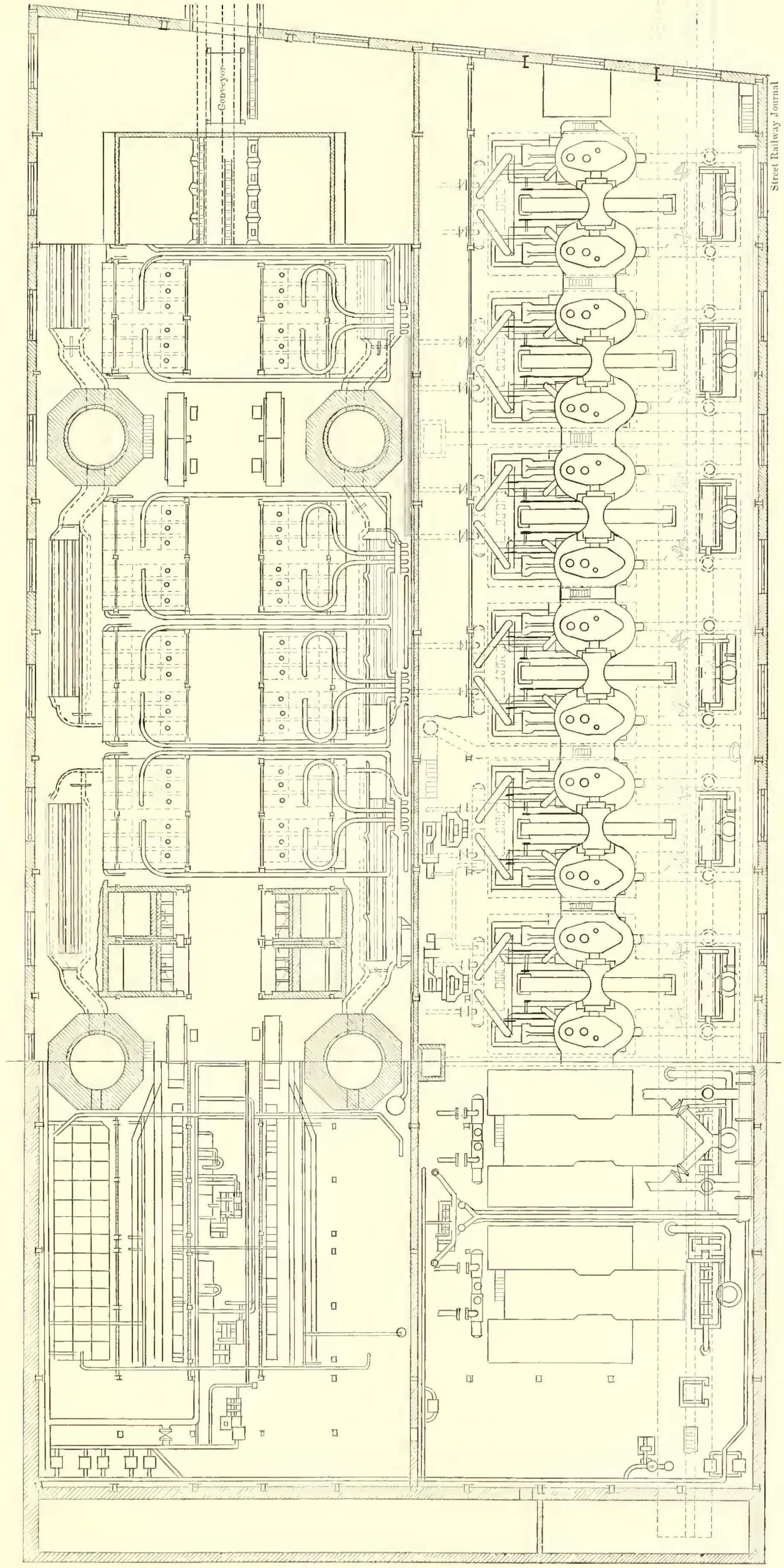
Land practice in large power plants seems always to lag behind marine practice. An example of recent marine practice is shown in the following figures, taken from a paper by James McKechnie, entitled "Review of Marine Engineering During the Last Ten Years" (*Engineering*, Aug. 23, 1901):

Steamer "Kaiser Wilhelm der Grosse," built in 1898—Two engines, triple expansion, four cylinders, diameters 52, 89.7, 96.4, 96.4 ins., stroke 68.8 ins., piston speed 885 ft. per minute, revolutions 77 +, steam pressure 178 lbs.; rated hp of each engine 15,000. H. M. S. "King Alfred," now building—Two engines, triple expansion, four cylinders, diameters 81½, 43½, 71, 81½ ins., stroke 48 ins., piston speed 960 ft., revolutions 120; steam pressure in boilers 300 lbs., at engines 250 lbs.; rated hp of each engine 15,000.

These engines are both rated at about 15,000 hp, that being presumably the power which is expected to be developed in driving each ship at its normal speed, but the same engines for land service with variable loads would probably be given two ratings, one for normal loads corresponding approximately to the most economical steam consumption per horse-power, and the other to the maximum load. The engines being of quite different dimensions and piston speeds and being supplied with steam at different pressures, their ratings, both for economical and maximum loads, would correspond to different rates of expansion. Assuming rates of expansion from 16 to 30, back pressure 3 lbs. absolute, with hyperbolic expansion, and neglecting the effect of clearance and of the diagram factor, the horse-power developed by these engines would be as follows for different rates of expansion:



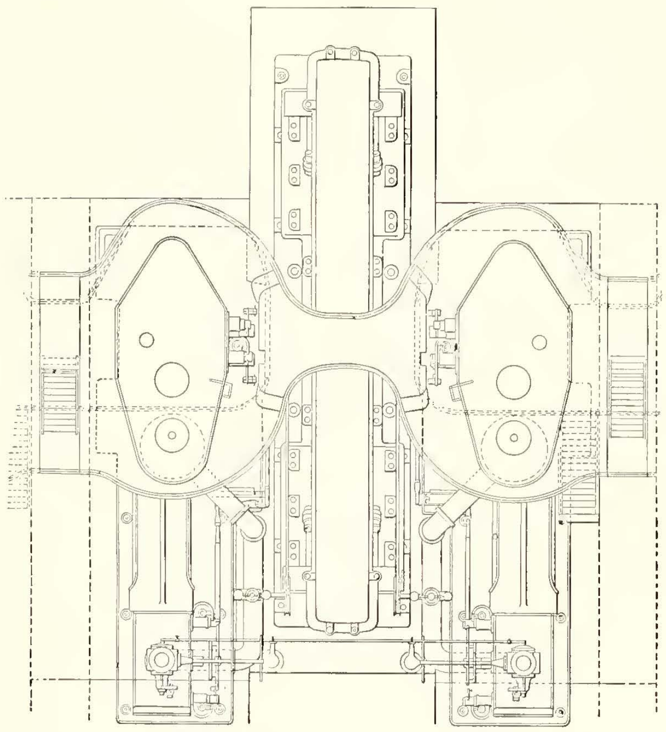
CROSS SECTION OF POWER STATION, MANHATTAN RAILWAY COMPANY

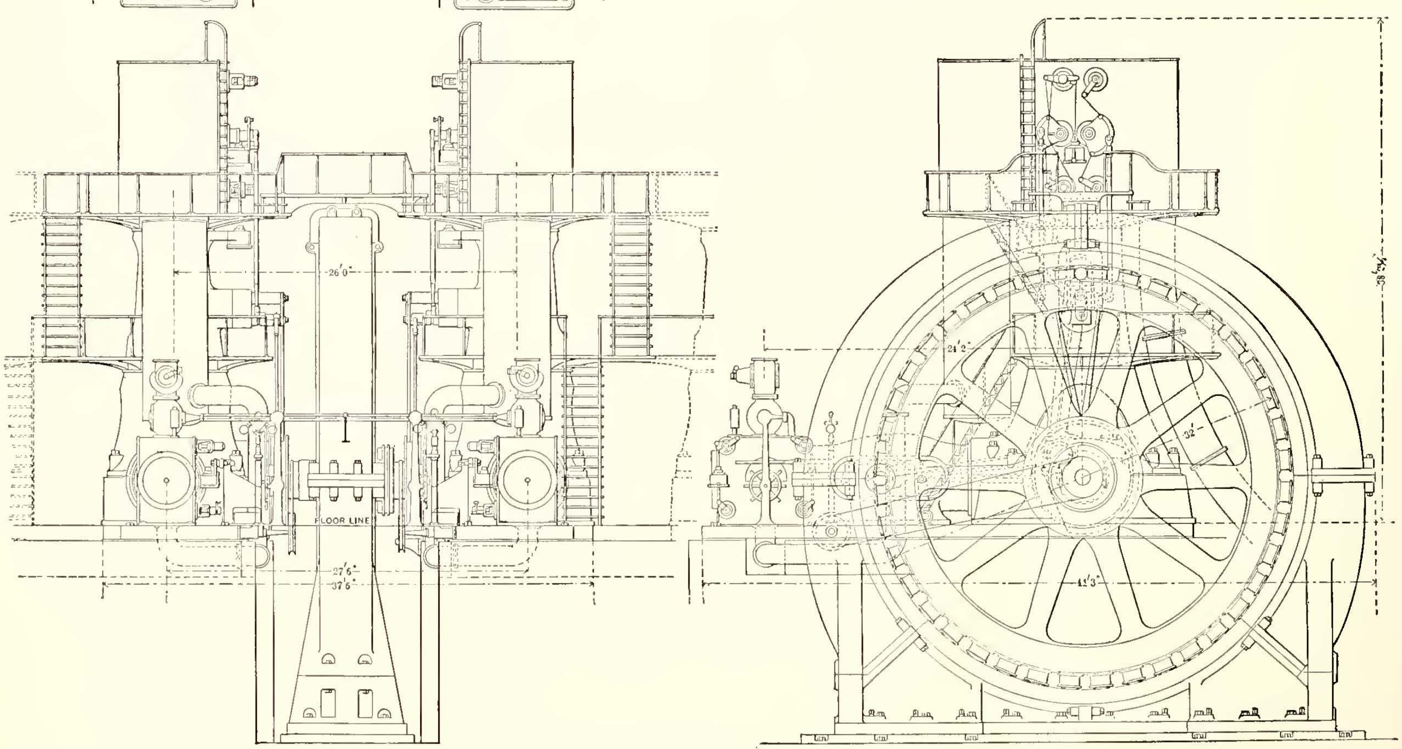


PLAN OF POWER STATION, MANHATTAN RAILWAY COMPANY

	Mean effective pressure *		Horse-power	
Rate of expansion	Steam 180 lbs.	Steam 250 lbs.	Kaiser Wilhelm	King Alfred
30	23.41	33.68	9,115	10,146
28	24.85	35.67	9,675	10,745
26	26.48	37.95	10,310	11,432
24	28.34	40.53	11,035	12,210
22	30.48	43.50	11,868	13,104
20	32.96	46.95	12,833	14,144
18	35.90	51.03	13,978	15,372
16	39.44	55.95	15,356	16,854

* Reduced to the low-pressure cylinders.





FRONT END AND SIDE ELEVATIONS OF 8000 HP MANHATTAN UNIT

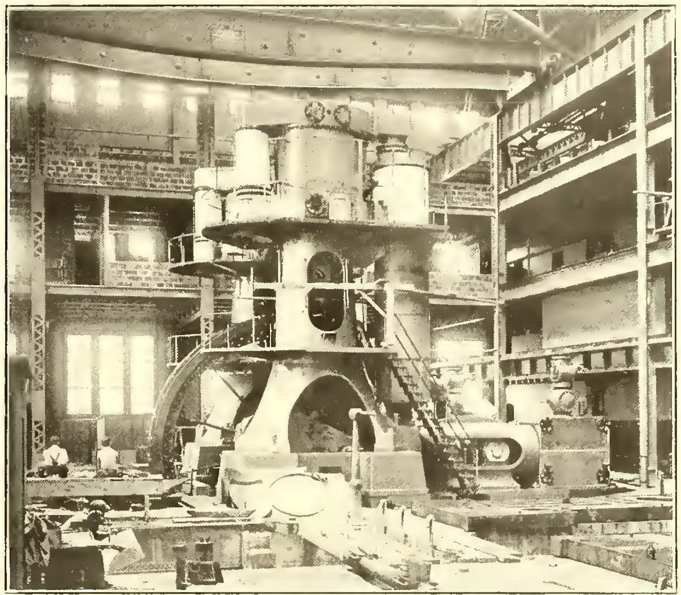
There seems to be no good reason why either of these engines would not be well adapted for a power station. Either would develop in the neighborhood of 11,000 hp at the most economical rate of driving and 16,500 at maximum load, or 37½ per cent more than the Manhattan duplex engines, while the engines of the "Kaiser Wilhelm der Grosse" are but little larger in size, and those of the "King Alfred" considerably smaller than the Manhattan engines.

To adapt these engines to electric traction service, probably the best arrangement would be to have the four vertical cylinders in line, each with a double crankshaft, the crank of each outer cylinder being set at 135 degs. to that of its adjoining inner cylinder and the cranks of the two inner cylinders at 90 degs. with each other. This would give eight impulses in each revolution, as in the Manhattan engines. Two alternators might be used, one at each end of the shaft, each of half the power of the engine unit, or if it is practicable to build one alternator of sufficient capacity to utilize the total power of the engine, it might be set between the two inner cylinders. In the latter case there need be only two double cranks, single cranks with overhung pins being used for the outer bearings, and only four main bearings would be needed, while in the former case there would be four double cranks and seven main bearings. In either case only half of the total power of the engine would be transmitted through each crank fitted on the short shaft carrying the alternator, while in marine practice the whole power of the engine is transmitted through the after crank to the propeller shaft.

The running conditions of such an engine driving an alternator on land would be much less severe than those of a marine engine. The latter is built on an unstable foundation, that of the hull of the vessel, while the engine on land is supported on a solid concrete foundation. A marine engine has to run constantly for six or eight days and nights without intermission, and with no opportunity for inspection and adjustment of the bearings, while in a large power plant on land each engine may be stopped for several hours each day. The marine engine has to be designed for economy of space occupied and for minimum weight consistent with strength, giving small factors of safety, while no such considerations limit the design of the land engine.

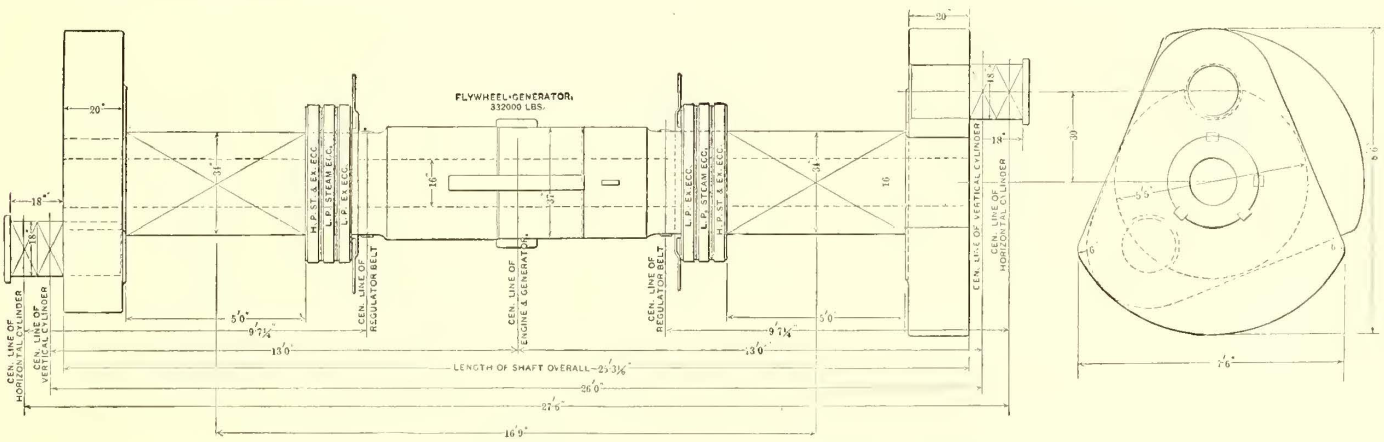
The owners of an ocean-going vessel say to the engine builders, "You must build us an engine of greater power than was ever built before, yet it must occupy the minimum of space and be of minimum weight; it must run for eight days and nights without stopping; it must economize fuel to the utmost degree, and it must run with practically no oil." The owners of an electric power station say, "We want an engine which is a copy of the largest one you have yet built (that is an engine of half the power of the largest marine engines); we want it heavy and strong, and the first consideration is that it shall give the least possible trouble to our engineers." Each purchaser gets what he asks for, and the result is rapid progress in marine practice and great conservatism and slow progress in land practice. The power station gets an engine of great size and weight per horse-power developed, with slow rotative speed, involving large size and cost of alternators, large foundations, and large space occupied. It has unbalanced rotating slide valves, uses low steam pressure (150 lbs. when the boilers can easily carry 200) without superheating, and only two stages of expansion; and its maximum steam economy is 13 lbs. per ihp per hour. An engine to do the same work based on the lines of the latest marine practice would be triple or quadruple expansion, with steam of 200 lbs. highly superheated, balanced valves (poppet valves would be the better form for superheated steam), not less than 100 r. p. m., involving smaller size and weight of both engine and alternator for a given horse-power, less floor space, smaller foundations, and smaller building, and the steam consumption would be between 10 and 11 lbs. per ihp per hour when driven at its most economical load. Such an engine will run with almost no cylinder oil, so that surface condensers can be used and the water condensed from the steam returned to the boilers, saving the great cost of city water, which is estimated to be $50,000 or more per year in one of the three large plants here described. Such engines are likely to be adopted before long in large power stations, and then the engines of these three large plants will be regarded as magnificent examples of a transition period in power plant engineering.

Already there are signs of development of the design of engines for large power plants in the direction above indicated. The Allis-Chalmers Company (successor to the Edward P. Allis Company) is building an engine rated at 4000 hp for the Brooklyn Rapid Transit Company, of which the following are the principal features: The engine is a two-cylinder compound, with cylinders 42 and 86 ins. diameter by 60 ins. stroke. Ratio of cylinder volumes, 4.19; steam pressure, 175 lbs.; revolutions per minute, 75. The two cylinders, both vertical, are placed side by side, with a single crank for the high-pressure cylinder and a double crank for the low-pressure. There are two main bearings, 27 ins. x 42 ins., and the shaft is continued beyond the low-pressure cylinder to an outboard bearing 30 ins. x 56 ins. The extended shaft carries a fly-wheel weighing 240,000 lbs. and an armature next to the outboard bearing weighing 110,000 lbs. The shaft is hollow forged, and its diameter at the hub of the fly-wheel is 28 ins., and at the hub of the armature 35 ins. Corliss valves are used for both cylinders.



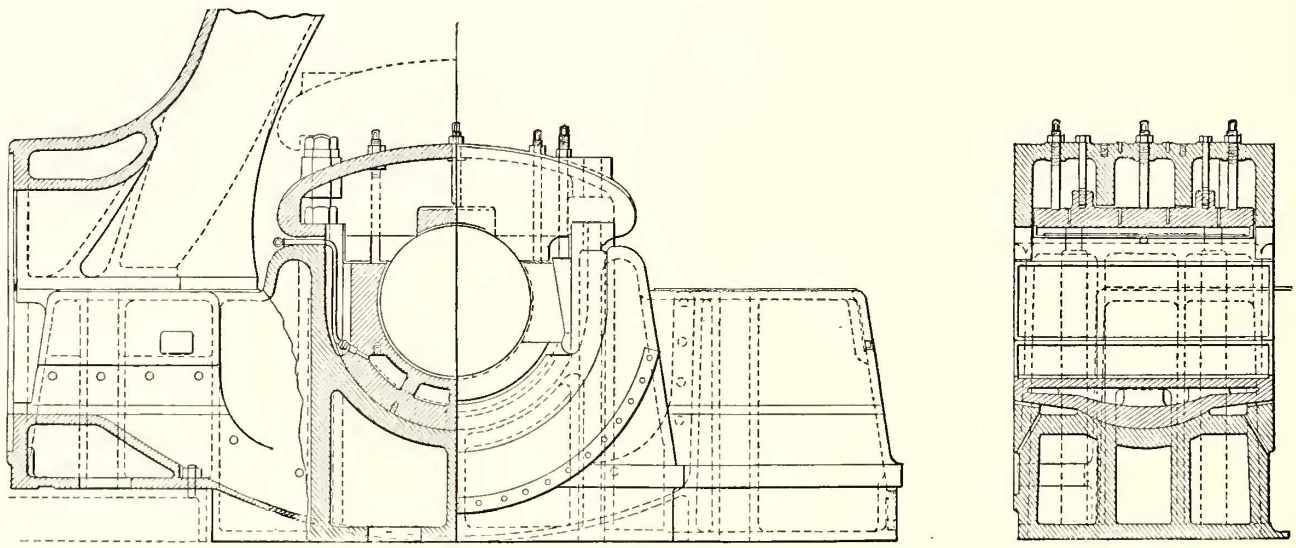
ONE OF THE 8000-HP UNITS IN THE MANHATTAN STATION

It only needs the addition of two more cylinders, one an intermediate and the other a low-pressure cylinder, with one single and one double crank, these cranks being set at an angle of 135 degs. to the other two, the removal of the fly-wheel and putting in its place another armature, the use of steam at 200 lbs. and a speed of 90 r. p. m., to convert this 4000-hp engine into a 10,000-hp triple-expansion engine, giving the shaft eight impulses per revolution. With balanced poppet valves and superheated steam it will run with an economy far superior to that of the 4000-hp engine, and it will cost much less per horse-power, both for engine and alternator, as well as for foundations and for space occupied. If the present dimensions of high and low-pressure cylinders are retained and the intermediate cylinder is made 71.4 ins. diameter, the ratio of volumes of the high to the two low-pressure cylinders will be as 1 to 8.38, and



ELEVATION OF MAIN ENGINE SHAFT, MANHATTAN RAILWAY POWER STATION the ratios of high to intermediate and of intermediate to low will be as 1 to 2.895.

The change from Corliss to poppet valves, with the use of superheated steam, has already been adopted in the high-pressure cylinders of the most recent designs of both the Westinghouse Machine Company and the Allis-Chalmers Company, so that all the elements needed for the production of the proposed 10,000-hp engine are found in existing designs. The eight engines recently ordered of the Allis-Chalmers Company for the Rapid Transit Subway in New York City have poppet valves in the high-pressure cylinders and Corliss valves in the low. The style of engine is the same as that used in the Manhattan station, each engine consisting of two component engines operating on one shaft, with a 5000-kw alternator in the center, each component having a horizontal high-pressure and a vertical low-pressure cylinder. The dimensions of the cylinders are 42 and 86 ins. x 60 ins.; revolutions per minute, 75; steam pressure, 175 to 200 lbs. It is expected that the poppet valves will operate without excessive use of oil with steam superheated to 500 or 550 degs. F. The rated horsepower of each pair of engines at their best efficiency is 7500, and at maximum output 11,000.



MAIN ENGINE BEARINGS, MANHATTAN RAILWAY COMPANY

CONDENSERS

Each of the three stations under consideration has a different arrangement of condensing apparatus. The Metropolitan station has a surface condenser for each engine, the Manhattan a jet condenser for each engine, and the Kingsbridge a large jet condenser for each four engines. The locations of these condensers are shown in the drawings.

Although the Metropolitan station has surface condensers, no provision has been made for returning the water of condensation to the boilers, it being considered cheaper to buy fresh water for the boilers from the city supply than to go to the expense of installing oil separators and filters, which are necessary to take the oil out of the water of condensation and make it fit to be used in the boilers, and to pay for the labor required to keep them in order. If it is a fact that it costs less to buy fresh water than to purify the water from the condensers from the oil it contains, there would seem to be no good reason for using surface condensers. The designers of the other stations have gone on this theory, and have adopted jet condensers instead of surface condensers. Objection is made to surface condensers not only on account of the difficulty of removing oil from the water of condensation, but because a surface condenser is a troublesome thing in itself, being liable to leaky tube ends and to general corrosion.

In the Manhattan and Kingsbridge stations, however, provision has been made for the substitution of the jet condensers by surface condensers at some future date, whenever a satisfactory method of removing the oil from the water of condensation can be found.

The necessity of the removal of oil from boiler feed water is apparent when it is known that it is apt to form a coating on the tubes of the boiler, which acts as a non-conductor of heat and causes the burning out of the tubes. The possibility of its removal without going to the great expense of chemical treatment and removal by filtration of the gelatinous mass formed by such treatment is one upon which there is great difference of opinion among engineers. Several kinds of apparatus for separating oil from the steam before it reaches the condenser are in the market, and also filters for removing oil from the water after passing the condenser, and they are reported by those using them to be giving good satisfaction. The makers of one of these filters, the Rankine, give a list of about seventy-five plants where it is used with land boilers, including the Chicago Edison Company, 4000 hp, and the City of London Electric Light Company, 8000 hp. They are chiefly used, however, in England and other foreign countries, and American engineers have been very slow in adopting them.

The eleven surface condensers at the Metropolitan station are rated at about 5000 hp each, and have 8000 sq. ft. of condensing surface, or 1.6 sq. ft per rated hp. Each contains 2600 seamless drawn tubes of Muntz metal (60 copper, 40 zinc) 1 in. outside diameter and 12 ft. long. The water passes through the tubes, entering at the bottom, and baffle-plates cause it to pass three times through the length of the condenser. Steam enters at the top.

The condensing apparatus at the Kingsbridge station is somewhat novel in design and arrangement. The following description was given in the Street Railway Journal of Jan. 6, 1900:

The condensing plant is a central elevated jet plant, so arranged as to admit of the substitution of surface condensation at such time as it may be desired to reclaim the feed-water, which in this plant will be worth upward of one hundred thousand dollars per year. The large exhaust trunks, some 54 ins. in diameter, lead from the four sections, each serving four engines. Provision is made for free exhaust through a smaller auxiliary trunk, for each pair of sections, carried through the roof independently. The main trunks lead to their respective elevated jet condensers of the Worthington type, and are so connected as to enable any three to carry the full load, while one is cut out for cleaning or repair, or any one may be cut out singly, to prevent abnormal leakage on any trunk from affecting the vacuum on the others. The condensers are operated on the dry-air system, the injection water being handled by four large centrifugal pumps, operated by Westinghouse compound engines, which serve the condenser heads at an elevation of about 48 ft. The water passes through elevated air coolers, where it surrounds brass pipes, in which the air is cooled until its volume is reduced by about one-half; it is then exhausted and the vacuum maintained by close clearance air pumps of the fly-wheel type, with positively actuated valves."

There is, no doubt, some saving in first cost in having the sixteen engines served by only four condensers, located centrally, but it may be questioned whether it is desirable to have the exhaust trunks, which are under the external atmospheric pressure outside with vacuum inside, as large as 54 ins. diameter and of as great length as the central plant requires. It also seems somewhat hazardous to locate the condensers so close together, since an accident such as the bursting of a steam pipe or the falling of a weight from the traveling crane, which might damage one condenser, might cause a shock which would put them all out of service at once. An arrangement with one condenser to each engine or pair of engines in close proximity, with cross-over pipes leading from one exhaust main to another, to permit the diversion of the exhaust steam from any condenser that might be out of service to the other condensers, would appear to be preferable to the central condensing plant.

In the Manhattan station there is one independent jet condenser for each engine, so arranged that each can be modified into a surface condenser whenever in the future it may be found practicable to extract the cylinder oil from the water of condensation. Vertical triplex air pumps are used, driven by electric motors at a speed of about 30 r. p. m. It is expected that 10 to 15 revolutions will be sufficient with surface condensers. When these are used a centrifugal circulating pump can be attached to the free end of the motor-driven pump shaft.

In the Manhattan station the intake and outlet tunnels for the condensing water are built in the concrete foundation under the basement of the engine room. The intake tunnel is 8½ ft. wide from the rear end of the building to the front, where it increases to 14 ft. wide from the building to the river, where there is a screen pit with two screens sliding in guides so that they may be removed for cleaning. The outlet tunnel is 5 ft. wide. It is parallel to the intake tunnel under the building, but the two tunnels diverge outside, so that they are 85 ft. apart at the river, so that the outflowing warm water may not have any chance of mixing with the cold intake water. Similar arrangements of the tunnels are made at both of the other stations.

BOILERS

All three of the stations have adopted the same type of boiler, and all the boilers have been furnished by the same manufacturers, the Babcock & Wilcox Company, although boilers of the same type and identical in nearly every detail are built by other makers. No fault can be found with the selection of this type of boiler. It represents the most advanced practice in boiler design and construction all over the world. The general features of the type are a nest of 4-in. water-tubes 18 ft. long, inclined about 15 degs. from the horizontal, two or three horizontal water drums 36 or 42 ins. in diameter, and staggered headers connecting the tubes to the drums. The structural details of the boiler built by the Babcock & Wilcox Company which distinguish it from boilers of the same type built by other makers are the forged-steel headers and the forged-steel connections between the headers and the drums. The boiler of standard dimensions is guaranteed for 200 lbs. working pressure.

The size and arrangement of the tubes in these boilers is not the same in all the stations. The boilers for the Metropolitan station were originally designed to have fourteen sections, each of nine tubes high, 18 ft. long, with two 42-in. drums, with 2650 sq. ft. of heating surface, rated at 265 boiler hp, a horse-power being defined as equivalent to an evaporation of 34½ lbs. of water from and at 212 degs. per hour. Most of the station was equipped with boilers of this size, but before the last lot of boilers were ordered for the third floor of the station it was concluded to pile more heating surface on the same floor area and the same grate surface, and the sections were made twelve tubes high instead of nine, giving the boiler about 3500 sq. ft. of heating surface, and making its rating 350 hp.

The boilers of the Manhattan and Kingsbridge stations are exactly alike. They are twenty-one sections wide, instead of fourteen as in the Metropolitan station, and have three 42-in. drums. Each contains about 5200 sq. ft of heating surface and is rated 520 hp.

The grate surfaces, as ordinarily measured being the width between the walls by 7 ft. long, are 59½ sq. ft. in the Metropolitan boilers and 88 sq. ft. in the Manhattan and Kingsbridge boilers. The ratio of heating to grate surface in the latter is 59.1 to 1; in the boilers on the third floor of the Metropolitan station 58.8 to 1, and in those on the first and second floors 44.5 to 1.

Roney mechanical stokers, however, are used instead of plain grates in all the stations, and the areas measured on the slope of the stoker grates are: Metropolitan, first and second floors, 52 sq. ft; third floor, 57 sq. ft; Manhattan and Kingsbridge stations, 115 sq. ft; and the corresponding ratios of heating to grate surface are respectively 51.0, 61.4 and 45.2 to 1. The corresponding amounts of stoker grate surface per rated horse-power are respectively 0.196, 0.163 and 0.221.

The boilers are all rated on the basis of 10 sq. ft. of heating surface per horse-power, but it is evident that the power they are capable of developing will depend more on the area of grate, on the kind of coal, and on the force of the draft than upon the heating surface.

Let us make a calculation to determine how fast the coal must be burned under these boilers in order to develop their rated horse-power, assuming two kinds of coal of different heating values, and also to determine the horse-power that may be developed in emergencies, assuming an emergency rate of combustion. The results are as follows:

Kind of Coal	Semi-Bituminous	Anthracite Clean Buckwheat
Heating value per lb. combustible, B. T. U.	15,700	15,000
Per cent of ash and moisture......	10	16
Heating value per lb. coal, B. T. U.	14,130	12,600
B. T. U. utilized by boiler, assuming efficiency = 65%, B. T. U.	9,185	8,190
Equivalent evaporation from and at 212 degs. per lb. coal, lbs...	9.51	8.48
Lbs. coal per hp (1 hp = 34.5 lbs. from and at 212°), lbs.......	3.61	4.07
Rate of combustion, lbs. per sq. ft. of grate, required to develop rated hp—		
1. If grate surface = 0.196 × hp, lbs.	18.4	20.8
2. " " = 0.163 × hp, lbs.	22.1	25.0
3. " " = 0.221 × hp, lbs.	16.3	18.4
Per cent above rated power that boilers will develop in emergencies, with forced blast, if 30 lbs. of coal is burned per sq. ft. of grate per hour, assuming efficiency reduced to 60%—		
1. If grate surface = 0.196 × hp, %.	50.5	33.1
2. " " = 0.163 × hp, %.	25.3	10.8
3. " " = 0.221 × hp, %.	69.9	50.5

The efficiencies assumed in the above calculations, 65 and 60 per cent, may seem rather low in view of the fact that from 70 to 75 per cent is frequently obtained in boiler tests, but they are about as high as can be expected in everyday running. The boilers on the third floor of the Metropolitan station, however, will probably give higher efficiencies than the other boilers at rapid rates of combustion, on account of their higher ratio of heating to grate surface.

The proportions of the boilers of the Manhattan and Kingsbridge stations appear to be better than those of the Metropolitan station, for they allow of the boilers being driven to their rated capacity with a rate of combustion of only 16 to 18 lbs. of coal per sq. ft. of grate per hour. This moderate rate of combustion, requiring only moderate draft, is conducive to ease of running and long life of stokers, and to less danger of having air holes through the bed of coal than exists with rapid driving. It also gives much greater available capacity for overloads, 70 per cent above rating with semi-bituminous coal and 50 per cent with anthracite. Making the sections twelve tubes high instead of nine on the third floor of the Metropolitan station increases the efficiency of the boilers for overloads, but does not greatly increase their capacity, since the grate surface is increased but little. Making the boiler twenty-one sections wide instead of fourteen increases the grate and heating surfaces in the same proportion. A boiler twenty-one sections wide is also more economical of ground space and of setting than one fourteen sections wide. The former utilizes in width of grate surface about 75 per cent of the whole width of a battery, including the width of the passage between adjoining batteries, and the latter only about 64 per cent. A boiler with sections nine tubes high is better than one twelve tubes high in that it can be run at its rated capacity with less draft pressure, giving greater ease in firing and longer life of the stokers, besides giving much greater capacity for overloads, but it costs more for a given rated horse-power, for boiler, setting and ground space.

The number and arrangement of the boilers in the three stations is as follows: In the Metropolitan station there are three floors, with twenty-nine boilers on each floor. The boilers are in two rows, with fronts facing each other, seven batteries of two boilers each being in one row and seven batteries and a single boiler in the other. In the Manhattan station there are two floors, with thirty-two boilers in each, in two rows, and eight batteries of two boilers each in each row. In the Kingsbridge there are also two floors, thirty boilers on each floor, in two rows, eight batteries in one row and six batteries and two single boilers in the other. The arrangement in the several stations is clearly shown in the ground plans.

The question of putting boilers on two, three or more floors in a building is usually one of balancing the cost of ground against the cost of foundations and buildings, and the solution of the question will differ in different locations. In the Metropolitan station the arrangement of the boilers on three floors was probably adopted because on the limited ground area available there was not room to locate the desired number of boilers on two floors.

The total boiler power of the stations is as follows:

	No. of Boilers	Rated H.P. each	Total H. P. at 10 sq. ft. Heating Surface per H.P.	Grate Surface (Stoker)	Horse Power at 4½ H.P. per sq. ft. of Grate
Metropolitan	87	(av.) 290	25,230	4,669	21,143
Manhattan	64	520	33,280	7,360	33,120
Kingsbridge	60	520	31,200	6,900	31,050

Taking the maximum output of the engines at the Metropolitan station at 66,000 hp and at the other stations at 100,000 hp, we obtain the following figures for heating surface and grate surface per horse-power (maximum) of engines:

	Heating Surface per Engine H.P.	Grate Surface per Engine H.P.	Engine H. P. (Max) per sq. ft. Grate
Metropolitan	3.82	.0707	14.14
Manhattan	3.32	.0736	13.59
Kingsbridge	3.12	0690	14.49

The boilers at the Metropolitan station have the most liberal allowance of heating surface, and should therefore give higher efficiency at a rate of driving corresponding to the maximum engine load than the boilers at the other stations; but the Manhattan boilers, having a more liberal allowance of grate, should be capable of being driven at higher rates during the peak of the load or in emergencies. The boilers at the Kingsbridge station have both less heating surface and less grate surface per horse-power of maximum rating of engines than those at the other stations. For emergencies, therefore, they will require a stronger draft, and may be expected to show lower economy.

STOKERS

Roney mechanical stokers are used in all the stations. They receive their coal through vertical cast-iron pipes from the coal bins overhead. It is estimated that a boiler-room force of ninety men will be required in the Manhattan station, and that 270 men would be required if hand firing were to be adopted.

CHIMNEYS, FORCED DRAFT AND ECONOMIZERS

The size and arrangement of the chimneys and economizers and forced-draft apparatus differ considerably at the three stations. At the Metropolitan station there are no economizers nor blowers for forced draft, and the whole draft of the station is furnished by a single chimney 353 ft. high and 22 ft. internal diameter. At the Manhattan station there are four chimneys, each 278 ft. high and 17 ft. inside diameter, with sixteen economizers, and forced draft is used as an auxiliary, the blast being delivered under the ashpits of the boilers. At the Kingsbridge station there are four chimneys, each 200 ft. high and 12 ft. inside diameter, with sixteen economizers, and forced draft on the induced system, exhausting fans being used between the economizers and the chimneys. In the Manhattan station the chimneys are large enough to give all the draft that is required in ordinary running conditions, and the forced draft is only a provision for emergencies, such as very heavy overloads, poor coal, or one chimney being out of service for repairs. In the Kingsbridge station the chimneys are of insufficient size for driving even the normal load, and forced draft is to be used as an auxiliary.

A well-built chimney ought to last a hundred years without repairs, but there is always the possibility of an accident, such as damage by lightning, or the falling of the interior lining, which happened a few years ago in the Houston Street cable railway station, and it therefore does not seem wise to make the running of a central power plant of 66,000 hp depend on a single chimney, as in the Metropolitan station. The use of four chimneys, as in the other stations, is undoubtedly a better plan. It gives shorter, smaller and more direct flues than a single chimney.

The chimneys may be compared by the use of the writer's formula for chimneys, viz.: $Hp = 3.33 (A - 0.6 \sqrt{A}) \sqrt{H}$, where A = area in square feet, H = height in feet, and Hp the horse-power taken as equivalent to the burning of 5 lbs. of coal per hour. We thus obtain the following:

	Height ft.	Area sq. ft.	Rated H.P. of Chimney	H.P. of Boilers at 4½ H.P. per sq. ft. Grate	Approx. Coal Burning Capacity per hour of Chimney = H.P × 5	Approx. Coal Burning Capacity per hour of Grate = area × 20
Metropolitan (1).	353	380.13	22,562	21,143	111,810	93,380
Manhattan (4)...	278	907.92	47,060	33,120	253,300	147,200
Kingsbridge (4).	200	452.40	19,304	31,050	96,520	138,000

From these figures it appears that the single chimney of the Metropolitan station is ample in size to develop more than the rated power of all the boilers, and probably from 10 per cent to 20 per cent in excess of the rated power; that the four chimneys of the Manhattan station have a capacity of 40 per cent or 50 per cent in excess of the boiler capacity, thus making forced draft unnecessary except in extreme emergencies, and that the four chimneys at the Kingsbridge station are not nearly large enough to develop the rated power of the boilers without the assistance of mechanical draft.

It is probable that the selection of the comparatively small and light chimneys for the Kingsbridge station (only the lower half of these chimneys is built of brick, the upper half being steel) was largely due to the difficulty of securing a good foundation for tall and heavy brick chimneys. The whole of the Kingsbridge station is built on piles, while the other two stations are on solid rock. Except for this reason it would seem better to have large brick chimneys, as in the Manhattan station, and not to have to rely on forced draft.

The chimneys of the Manhattan station deserve especial notice. They are built of radial or segmental brick, by the Alphons Custodis Chimney Construction Company. The base is octagonal, 26 ft. 6 ins. between the parallel walls, 73 ft. high, 5 ft. thick, of hard burned brick, lined with independent hollow firebrick walls, supported in sections 10 ft. high on corbeled shelves, to allow of expansion. The shaft is of the Custodis shape, of brick, 4 ins. high, 6 ins. wide, and from 6 ins. to 12 ins. long; it is 32 ins. thick at the bottom and 8½ ins. at the top. The foundations are 33 ft. square, of concrete, with a grillage of old 90-lb. rails laid 2 ft. centers, which is used on account of the seamy nature of the bedrock. The four chimneys contain 30,000 cu. ft. of concrete and 204,000 cu. ft. of brickwork. They were begun on July 11 and completed Dec. 16, 1900.

ECONOMIZERS

No economizers are used in the Metropolitan station. Each of the other stations is provided with sixteen Green economizers, having a total of 8192 tubes in the Manhattan station and 9600 tubes in the Kingsbridge station. In the Kingsbridge station the total external fire surface is 115,200 sq. ft., or 0.37 sq. ft. to each square foot of boiler-heating surface. It is noticeable that the Kingsbridge station has larger economizers than the Manhattan, but fewer boilers (sixty) as compared with sixty-four in the latter station. In the Manhattan station the use of economizers is more essential than in the other stations, for the reason that the auxiliary machinery is motor driven, instead of steam driven, and therefore there is no exhaust steam available for heating the feed-water, and there are no primary heaters between the main engines and the condensers.

FEED-WATER SUPPLY—FEED-WATER HEATING

In all the stations the feed-water is taken from the city mains. In the Manhattan station a centrifugal pump is installed to take salt water from the intake tunnel to the condensers in case the city supply should at any time be shut off. There are also four large storage tanks of 4000 gals. capacity each, and eight large surge tanks in the basement, corresponding to the eight power units, which receive the feed-water from the city mains and give it some preliminary heating by mixing with it the water of condensation from the main steam pipes, the reheaters of the engine receivers and the water used in the water jackets of the main engine bearings. This heating prevents the cold feed-water from sweating the pipes at the entering end of the economizers. The storage tanks and surge tanks will hold enough water to run the station four hours.

In the Metropolitan and Kingsbridge stations there are no surge tanks, and the water is warmed by primary heaters located between the engines and the condensers. In the Metropolitan station the water goes from these heaters to the boilers. In the Kingsbridge station it passes first to primary heaters, then to the auxiliary heaters, which completely utilize the heat of the exhaust steam from the auxiliary machinery, and then into the economizers. In the Metropolitan station the exhaust from the air pumps, driven by single-cylinder engines, is taken into the receivers of the main engines, and is thus used over again in the low-pressure cylinders of the main engines.

ELECTRICALLY-DRIVEN AUXILIARIES

As has been stated, the auxiliary machinery, such as air pumps, boiler-feed pumps, blowers, exciters, etc., in the Manhattan station is driven by electric motors, while in the other two stations it is steam-driven. The advantages of electrically-driven auxiliary machinery are stated to be cleanliness, absence of heat and leakage from pipes, less labor in operation, less cost of repairs and greater economy in consumption of power. It is questionable whether the statement as to power is accurate. If the heat of the exhaust steam from steam-driven auxiliaries can be utilized in heating the feed-water from the temperature in the surge tank to, say 200 degs., the net cost of power for running the auxiliaries should be smaller than that of driving them electrically.

COAL BINS—COAL AND ASH CONVEYORS

At all the stations coal is received in barges and is elevated to a pocket in a tower on the dock, whence it is run through a crusher. It is then conveyed by a continuous chain of traveling overlapping buckets, on the McCaslin system, to coal bins in the top of the boiler house. In the Metropolitan station the bins have a storage capacity of 9000 tons; in the Manhattan station, 15,000 tons, and in the Kingsbridge station, 12,000 tons. The bins are of massive construction, with bottoms of sheet steel lined with concrete to prevent corrosion. They may be flooded with water in case the coal should take fire.

The ashes fall from the ashpit of each boiler through vertical pipes to the basement of the boiler house, where they are received in cars, run out to the tower on the dock and stored in a pocket until they are dumped into a barge for removal. At the Manhattan station the ash bin has a capacity of 1200 cu. yds. In addition to the coal conveyors at the Manhattan station, there is a large freight elevator, capable of lifting a horse and cart to the boiler-floor levels, to be used in case of the failure of the regular coal supply.

LIVE-STEAM PIPING

The steam piping of a large power plant is one of the most troublesome elements to design properly so as to avoid the dangers due to expansion and contraction and to water pocketing. In all of these stations the piping has been designed with great care to avoid these dangers, and also to make provision against stoppage of more than one of the engines in case of an accident to any portion of the piping. The connections from the boilers to the engines are made as direct as possible; the pipes are all of moderate diameters; bends are of long radius, and there are no expansion joints. The flanges of all pipes over 6 ins. in diameter are of wrought iron or steel. The system of piping in the Kingsbridge station, shown in the drawings, is well worthy of study. It is as follows:

The piping is run on the system of equalizing mains, connected on the one hand to the boilers through feeders, and on the other to the engines through separating receivers, so as to permit the entire system to be composed of piping of substantially the throttle diameters, no pipe carrying much over the capacity of one engine. This avoids the necessity of very large valves and fittings, while conducing to an equal distribution of steam and pressure with a substantially uniform flow.

The design for accomplishing this, as shown in the ground plan, consists of dividing the station into quarters of four units each; then connecting each set of four units by an equalizing main of 20-in. pipe, served by four feeders of 16-in. pipe, which deliver steam from the respective quarters of the boiler plant. From the connecting headers of the boiler drums of each upper battery of two boilers two 8-in. branches join to form a feeder 12 ins. in diameter, which sweeps over and drops to a point where it is joined by a similar feeder from the corresponding battery immediately below; these two feeders then forming one of 16-in. pipe, which crosses the engine-room basement to an equalizing main. Each quarter of the boiler plant, with its respective quarter of the engine plant, will thus be independent of the other quarters, but adjacent longitudinal quarters will be connected through a by-pass so that each may serve the other.

The arrangement of the valves is such that any portion of the pipe, or any fitting or joint, may be repaired or renewed without interfering with the operation of the plant as a whole, and without cutting more than one engine or feeder out of service at one time. Expansion and contraction is provided for by careful design, proper anchoring, and by the flexibility of long-sweep bends.

The live-steam piping is free from pockets whether valves are open or closed, except in the equalizing mains, which are intentionally pocketed for drainage. The dead ends at closed throttles of engines are to be continuously drained and kept hot by connections running from the separator drips to the drains from the equalizing main pockets, and then by "Holly system" returns to the boilers, thus providing a continuous automatic drainage, for the entire steam system, to the boilers without moving mechanism.

In the Manhattan station the boiler plant is divided into eight groups of eight boilers each, corresponding to the eight engine units. Between the boilers and the wall dividing the boiler-room from the engine-room, and opposite each group of boilers, there is a short header 18 ins. in diameter. The pressure in adjoining headers is equalized by bent pipes connecting them. A steam reservoir 36 ins. in diameter, 24 ft. long, is located near each engine, and from it a pipe runs to the high-pressure cylinders.

AUXILIARY MACHINERY

Space will not permit a discussion of the great variety of auxiliary apparatus used in the three steam plants. It has all been described before in the papers referred to at the beginning of this article. It includes the boiler-feed, air and circulating pumps, the cold and warm-water and steam-drip piping, the water meters, the flues leading from the boilers to the economizers and chimneys, with three dampers and by-passes, the oiling systems, the exciters for furnishing current to the alternators, some of them being steam and others motor-driven, etc.

GENERAL ARRANGEMENT OF THE POWER PLANTS

The arrangement of the several elements in each of the stations is clearly shown in the illustrations accompanying this article. Especial attention is called to the four-division plan of the Kingsbridge station, which was designed by Westinghouse, Church, Kerr & Company. The plant is divided into four sections of four power units each. Each section occupies one-quarter of the boiler house and one-quarter of the engine house. Each has its own independent flues, economizers, stack, induced-draft machinery, exhaust leads and condenser. Equalizing flues allow each stack to be relayed to the other stack on the same side of the house. The steam piping, constructed on the equalizing-main system, is so connected that one section may relay the other three, and the condensers are so connected as to work as one unit, or either one may be cut out and the

PRINCIPAL DIMENSIONS OF THE ENGINES, ETC., IN THE THREE POWER STATIONS.

Name of Station	Metropolitan	Manhattan	Kingsbridge *
Location	96th St. and East River	74th St. and East River	216th St. and Harlem River
Size of building	200′ × 244″ av. = 48,800 sq. ft.	204′ 8″ × av. 404′ = 82,416 sq. ft.	246′ 4″ × 320′ = 78,830 sq. ft.
Size of boiler room, interior	83′ × 225′ av. 3 floors each 21,165 sq. ft.	104′ 2″ × 408′, 2 fls., each 42,500 sq. ft.	108′ × 308′ 2 floors, each 33,340 sq. ft.
Size of engine room	110′ × av. 222′ = 24,420 sq. ft.	93′ 6″ × 399′ = 37,107 sq. ft.	131′ 6″ × 308′ = 40,450 sq. ft.
Electrical output, nominal	6,600 volts, 38,500 kw.	11,000 volts, 40,000 kw.	6,600 volts, 56,000 kw.
Engines, number	11	8	16
H. P. each, rated	4,500	8,000	4,500
maximum	6,000	12,500	6,250
H. P. total, rated	49,500	64,000	72,000
maximum	66,000	100,000	100,000
Type	Vert. cross-comp. 2 cyl.	Duplex, comp., 4 cyls 2 hor. 2 vert., 2 cranks at 135°	Vert. cross-comp. 2 cyl.
Valves	Corliss	Corliss	Corliss
Size of cylinders	46 and 86 × 60 in.	44 and 88 × 60 in.	46 and 86 × 60 in.
Revs. per minute	75	75	75
Steam pressure	160 lbs.	150 lbs.	150 lbs.
Receiver, heat'g surf.	----------	773 sq. ft.	1,500 sq. ft.
Piston rods, diameter	9 and 10 in.	8 in.	9 and 10 in.
Connect'g rods, length	5 cranks	5.4 cranks	5 cranks
Crank pins	14 × 14 in.	18 × 18 in.	14 × 14 in.
Wrist pins	14 × 14 in.	12 × 12 in.	14 × 14 in.
Shaft, length	27 ft. 4 in.	25 ft 3 in.	27 ft.
max. diam	37 in.	37 in.	39 in.
bearings	34 × 60 in.	34 × 60 in.	34 × 60 in.
Weight on two bear'gs	----------	439,000 lbs.	507,000 lbs.
Fly-wheel, diameter	28 ft.	None	28 ft.
wt. of rim	100 tons	None	100 tons
Alternator, wt. of field	65 tons	116 tons	----------
Condensers	11, surface 8,000 sq. ft. each	8, jet	4, jet
Boilers, No.	87	67	60
H. P. each	1st and 2d floor, 265 3d floor, 350	520	520
Tubes high	2d floor, 9, 3d floor, 12	12	12
Sections wide	" 14, " 14	21	21
Stokers, grate surface, each	2d floor, 52 sq. ft. 3d floor, 57 sq. ft.	115 sq. ft.	115 sq. ft.
Chimneys	1—353 × 22 ft.	4—278 × 17 ft.	4—200 × 12 ft.
Fan blowers	None	16	8
Blast pressure, ins. of water	None	1.7 in.	about 3 in.
Economizers	None	16—8,192 tubes	16—9,600 tubes
Feed water heaters	Primary heaters	Surge tanks	Primary & aux'lry
Auxiliaries, driven by	Steam	Motors	Steam
Maximum H.P of engines per sq. ft. of area of			
Building	1.375	1.213	1.269
Engine room	2.703	2.695	2.472
Boiler floors	1.394	1.176	1.499

*The figures for the Kingsbridge station are those of the original design. Only one half of the plant is now under construction.

three remaining have capacity for the whole plant. As was said in a former description of this station, "compactness is gained without crowding, and completeness without complexity."

In the Manhattan station the same principle of subdivision prevails, but each of the eight power units is made as far as possible independent of the others, except as to the chimneys, of which there are four, one for each two power units.

TABLE OF DIMENSIONS

The table in the accompanying column gives in condensed form the dimensions of the principal apparatus described in this article, as well as of the stations themselves, for convenient reference.

PRESENT CONDITION OF THE THREE STATIONS

This article describes the steam plants of the three stations as if they were all complete and in operation. As a matter of fact they are all in different stages of progress. The Metropolitan station is now nearly complete, and part of the machinery has been running for over a year. Eight of the eleven engines are now erected and in operation, and the other three are in process of construction. The two lower floors of boilers are complete and running, and boilers are now being erected on the third floor. In the Manhattan station the building is finished, one of the engines and several of the boilers and economizers are in position, and the parts for several other engines, boilers, etc., are on the ground and are being put in place as fast as possible.

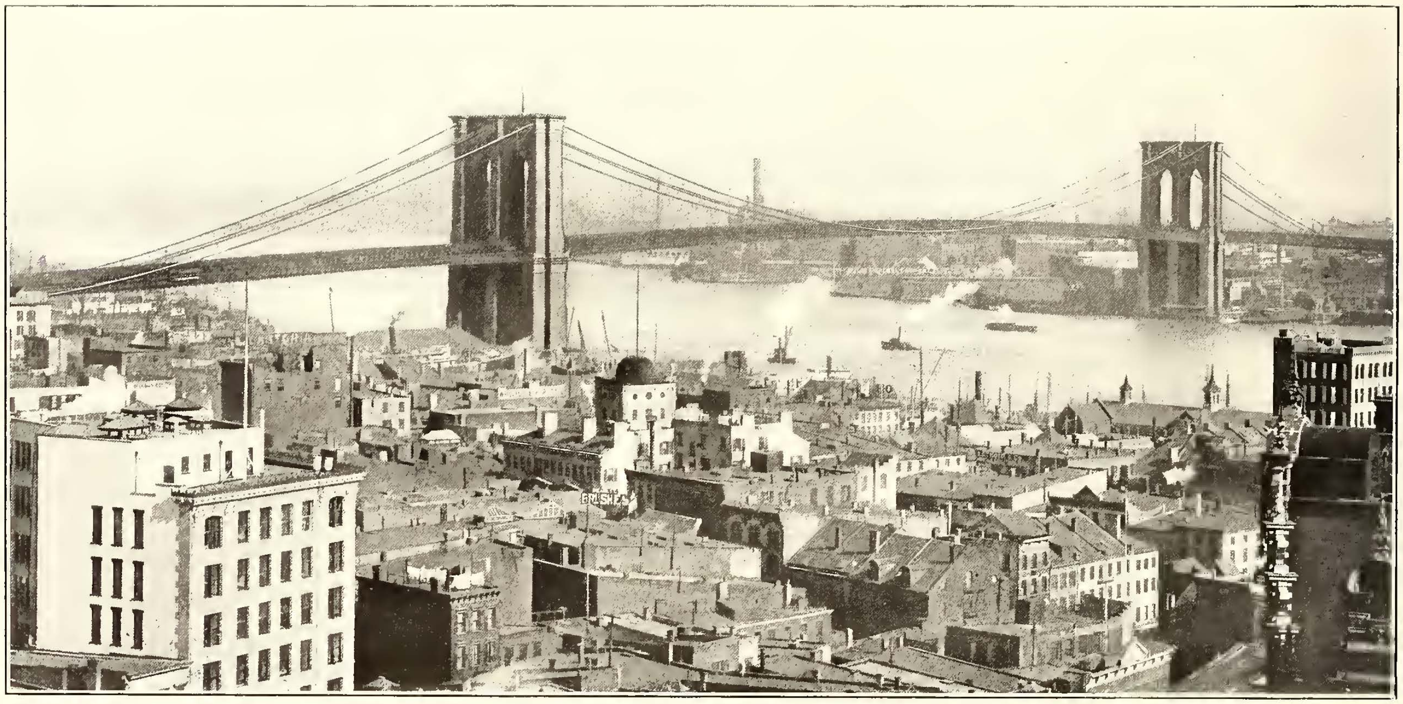
At the Kingsbridge station it is intended to complete only one-half of the plant at present. The foundations for boilers, engines and chimneys are finished, and the building is nearly ready to receive the machinery. Work upon it is now in rapid progress.

SOME RAILWAY PROBLEMS OF BROOKLYN

BY J. L. GREATSINGER

President, Brooklyn Heights Railroad Company

WHEN I became president of the Brooklyn Heights Railroad Company, last March, I was not surprised to find a system in which nearly every department was actively engaged in perfecting much-needed improvements. Although in coming to Brooklyn from Duluth I not only made a considerable change geographically, but went from steam railroad management to that of electric railways, I was familiar with the conditions existing in Brooklyn, having, in common with other railroad men throughout the country, watched with interest the vicissitudes with which the growth of its street railways has been accompanied. Perhaps in no other city is there such a multiplicity of local conditions adverse to the proper supplying of satisfactory transportation facilities, and the overcoming of these difficulties presents many problems upon which the officers and engineers of the company are continually working. It is my intention in this article to mention, in as brief a manner as possible, some of the reasons why the service is at present inadequate to accommodate the demands made upon it and to point out the plans which are being adopted for greatly increasing the system's efficiency.

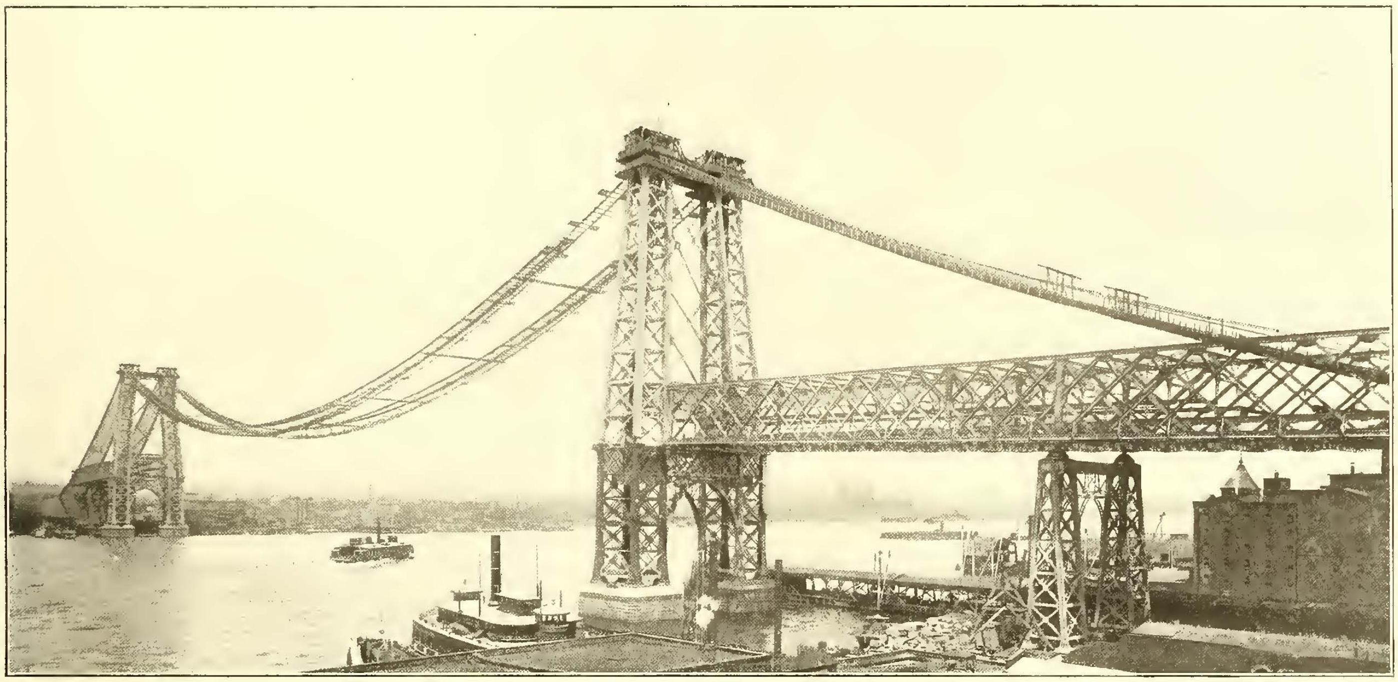


THE PRESENT NEW YORK AND BROOKLYN BRIDGE

The traveling public of Brooklyn which uses surface and elevated lines during the rush hours morning and evening may be divided into two portions—those who work in their own borough and those who have their place of business in Manhattan. The latter greatly exceed in numbers the ones who remain on this side of the East River, although the large number of factories, warehouses, etc., makes the local traffic of much greater proportions than is generally realized, and such lines as the Crosstown and others especially patronized by this class receive as heavy a share of the work of transportation as many of the others. But a small fraction of the thousands that cross to Manhattan and back daily use the ferries, so that the vital point of the whole system is at the bridge, and the number of through cars that can be operated is limited by the facilities afforded by that structure. The quick response that has followed the betterment of service on existing lines, and the practically simultaneous growth of outlying districts with the extensions made to the system, has taxed these facilities far beyond the capacity for which they were originally intended, and the resulting congestion can be obviated only by the most radical changes in the bridge itself. With the elevated trains the terminals offer further limitations, insufficient space now being provided for the proper switching, loading and unloading of the cars when through service is installed. Although holding a franchise whereby it is allowed to operate cars over the bridge, the railway company must abide by the rules laid down for such operation by the city authorities in control of the bridge, and is entirely powerless to modify the conditions at the Manhattan end without the sanction of the city government.

As is well known, a commission has been appointed and is now co-operating with the railway company in improving this serious obstacle to rapid transit, but until the commission has rendered its report, the plans for such improvement can not be made public. It may be said, however, that the work is progressing most satisfactorily, and that means will undoubtedly be found whereby the present accommodations will be replaced by such as will insure much greater comfort to the public. The new bridge which is now being built between Grand Street, Manhattan, and Broadway, Brooklyn, will probably serve but little to relieve the traffic on the present one, but it will result in building up a new section of territory, which may in a measure hold back the steady increase in the number of daily passengers on the latter. It can not be, therefore, until after bridge number three, which is to be placed between the ones just mentioned, is built that the Brooklyn Rapid Transit will find a very great relief to its present Manhattan service, and it is to be hoped that the work on this bridge, which has already commenced, will be pushed with the greatest expedition. In the interim the company can give only as good service as the physical limitations of the present bridge allow, and must wait with the public until more tracks to Manhattan are afforded. The construction of tunnels under the East River will further facilitate the distribution of traffic, and as these improvements will be made before the natural growth of the borough can have increased it proportionately, it is not too much to expect that within a very few years the various lines of the system will be operating under the most favorable conditions, as far as possible congestion at termini is concerned.

One of the greatest needs of the Brooklyn Heights Railroad Company at the present time is an enlargement of the power-generating facilities. The untoward demands on the existing plants caused by the rapid growth of the city, the unfortunate fire which recently destroyed one of the important power stations, and the large increase in distant suburban population has cut down the margin of reserve power to zero. It has been the unfortunate predicament, therefore, of the Brooklyn Heights Railroad Company to be compelled during the rush hours to operate its various power plants much above their full rated capacity, allowing no spare units whatever, and being inconvenienced to the extent of the actual shutting down of certain lines by the breakdown of a single generator. Realizing the coming shortness of power from natural growth of the city and service, the board of directors some time ago commenced the formulating of plans for the enlargement of the generating capacity, and these plans have now taken a definite form, have been approved by the consulting engineer of the company, and are being rapidly put into execution. The loss of some of the most useful aids to carrying some of the peak load, such as the Ridgewood Power Station, could, however, not have been foreseen, and during the spring of this year, therefore, the power supply became so small that it was necessary for us to return to the former practice of steam operation on the elevated railways. The immense crowds which have been handled in our Coney Island, Bergen Beach and other excursion service this summer has necessarily maintained the undue pressure upon the power stations, working them as stated largely above their nominal capacity, and preventing the reinstating of electrically-operated elevated trains, but before this is published some of the lines will again be running without locomotives. Immediately after the demands for power became oppressive, with no likelihood of relief, every effort was made to secure help from outside sources. A most natural aid in the way of current came from the Kings County Electric Light & Power Company, whose Sixty-Fifth Street station could deliver alternating current at 6500 volts in any part of the city to local sub-stations. Negotiations were therefore opened with this company, and as soon as the proper arrangements could be made for obtaining the high-tension cable and rotary converters, an additional supply was secured.



THE NEW EAST RIVER BRIDGE AS IT IS TO-DAY

The increase in power will double the present capacity, and the adoption of high-tension feeders will give great flexibility to the system. Everything pertaining to the service has been provided for in the development of the new power-distribution system. The great changes in traffic distribution which will result from the completion of the new bridge at Broadway and the proposed extension by tunnel of the underground rapid transit from Manhattan to Brooklyn has been carefully considered, and the present layout of power cables, with the accompanying reserve ducts and space for auxiliary power in the power stations, is confidently expected to be sufficient for the supply of the company's lines until 1906.

Brooklyn being primarily a borough of homes, the railway lines run through more than the usual proportion of residence streets. As most of these thoroughfares were not laid out with the view of accommodating heavy vehicular traffic, to say nothing of the introduction of street railways, they are in the majority of cases narrow, allowing but a narrow margin between the tracks and sidewalks, and necessitating extra vigilance on the part of the motorman in avoiding collisions with trucks or carriages. A much greater tax on his ability, however, results from the general use of the streets as a children's playground. There seems to be either a peculiar fascination for the most dangerous localities or a distorted conception of the relative recreation advantages of the various streets in their vicinity existing in the youthful mind, for the younger population come from considerable distances to play on the streets traversed by trolley cars. The records show that the larger part of the children injured have resided at some distance from the tracks, those whose homes are on a street containing a railway line developing a faculty of self-preservation that counteracts the contempt bred from their familiarity with the passing cars. For some months past the police force has co-operated with the railway company in restraining children of neighboring streets from playing on or near the tracks, with a most gratifying result in cutting down the number of this class of accidents, although, of course, it was impossible to restrict the use of the streets to any great extent. With the smaller children it is not an uncommon occurrence for the motorman to be obliged to stop his car in order to get down and remove some little tot who is sitting peacefully between the rails, and while the car is stopping for passengers they have been known to come up and sit on the fender.

THE RAILWAY TERMINAL AT BRIGHTON BEACH

During the summer season the numerous beaches create a large pleasure traffic on the lines. Throughout the daytime this is made up almost entirely of women and children, placing considerably more responsibility on the conductor, both on account of the open type of car used and the character of his passengers, than does the regular winter service. The specially-chartered car has always been popular in Brooklyn, and in summer it generally accommodates some excursion to the seaside. In this way hundreds of children are given a most enjoyable outing during the hot weather at small expense.

With a system of the Brooklyn Heights Railroad Company's magnitude a large number of changes are constantly taking place among the employees. It is not exceptional, especially in the spring of the year, when we are preparing for the summer rush to the seashore, to take on from three hundred to four hundred new motormen per month, and the training of these men to the standard of efficiency demanded on all divisions of the road requires no little labor. Much attention has been given to the perfecting of this department, and careful examinations of proficiency are made before a man is allowed to take out a car. There is, however, a certain amount of reliability which comes only with the mental equipoise following long familiarity with the position on the front platform, so that the company takes every opportunity to prevent dissatisfaction among its men, and places a premium on long service by a periodical increase in wages. Club rooms of a most attractive character, with reading rooms, bowling alleys and gymnasiums, are contemplated to replace those already in use, furnishing the employees with healthy recreation near their posts when off duty.

The advantages of a generous transfer system are fully appreciated by the company, and it has adopted a most liberal policy in this direction. The general plan of the network of tracks makes it difficult to have rules prohibiting the passenger from continuing in the same general direction or the issuing of a transfer on a transfer without inconveniencing a great portion of the patrons. In general, a passenger is not allowed to transfer from one car to another which has come over the same track, and which he could have first boarded by a little longer wait, but at the City Hall even this restriction is not employed, and an opportunity is given to change from a Fulton Ferry car to one going over the bridge or vice versa. In this way considerable time is saved, as it enables the passenger to catch a car of another line having his desired destination. By looking at a map of the company's lines, it will be seen that at some junctions they radiate to all points of the compass. If one of these branches is followed, many other intersections will probably be found, and in order to give satisfactory communication from any part of the borough to any other part transfers given on transfers are at present issued as a temporary convenience. At the principal transfer points agents are stationed, relieving the conductor of much unnecessary work.

A SUMMER PICNIC PARTY

In conclusion, it may be said that while at present the road is handicapped by having none too much power and entirely inadequate means of reaching Manhattan, the remedies for both these evils are in sight. Within a very few years the completion of new bridges and tunnels will provide sufficient outlets to prevent congestion on any part of the system and give favorable opportunities for operating a high-speed, short-headway schedule, which will serve to build up new suburbs while increasing the density of population in those already prospering.

THE DEVELOPMENT OF SUBURBAN TERRITORY

BY J. C. BRACKENRIDGE

General Manager, Brooklyn Heights Railroad Company

WITHIN the last decade the movement of population to the cities for residence has begun to retrograde, and to the most casual observer it is evident that the tendency now is to forsake the crowded life of the city for the comparative freedom of suburban homes. This is one of the most gratifying tendencies of the times, and seems bound in time to solve many of the socialistic problems which to-day confront us. A suburbanite is, in seven-eighths of the cases, his own landlord; he is no longer a roving tenant; he has vested interests which can not but cause him to interest himself in the welfare of the community with which his interests are allied. No destructive tendencies can be developed. All his interests make him a builder-up, an improver.

Before any suburb can be developed, however, and become a desirable residence location, it must be made easy of access, and at a low rate of transportation. New York is undoubtedly the Mecca of .99 of our suburban residents. Until New York was made easy of access, no inducements could develop popularity for any neighboring site.

The accompanying table shows the relation between the population of Brooklyn, the increase in transportation facilities shown by track mileage, the opening of the New York and Brooklyn Bridge, the elevated service and the number of passengers carried.

All figures show that with increase in transportation facilities came a jump in the increase in population and in passengers carried, which in many cases was even greater after the second year, showing that the population realized the opportunities for spreading out and obtaining comparative freedom from crowding, and took advantage of it.

But it was not until the trolley companies were able to cross the bridge—in February, 1898—that this vast movement to our suburbs assumed its real proportions. Until that time the inconvenience of the overcrowded terminal facilities, both elevated and surface, the necessity of changing cars, the additional fare, the overcrowding of the bridge platforms and cars in their endeavor to handle both surface and elevated traffic, turned away many who looked with longing eyes at our suburbs, which were so rich in possibilities and beauties, and sent them to less attractive locations in New Jersey and upper Manhattan. With the opening of the bridge to the trolley all this was changed. By stepping into a trolley car in New York, the business man can resign himself to his paper and alight at his own door, or the nearest corner, in any of the many beautiful little communities which have sprung up along the lines of the steel rails and the copper trolley wire. Flushing, Corona, Elmhurst, Jamaica, Richmond Hill, Canarsie, Bergen Beach, Bensonhurst, Fort Hamilton, Dyker Heights, Borough Park are all developing rapidly, now that rapid transit is assured. Many of these sections, which a few years ago were vacant lots, mud holes, are to-day the sites of detached houses.

For example, seven years ago land in the Flatbush district was selling for $1,500 per acre. To-day building lots 25 ft. x 100 ft. sell for from $3,000 to $4,500. This increase has followed the railroad lines exclusively. In old Brooklyn, on the Heights, there is practically no sale for property. In the suburbs, along the trolley line, there is unlimited sale. Away from the tracks there is no sale. A railway can lay its tracks between vacant lots, and in a short time a comfortable patronage will build itself up.

In the year following the admission of the surface cars to the bridge roadways one Brooklyn real estate firm sold suburban property in the bulk at the total price of over twelve million dollars, over three-quarters of the buyers being from outside of New York. Capitalists from Boston, Philadelphia, Rochester, and even further away, have taken this opportunity to make enormous profits, and in the case of the sales just mentioned, after laying out streets, improving the property and dividing into building lots, all the sales at retail have been at a profit of from 100 to 200 per cent, and there has been no difficulty in finding purchasers at this figure.

One real estate firm placed a reliable man at the Jersey City Annex ferry slip the first day of May a year or two ago, and he reported that in the eight hours he was at the ferry fifty truckloads of furniture arrived from Jersey, and none went back.

By glancing at the table it is easy to pick out the years when increase in travel was nearly at a standstill, and the years when the increase was so large as to be certainly due to some increase in population or to removals of large numbers to such a distance from the business centers as to necessitate more riding.

The increase between the years 1860 and 1870 amounted to 221 per cent in passengers carried, against an increase of only 50 per cent in population. Even with the old horse-cars, the populace found it advisable to move from the business centers to quieter residence districts. Thus the hill section in the neighborhood of Clinton Avenue was developed. In 1880, ten years later, over twice as many passengers were carried as in 1870, the increase being 106 per cent. From 1880 to 1884, when the Brooklyn Bridge was opened for traffic, the annual increase was about six million. The year the bridge opened, the number of passengers carried on surface roads was over 102,000,000, an increase of nine millions. In the following year, on May 14, 1885, the Brooklyn Elevated Road first carried passengers, and though the total increase of traffic that year was over six millions persons carried, only 1.7 millions went to the surface, the elevated getting 4.5 millions. This first promise of rapid transit resulted in an increase in 1886 of nearly fifteen million passengers, only 4.6 millions on the surface, and 10.3 millions on the elevated. This taxed the carrying capacity of the elevated to the utmost, as during this time only 6.75 miles were operated, and the following year marked an increase of only four million, evenly divided. April 24 of the next year, 1888, found the Kings County Elevated open as far as Nostrand Avenue, and an additional six miles of the Brooklyn Elevated was opened, so that while there was an increase of six million passengers in the elevated traffic there was a decrease of 3 1-3 million in the number carried by the surface roads. There was a still further decrease of 1¼ millions in the passengers carried by the surface roads the next year, while there was an increase in "L" traffic of 15¾ millions. The following year, 1890, closed the decade with a rush of travel, an increase of nearly eleven millions for both elevated and surface, a total increase for the year of 21.8 millions. This doubled the traffic of 1880, the increase being 117 per cent.

TABLE SHOWING POPULATION, MILES OF TRACK ON MAIN LINES AND NUMBER OF PASSENGERS CARRIED IN BROOKLYN

YEAR	Population	Miles of Track Main Lines: Surface (Double Track)	Miles of Track Main Lines: Elevated (Structure)	Passengers Carried: Surface	Passengers Carried: Elevated	Passengers Carried: Total	Increase: Surface	Increase: Elevated	Increase: Total	Remarks
1854	------	------	------	--------	--------	--------	--------	--------	--------	First surface cars operated in Brooklyn
1858	------	------	------	7,705,839	--------	7,705,839	--------	--------	--------	
1860	265,000	47.00	------	11,328,009	--------	11,328,009	3,622,270	--------	--------	
1870	396,000	100.00	------	36,431,695	--------	36,431,695	25,103,686	--------	--------	221 % increase in 10 years
1880	599,495	142,395	------	75,000,000	--------	75,000,000	38,568,305	--------	--------	106 % " " "
1881	------	143.27	------	79,933,913	--------	79,933,913	4,933,913	--------	--------	
1882	------	152.645	------	86,789,688	--------	86,789,688	6,855,775	--------	--------	
1883	------	158.048	------	93,287,969	--------	93,287,969	6,498,281	--------	--------	
1884	631,383	159.385	------	102 256,548	--------	102,256,548	8,968,579	--------	--------	Brooklyn Bridge opened
1885	710,000	155.904	6.05	103,959,052	4,447,667	108.406,719	1,702,5[illegible]4	4,447,667	6,150,171	May 14, Brooklyn Elevated opened
1886	745,100	145.719	6.75	108,555.448	10,158,665	118,714,113	4,596,396	10,307,398	14,903,794	
1887	774.870	133.802	6.75	111,501,852	12,172,353	123.674,205	2,946,404	2,013.688	4,960,092	
1888	805,885	138.725	16.002	108,152,409	18,332,174	126,484,583	—3,349,443	6,159,821	2,810,378	April 24, K. C. Elevated opened
1889	820,000	139.845	23.048	106,874,365	34,127,359	141,001,724	—1,278,044	15,[illegible]95,185	14,517,141	
1890	838,547	168.409	24.822	117,830,098	45,007,410	162,837,508	10,955,733	10,880,051	21,835,784	117 % increase in 10 years
1891	995,276	162 580	24.822	115,261,992	50,417,563	165,679,555	—2,568,106	5,400,153	2,832,047	
1892	1,000,000	158.595	24.433	122,518,186	53,353,769	175,871,955	7,256,194	2,936,206	10,192,400	
1893	1,020,000	165.452	27.912	137,715,699	56,654 409	194,370,108	15,197,513	3,300,640	18,498,153	Motive power began to be changed to electricity
1894	1,080,000	163.571	27.603	138,259,976	48,705,847	186,965,823	544,277	—7,948,562	—7,404,285	Motive power nearly all changed to electricity by end of year
1895	1,100,000	163.724	28.408	153,420,474	53,251,922	206,672,396	15,160,498	4,546,075	19,706,573	Year of trolley strike
1896	1,113,000	203.184	28.408	172.115,126	50,400,820	222,515,946	19,916,809	—2,851,102	17,065,707	
1897	1,126,000	213.915	31.821	200,139,500	45,684,379	245,823,879	28,024,374	—4,716,441	23,307,933	
1898	1,139,100	237.973	31.911	217,278,119	44,170,810	261,448,929	17,138,619	—1,513,569	15,625,050	Jan, 23, trolley cars first crossed bridge. June 18, elevated first crossed
1899	1,152,000	238.603	31.911	241,716,817	48,086,278	289,803,095	24,438,698	3,915,468	28,354,166	In addition, the N. Y. & B. Bridge carried passengers who didn't continue on the elevated—9,560,806
1900	1,166,382	237.800	37.00	309,530,880	67,008,614	376,539,494	67,814,063	18,922,236	86,736,399	Brighton Beach R. R. included in elevated lines beginning this year
1901	1,180,000	237.800	37.00	331,632,666	62,519,369	394,152,035	22,101,786	—4,489,245	17,612,541	

The year 1891 found a decrease of 2½ million passengers in surface traffic, and the small increase of 5½ millions in elevated traffic, while the population increased 100,000. This resulted in an increase of 10 million passengers carried in 1892, but the population only increased by about 5000 over 1891.

Evidently some improvement in service was necessary. In the year 1893 the motive power of a few lines was changed to electricity, and by the close of the year 1894 practically all the lines were converted to mechanical traction. The increase in passengers carried in 1893 was fifteen millions for the surface, and only three millions increase for the elevated; a total of 137,715,699 for the surface roads and 56,654,409 for the elevated, while the estimated population increased 20,000. The following year the elevated traffic decreased nearly eight millions, while the surface retained its gain of the year before, but added only one-half a million, yet the population was increased 60,000, which, with the completion of the electric conversion, before the beginning of the year 1895, was the signal for another jump in passengers carried, although this was the year of the strike, making 15 millions increase for the surface and 4½ millions increase for the elevated in 1895. Between the years 1890 and 1895 the assessed valuation of taxable property in the town of Flatbush was more than doubled, from $6,156,465 in 1890 to $13,356,909 in 1895; tripled in New Utrecht, from $3,897,968 in 1890 to $11,356,909; doubled in Gravesend, from $3,001,740 to $6,291,128; and doubled in Flatlands, from about $1,000,000 to $2,000,000.

From this time on the elevated steadily lost from one to four millions a year. The opening of the Nassau lines, and the consequent development of the districts they fed, caused an increase of 20 millions in 1896, of 28 millions in 1897 (making a total for the surface roads of 200 millions), and an increase of 17 millions in 1898, making a total of 217,278,119 passengers carried by the surface roads, against 44 millions by the elevated.

In February, 1898, the surface roads first crossed the bridge, and in June of the same year the elevated cars first transferred free to the bridge cars. As such a short time remained to the close of the fiscal year, June 30, the benefits were not shown so clearly in 1898, but in the succeeding year the satisfaction of the public in the accomplishment of this long-desired improvement appeared in the increase of 24½ millions in surface traffic, the increase of 4 million in elevated traffic (the first increase in the elevated, by the way, after three years of losses) and in the 9½ million persons carried over the bridge who were not elevated or surface passengers, all causing the enormous increase in the value of suburban real estate noted before—lots 25 ft. x 100 ft. selling at from two to three times the cost per acre five years ago.

In the year 1899 there were 241,716,817 passengers carried by the surface cars, 48,086,278 carried by the elevated; a total of 289,303,095, besides 9,560,806 passengers carried across the bridge only.

With the change of motive power on the elevated roads from steam to electricity came increased speed and decreased intervals between trains. The public, appreciative of every betterment, quickly saw the advantages that were thus held out to them, and the remarkable increase of 15 millions shows how quickly the improved facilities were grasped.

September, 1899, saw electric service installed on the

Fifth Avenue Elevated as far as Sixty-Fifth Street, with free transfers to the surface lines at Thirty-Sixth Street and at Sixty-Fifth Street to Bay Ridge, Fort Hamilton, Borough Park, Bath Beach, Unionville, Coney Island and many small settlements through which these lines passed. By the middle of September, 1899, trains were being operated electrically via the Kings County Elevated Railroad and the Brighton Beach road from New York to Sheepshead Bay and Brighton Beach, and as well over the Lexington Avenue line as far as Gates Avenue and Broadway. From 1899 to 1900 the improved elevated roads carried 67,008,614 passengers.

There was also a heavy increase in the traffic on the surface lines in the same time, amounting to 67,800,000; this was largely due to absorption of other systems, with which, however, connections were made which rendered it possible to operate more cars and gain access to the outlying residence districts by shorter routes. The total number of passengers carried by the surface and elevated lines in the year 1900 was 376,539,494, nearly 2 1-3 times the number at the close of the previous decade, the increase being 131 per cent. The population of Brooklyn increased in the same time a little less than 40 per cent.

The close of the fiscal year on June 30, 1901, shows an increase in the surface traffic of over 22 million passengers carried, while there has been a decrease in the number carried by the elevated lines of nearly 4½ millions. This apparent falling off in the elevated business is due to the Brighton Beach line being rated as belonging to the surface instead of the elevated division. There was a total increase of 17,612,541 passengers, while the whole number carried was 394,152,035; with our population of 1,180,000 this is equivalent to every one riding once a day for 310 days in the year. The increase this year compares favorably with that of other years (excepting last year, which was apparently abnormal, owing to the absorption of other systems, as has been said), although at present the Brooklyn Bridge is being taxed to its utmost capacity.

The figures used in this article were obtained from the reports of the New York Railroad Commissioners and the records of the various railway companies where they were available. No distinction is made between the boroughs of Brooklyn and Queens, and what seems to be the most logical separation of the different classes of traffic has been adopted.

It is interesting to note that with all this enormous yearly increase in the number of passengers carried, there has been little or no change in the mileage of the tracks, showing that the outlying residence districts are being rapidly thickly settled.

With the completion of the new East River Bridge we will undoubtedly see another large increase in the number of passengers carried, although it is not expected that the present bridge will be at all relieved. This latter condition will come only on the completion of bridge number three and the Rapid Transit Tunnel; with these avenues of communication between Manhattan and Brooklyn, and the altogether likely possibility of improvements in train and car equipment, we would see a still further movement of people from the crowded city districts to the freedom and pure air to be had in the suburban towns of Long Island.

THE ROLLING STOCK OF GREATER NEW YORK

BY EUGENE CHAMBERLIN

Superintendent of Equipment, Brooklyn Heights Railroad Company

IN attempting a description of the rolling stock at present operated in the boroughs of Manhattan and Brooklyn, especially on the surface street railways, it is essential to consider briefly the evolution from the horse car to the present standard overhead trolley or underground-conduit electric cars of the two boroughs. Without touching upon this history for the past ten years it would be difficult to explain why the various types of cars, trucks and motors are still in use.

It is quite generally understood that in Manhattan the control of all surface lines was originally in the hands of two corporations from the time that horse cars began to be superseded by other kinds of motive power, with the result that each company early adopted its standards and adhered to the same—first, their cable, and later, their electric, lines were extended. The consequence is that in that borough to-day the equipment is fairly well standardized; while, on the contrary, in Brooklyn the change from horse to electric cars began in the early nineties and was carried on simultaneously by five distinct companies, creating a multiplicity of types of car, truck and motor equipment which time alone can thoroughly eradicate.

The standards of the Metropolitan Street Railway Company were fully described by Thomas Millen, master mechanic of that company, in an article in the October, 1900, number of the Street Railway Journal, which at the present time probably covers the equipment in Manhattan. The acquisition of the Third Avenue Railroad by the Metropolitan added a different build of single-truck closed car equipped with Westinghouse 68 motors; a double-truck closed car having transverse, walkover seats, equipped with Peckham 14-A bolster trucks having four Westinghouse 56 motors; and a double-truck combination car which the Third Avenue Railroad had produced by joining together a single-truck closed and single-truck open car. These cars correspond in type, as far as the requirements of operation are concerned, to the standard cars of similar type which the Metropolitan Company had already in operation, differing only in detail of construction, finish and color.

The transverse type of seat above mentioned appears to have not proven a success in Manhattan, and certainly has not in Brooklyn, for the reason that with a car of greater width than the ordinary standards they give but a 19-in. aisle, instead of a 40-in. aisle, and the seating capacity is no greater than with the longitudinal side seats, thus materially reducing the carrying capacity of the cars, and during the hours that traffic is heavy causes considerable delay and inconvenience on account of the difficulty experienced by passengers and conductors in making their way through the crowded, narrow aisles.

In general, the types of cars and their uses in the two boroughs are the same, namely: single and double-truck closed cars for winter service, and single and double-truck open cars for summer service; the single-truck cars being operated on crosstown or side lines, where traffic is steady and requires a fairly short headway, but is rarely heavy enough to call for cars of large carrying capacity. They are also useful as "nighthawks"—cars operating between 1 a. m. and 5 a. m., when traffic is light. The double-truck cars are used on such lines and at such hours as demand not only very short headway, but the largest possible carrying capacity. The double-truck combination car, having a portion of one end closed and the rest of the car the same as the standard cross-bench open car, which is a type in very general and apparently successful use in Manhattan, has been experimented with in Brooklyn and found unsuited to the service, for the reason that in Manhattan all the lines run through thickly populated sections and lead directly to no seashore and but few summer resorts. The result is that the riding is largely a matter of business, and any car, either closed or open, winter or summer, will be used to get quickly to destinations. In Brooklyn, on the contrary, nearly all lines run through attractive suburbs to various seashore and summer resorts, and a large portion of the summer traffic consists in carrying pleasure seekers. For this service large numbers of open cars are needed, and closed cars, or cars having a portion of their length closed, would simply be additional dead weight, and receive little or no patronage.

The general dimensions of all cars in both boroughs are as a rule regulated by the clearances afforded on narrow streets, elevated railroad columns and other local conditions, and, as Mr. Millen's article gave in detail the dimensions, etc., of the standard cars in use in Manhattan, repetition, except in a general way, is unnecessary. The four-wheeled closed cars of the Metropolitan system are 30 ft. over the dashers, the width at sill being 6 ft., and at belt-rail 7 ft., and have eight windows on each side. The double-truck closed cars are 36 ft. over the dashers, with a width of 6 ft. 6 ins. at the sill, and 7 ft. 6 ins. at the belt-rail, thus being 6 ins. wider at both points than the single-truck cars. These cars have ten windows on each side and certain modifications in the body framing, to allow for the two trucks, which are of the maximum-traction type. The open cars have a length over the dashers of 35 ft. 11 ins., and width at the posts over seats 7 ft. 2½ ins., and a width at sills of 6 ft. 5 ins. There are twelve seats in all and three sash in the end bulkhead. The standard color for the Metropolitan cars is orange for the main panel, and cream on the lower concave part, with plain block lettering and simple ornamental lining. The cars are equipped with four signs, one at each end and one on the middle of each side. These signs are of the same square type described below as being used under the hoods of the Brooklyn cars, but are operated by hand wheels connected to them by a bevel gear. The cars used on what constitutes the old Third Avenue system are painted in red, having a distinctive color scheme to those of the Metropolitan road proper. There are, of course, in Manhattan a large number of horse cars in operation, and the Thirty-Fourth Street storage-battery line, but there is hardly room for a detailed description of these cars in an article of this kind, as there is nothing which has not already been thoroughly described about the latter, and the horse cars are of the same type that have been in use for the past six or eight years. Descriptions of the standard Brooklyn cars are given in more detail below.

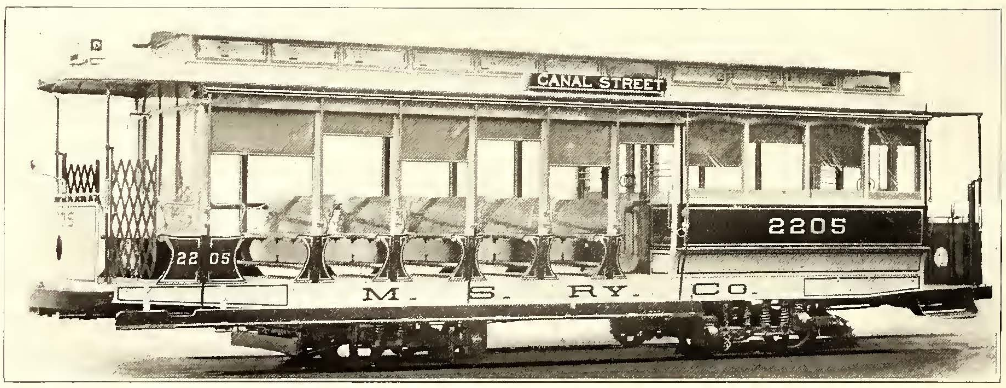
DOUBLE-TRUCK CLOSED CAR, MANHATTAN

The Brooklyn Rapid Transit single-truck closed cars have a length over all of 29 ft., body 20 ft., width at sills 6 ft., width over drip-rails 7 ft. 10$\frac{1}{2}$ ins., height from bottom of sill to top of trolleyboard 8 ft. 8 ins. Seven windows are placed on each side, having fixed sash fitted to prevent rattling; pantasote curtains on Hartshorn rollers, with fixtures sliding in grooves. The roof is of monitor type, with seven pivoted ventilator sash on each side, glazed with white chipped glass, the two end monitor sash being fixed. The platforms are 4 ft. 6 ins., with angle-iron bumpers slotted for malleable iron draw-heads. Platform gates are of the Wood patent folding type, and Brill patent B. H. standard 12-in. pressed steel platform gongs with fixed pin are used. The dashers are No. 16 iron screwed to end-stick at bottom, and at top to hickory rail, securely clipped to six iron dash stanchions, of which the two end ones extend from platform to bonnet.

DOUBLE-TRUCK OPEN CAR, MANHATTAN

The car body is trussed with $\frac{7}{8}$-in. round iron truss rods, with greatest depth possible under car seats. The car seats are covered with carpet of standard color and design without any upholstering. There are single doors hung on rollers, 27-in. openings placed in center of end bulkhead. These cars are equipped with 8-in. dash electric headlights, included in the two-light circuits with which cars are wired. Six Consolidated electric heaters are set in the seat-riser panels. The truck and electrical equipment is either Dupont trucks, 7-ft. wheel base, with Westinghouse 68 motors, G. E. K-11 controllers, Nuttall trolley stands; or Peckham trucks, 6-ft wheel base, G. E.-800 motors, G. E. K-2 controllers and Nuttall trolley stands.

The dimensions of the standard double-truck closed cars are as follows: Length of body, 25 ft. $\frac{1}{2}$ in.; length over all, 34 ft. 1$\frac{1}{4}$ in.; width of body over drip-rail, 8 ft. $\frac{1}{2}$ in.; width of body over sash-rail, 7 ft. 9 ins.; width of body at sill, 7 ft.; height from floor to plates, 6 ft. 1 in.; height from bottom of sill to top of trolleyboard, 9 ft. 1 in. There are eight widows on each side; fixed cherry sash, fitted tight with rubber bands or parting strips to prevent rattling; 3-16-in. American plate glass in rubber pockets; and pantasote curtains on Hartshorn rollers. The roof is of monitor type, with eight pivoted ventilator sash on each side, glazed with white chipped glass, 1-in. plain border; ceilings are of three-ply quartered oak veneer, three sections in upper deck and one section in lower deck. The inside finish of car is of cherry. The seats and their backs are of hard enameled rattan, in three sections, placed longitudinally. The four car steps are of soft iron with metallic safety treads. Two of the platform gates are of the Wood patent folding pattern, and the other two are folding Pitt gates, one of each kind being placed at each end. The platforms are supported by substantial oak arms, with angle iron bumpers slotted for fixed malleable iron



DOUBLE-TRUCK COMBINATION CAR, MANHATTAN

draw-heads. The dashers are of No. 16 iron, screwed at bottom to end-stick, and at top to a bent hickory strip clipped to six iron stanchions, two of which extend from the platform to bonnet.

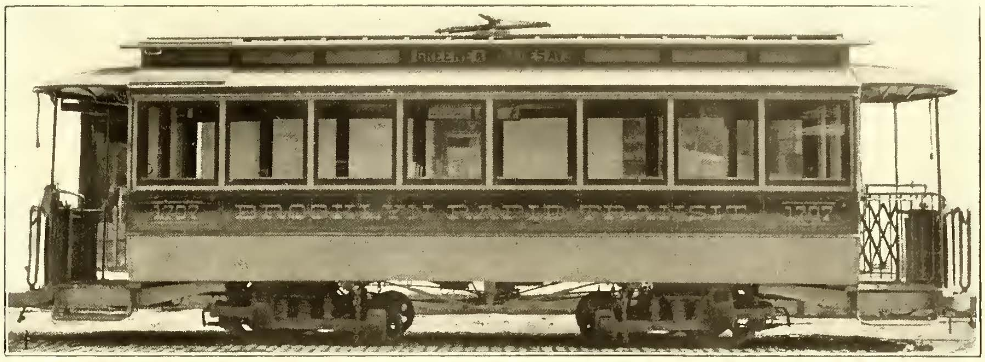
Each car is equipped with two sand boxes with levers, and two 12-in. steel platform gongs, Brill pattern B. H. standard with fixed pin. Three electric light circuits, including $9\frac{1}{2}$-in. Neal electric headlights set in center of dashers, and six electric heaters (Consolidated) in seat-riser panels and operated by a three-point switch. The doors are hung on rollers, have 30-in. openings, and are placed at diagonally opposite sides of the bulkheads, bringing the rear door always on the side nearest the sidewalk.

The dimensions of the standard ten-bench, single-truck open cars are as follows: Length over all, 31 ft. 10 ins.; width over all, 7 ft. $9\frac{1}{4}$ ins.; width at sills, 6 ft. $7\frac{1}{2}$ ins.; height from bottom of sill to top of trolleyboard, 8 ft. 8 ins. Of these six benches have reversible seats and four are bulkhead benches. The total seating capacity is fifty passengers. The car has the monitor type of roof, with eight fixed sash on each side, glazed with white chipped glass, and three drop sash with drop blinds in each bulkhead. The side steps are of the folding type, and canvas side curtains with Hartshorn rollers and steel rods slide in grooves in the pillars. Dashers, bumpers, draw-heads and platform gongs are similar to those described above for the double-truck closed cars.

Each car is equipped with two sand boxes placed under the inside bulkhead bench, and operated by hand levers. The seat panels are either Brill patent malleable iron or whitewood. The cars are equipped with either Peckham 8-ft. wheelbase trucks, G. E.-800 motors and K-2 controllers, the ends of the car being trussed up, or Dupont trucks, Westinghouse 68 motors and K-11 controllers and no trusses, but $\frac{5}{8}$-in. x 8-in. steel sill plates. There are two lighting circuits, including standard $9\frac{1}{2}$-in. Neal electric headlight placed in center of dashers, and standard Nuttall trolley stands.

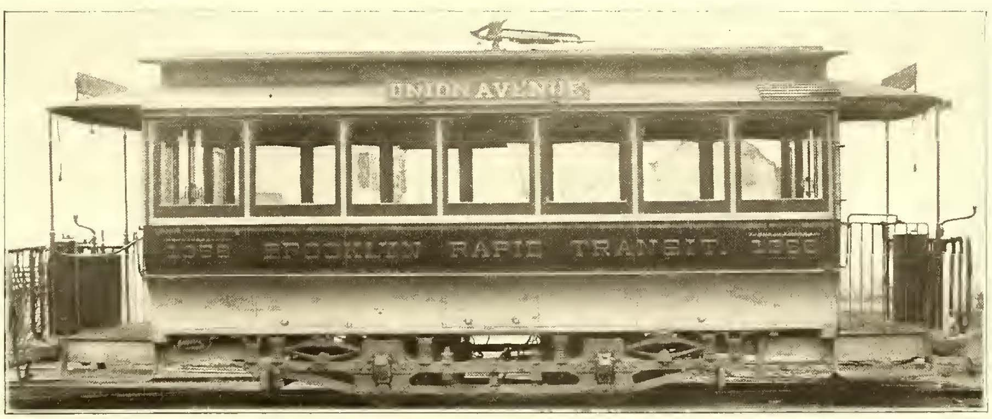
The standard double-truck open cars have thirteen benches (nine with reversible backs and four bulkheads). The length over all is 36 ft. 11 ins.; width over drip-rail, 7 ft. $10\frac{3}{4}$ ins.; width over pillars, 7 ft. 3 ins.; width over sill plates, 6 ft. $7\frac{1}{4}$ ins. The height from top of floor to under side of plate is 6 ft., and from bottom of sill to top of trolleyboard, 8 ft. $11\frac{1}{8}$ ins.

The roof is of monitor type with twelve fixed sash on each side, having white chipped glass with 1-in. plain border. Three drop sash are placed in each bulkhead, with pantasote curtains on Hartshorn rollers and Acme fixtures. The inside finish, as well as all corner posts and side pillars, is of white ash. The ceiling is of three-ply quartered oak veneer in three sections, and side panels of malleable iron of Brill pattern. The side curtains are of pantasote, with Hartshorn rollers and Acme fixtures, furnished with steel rods running in grooves in the side pillars. Folding steps are placed on each side, each supported by eleven drop-forged steel hangers. The dashers, angle-iron bumpers, draw-heads, platform gongs, etc., are all as described for the standard double-truck closed car. Two sand boxes are placed under the outside bulkhead benches. These cars are wired with two lighting circuits, including standard $9\frac{1}{2}$-in. Neal headlights.



DOUBLE-TRUCK CLOSED CAR, BROOKLYN

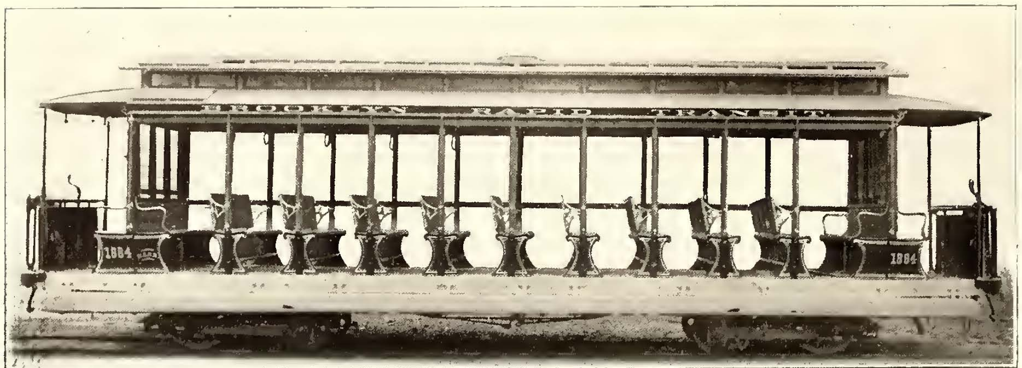
At present the standard signs for all cars in the borough of Brooklyn are as follows: For the side signs, the name of the street or avenue is painted in full on ground glass, fitted in two or more removable sash, which fit into the monitor sash openings on the side of the monitor roof. The end signs are in the same way painted on removable sash fitting into the end monitor sash openings. The side signs indicate the route, and the end signs indicate in a general way the destination. These signs are illuminated at night by the ceiling lights in the interior of the car.



SINGLE-TRUCK CLOSED CAR, BROOKLYN

In addition, there is installed under each bonnet a four-sided wooden sign, 4 ins. x 4 ins. x 24 ins., on each of the four faces of which is painted a different special destination, according to the lines on which the car operates. The conditions in Brooklyn necessitate signs being either removable or having a great number of different route and destination names. In summer on Sundays and holidays, on account of changed conditions of traffic, large numbers of cars must be diverted from their regular routes to lines that run to summer resorts, necessitating, of course, a complete change in signs. In Manhattan these conditions do not obtain, and a change of three or four signs is sufficient. This is amply provided for by the four-sided box signs in general use in the latter borough.

The standard fender in Brooklyn is of the Crawford type,



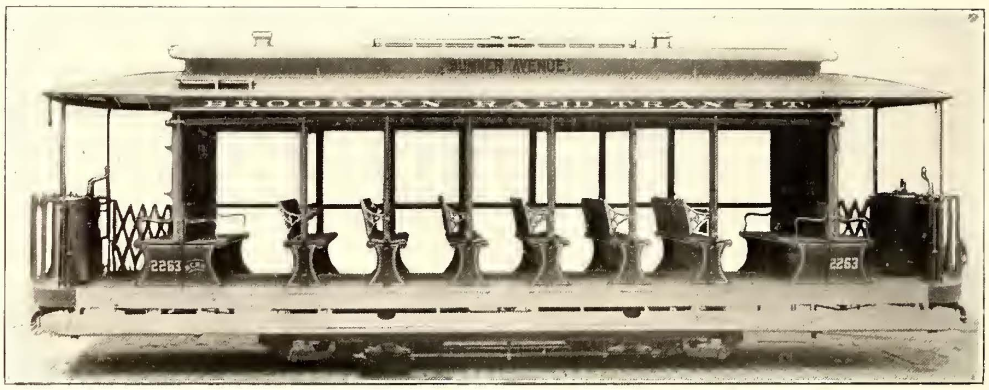
DOUBLE-TRUCK OPEN CAR, BROOKLYN

fitted with an annealed wire mat in mesh and with special hangers and guides, allowing it to be raised readily and placed out of the way on cars operating over the bridge. These fenders are made in the shops of the company, where special apparatus is installed for this purpose. In Manhattan the standard fender is of the Providence type, made by the Consolidated Car Fender Company. On the Broadway, Third Avenue and some other lines, however, no fender in front of the bumper is used, but an extra strong and efficient wheel guard is placed around the trucks. The extreme congestion of the vehicular and car traffic on these routes would possibly render a more cumbersome device impracticable. Here again the different operating conditions in the two boroughs is apparent, making a fender on each end of the car a necessity in Manhattan, whereas in Brooklyn one removable fender meets the requirements. In Manhattan a number of lines have their termini in crowded portions of the city, where cars must take a cross-over and the operating end of the car be changed. In Brooklyn there are either loops, so that no change is needed, or else the termini are in suburban districts, where there are both time and place to make such fender changes.

PARLOR CAR, BROOKLYN

All double-truck cars of the Brooklyn Heights Railroad Company in Brooklyn have Brill maximum-traction trucks, Westinghouse 68 motors, G. E. K-11 controllers, two G. E. type M. Q. circuit breakers placed under the bonnets, and one G. E. type M. D. lightning arrester. The single-truck cars have fuse box and motor switches, instead of circuit breakers. The standard wheels of this company for both single and double trucks are chilled cast iron, 33-in. diameter, $2\frac{3}{8}$-in. width of tread, $\frac{5}{8}$-in. flange, and weighing 420 lbs. They are mounted on 4-in. axles. The pony wheels on the Brill maximum-traction trucks are 20 ins. in diameter and mounted on $3\frac{3}{8}$-in. axles.

The painting of all cars of all types mentioned above is standardized. The main panels, letterboards and bulkheads are crimson lake, lettered and striped with gold leaf on the closed cars and aluminum leaf on the open cars. The cove panels, dashers, window sills and side sills are citron yellow with pale-blue striping. All bumpers, inside dashers, fender hangers and ironwork are Indian red. All the car trimmings, inside and out, are brass of standard design.



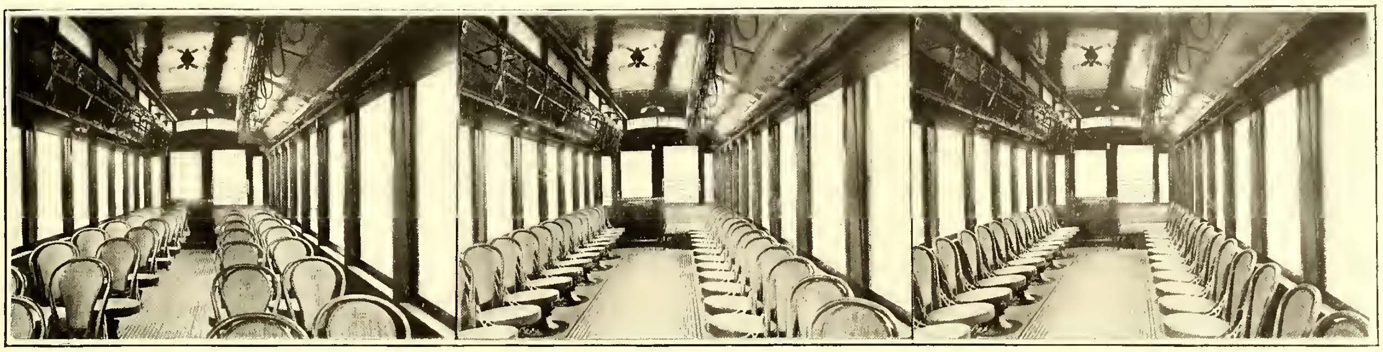
SINGLE-TRUCK OPEN CAR, BROOKLYN

The object sought after in build, as well as interior and exterior finish of the cars, has been simplicity, durability and strength, and the standardizing of all parts, with a view to making the cars attractive to the eye and at the same time economically maintained.

Besides the types of cars described above, there has been introduced in Brooklyn a combination car, of which the general dimensions are as follows: Length of body, 28 ft.; length over bumpers, 37 ft. $\frac{3}{4}$ in.; width over sill plates, 7 ft.; width over posts, 7 ft. 9 ins.; width over drip rails, 8 ft. $\frac{1}{2}$ in.; height from floor to plate, 6 ft. 1 in.; height from bottom of sill to top of trolleyboard, 8 ft. $11\frac{5}{8}$ ins.

The floor framing of these cars is the same as the double-truck open cars. The interior finish, body and roof of the car are similar in construction to the standard double-truck closed car, except that the main panels are narrower, leaving window openings $30\frac{3}{4}$ ins. x $38\frac{3}{4}$ ins.

Individual chair seats are installed in these cars (in place of the longitudinal side seats), and afford greater aisle room, while the possibility of a passenger occupying more space than alloted for one person is avoided. The inside finish is of cherry. The window sash can be removed by releasing the metal parting strips that are held



NOVEL SEATING ARRANGEMENT IN THE NEW TYPE OF BROOKLYN CAR

in position by three set screws through each pillar, and the car converted into an open car. The pantasote curtains, sliding in grooves cut diagonally across the pillars, furnish ample protection from the heaviest rain storm when sash are removed.

These cars are more fully described in a paper to be read at the meeting of the American Street Railway Association to be held in New York, Oct. 9-11, 1901. The accompanying photographs of the interior of the car indicate some of the various positions in which the revolving chair seats may be placed. The very apparent advantages of this type of car may be summarized as follows: Seating capacity equal to the longitudinal type seat, with 4 ins. more aisle space than in the ordinary closed car. Impossibility of anyone occupying more than one seat. Seating of thirty-six passengers, thirty-four of which are facing the direction in which the car is moving, whether the seats are in a transverse or longitudinal position. Possibility of changing position of seats from side to transverse, or vice versa, in less than one minute. Location of heaters back of seats, where it is impossible for them to come in contact and possibly damage passengers' clothing. Space provided under seats for setting away handbags or parcels out of the aisle. Possibility of removing window sash and converting car into an open car withing forty minutes, thus removing the necessity of a double-car equipment, as well as the necessity of either transferring motor and truck equipment from closed to open cars, or of having a double motor and truck equipment. Reducing in the ratio of three to one, as against the standard open car with running boards, the number of accidents, when the car is used as an open car, by compelling passengers to leave or enter car by the rear platform.

NEW TYPE OF BROOKLYN "COMBINATION" CAR

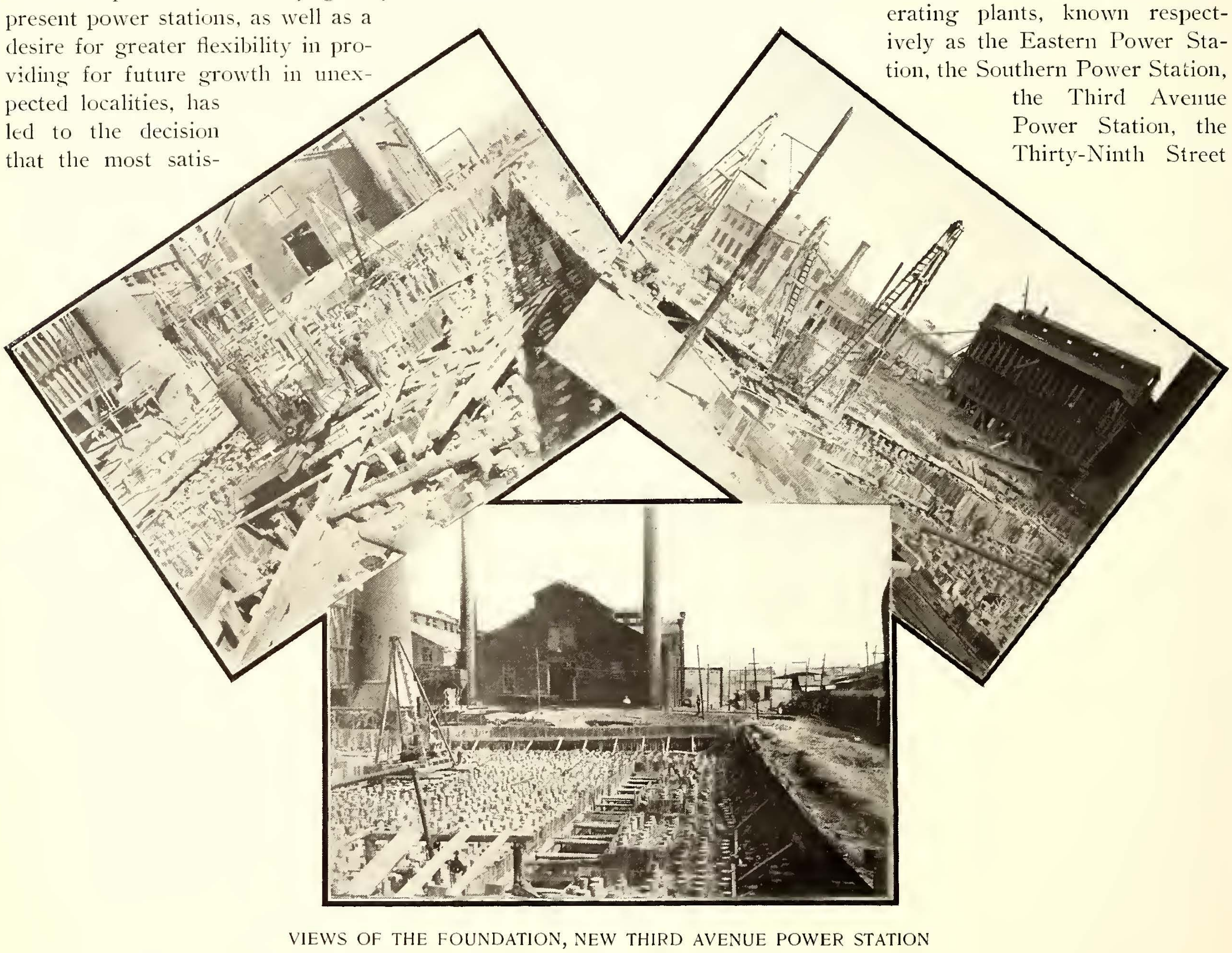
There has also been operated in Brooklyn during the past summer a regular parlor-car service between New York and Brighton Beach. These cars, on which an extra fare is charged, are limited to carrying twenty-five passengers, and are luxuriously fitted, having large and comfortable individual chairs, large observation platforms, an interior finish of mahogany or antique oak, and the exterior painted in royal blue, with gold lettering, striping and scroll work.

THE POWER STATIONS AND DISTRIBUTION SYSTEM OF THE BROOKLYN RAPID TRANSIT COMPANY

BY C. E. ROEHL

Chief Engineer of Power Stations, Brooklyn Heights Railroad Company

OWING to the abnormal increment which every year is made in the demands of the Brooklyn Rapid Transit Company upon its power supply, a large increase in its generating facilities has become imperative and is about to be made. Up to within a few months the system has been operated entirely by direct current, boosters being used where long distances necessitated, but the development of territory greatly removed from the present power stations, as well as a desire for greater flexibility in providing for future growth in unexpected localities, has led to the decision that the most satisfactory way to increase the power capacity is to adopt a system of high-tension distribution and rotary converters. This radical departure from present methods will allow the building of a large single station, most advantageously located for its supply of coal and water, yet able to distribute its current without excessive loss to any part of the system, and by placing the high-tension feeders underground, will obviate the further stringing of heavy overhead cables. Plans for this work have been completed, and in the following pages a description is given of some of the principal features of the development.



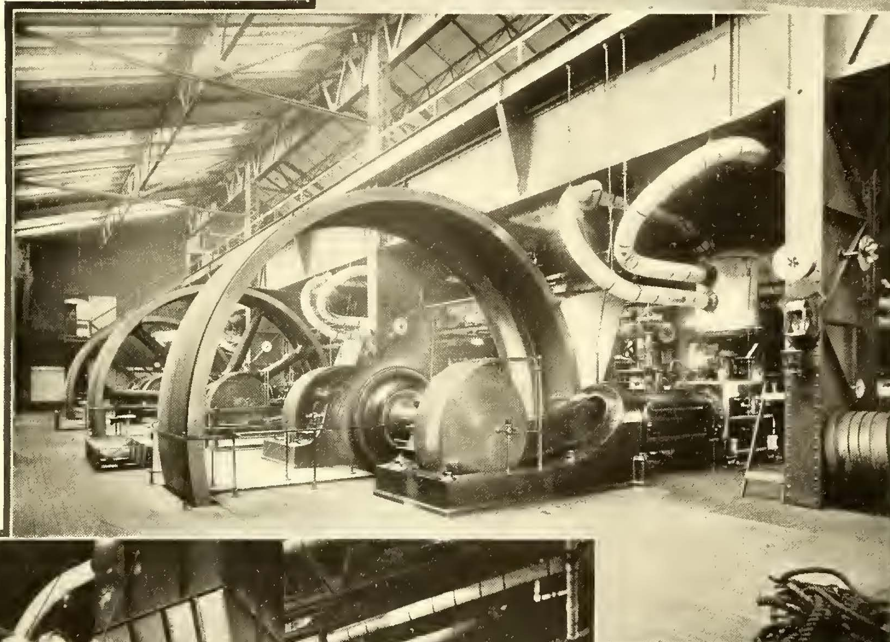
VIEWS OF THE FOUNDATION, NEW THIRD AVENUE POWER STATION

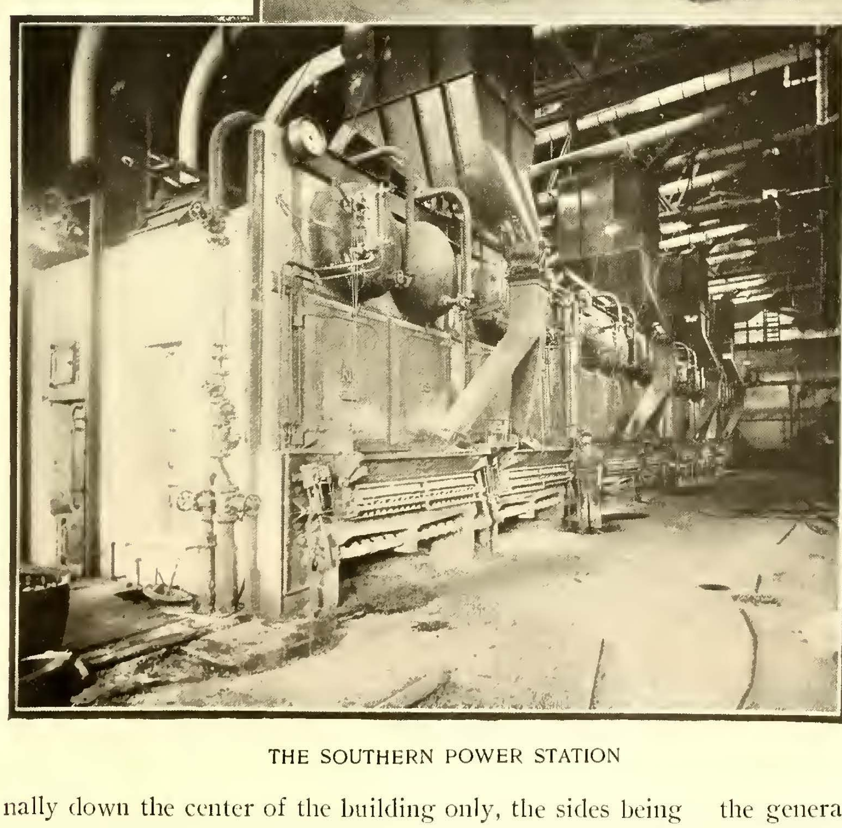
PRESENT EQUIPMENT

It will be of interest possibly before going into the details of the extensive improvements which are contemplated to briefly outline the equipments of the various power stations as they are at present, not including the cable power station on State Street, which is used to operate the Montague Street line solely, and which is of no interest from an electrical standpoint. There are now working five generating plants, known respectively as the Eastern Power Station, the Southern Power Station, the Third Avenue Power Station, the Thirty-Ninth Street Power Station, and the Bridge Power Station.

The largest of these stations, the Eastern Power Station, sometimes known as the "Kent Avenue," is situated at Kent and Division Avenues, and has a total capacity of 9200 kw. This output is obtained from four General Electric 1500-kw and two Walker 1600-kw generators. It will be remembered that the first General Electric generators which were installed in this station in 1893 were the largest railway generators which had at that time been built. The two Walker generators were installed in 1898. The engines of this station are of the cross-compound, condensing, direct-connected type, made by the E. P. Allis Company, and are six in number and of 2000 hp each. They have cylinders 32 ins. x 62 ins. x 60 ins. stroke, and run at 75 r. p. m. at 160 lbs. steam pressure. Each engine is connected to a Wheeler surface condenser. There are thirty-four boilers of 250 hp each, twenty-four of which were installed in 1893, when the station was built, and ten in 1898, when the Walker generators were added. Twenty-four of the boilers were made by the Babcock & Wilcox Company, and the remaining ten by the Aultman & Taylor Company, and are furnished with six economizers made by the Green Fuel Economizer Company, of Matteawan, N. Y.

The next largest station is the Southern Power Station, situated at Fifty-Second Street and First Avenue, directly behind the main repair shops of the company. This station was built 1892, and is of a somewhat peculiar type. It contains six 1000-hp cross - compound condensing Allis engines on the main floor, belted to twelve General Electric 400-kw four-pole generators placed on the second floor. These engines occupy floor space running longitudinally down the center of the building only, the sides being supported by the columns upon which the roof rests. By this means the dynamo tenders can at all times see the engines on the main floor and be in easy communication with the engineer. The switchboard is at the end of this second floor. The engines are 26 ins. x 48 ins. x 48 ins. stroke, running at 75 r. p. m., and 160 lbs. steam pressure. In 1898 two Westinghouse compound, automatic condensing engines of 500 hp each were added, one direct connected to and the other driving by belt a booster. The two boosters are of 1000 amps. capacity each. To each of the eight engines is connected a Wheeler surface condenser. Sixteen Babcock & Wilcox water-tube boilers of 250 hp each, equipped with Wilkinson automatic stokers and four Green fuel economizers, were installed in 1892, and have proved sufficient for carrying the extra load of the 1000-hp booster capacity.

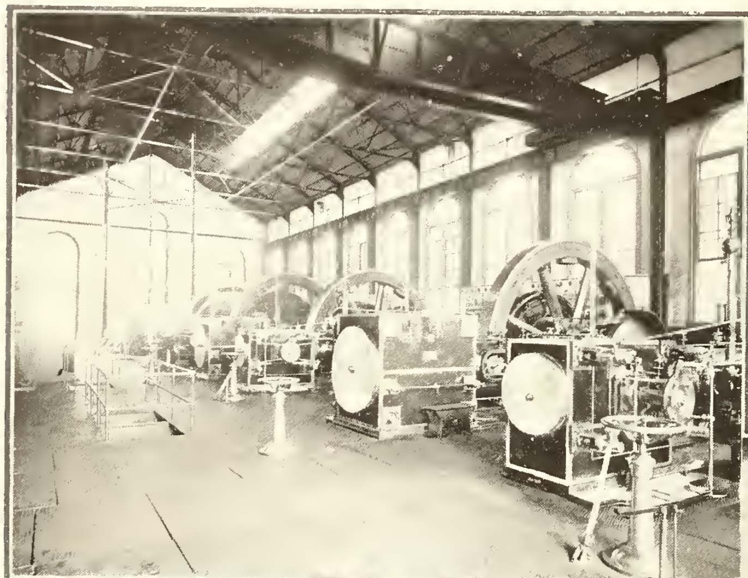


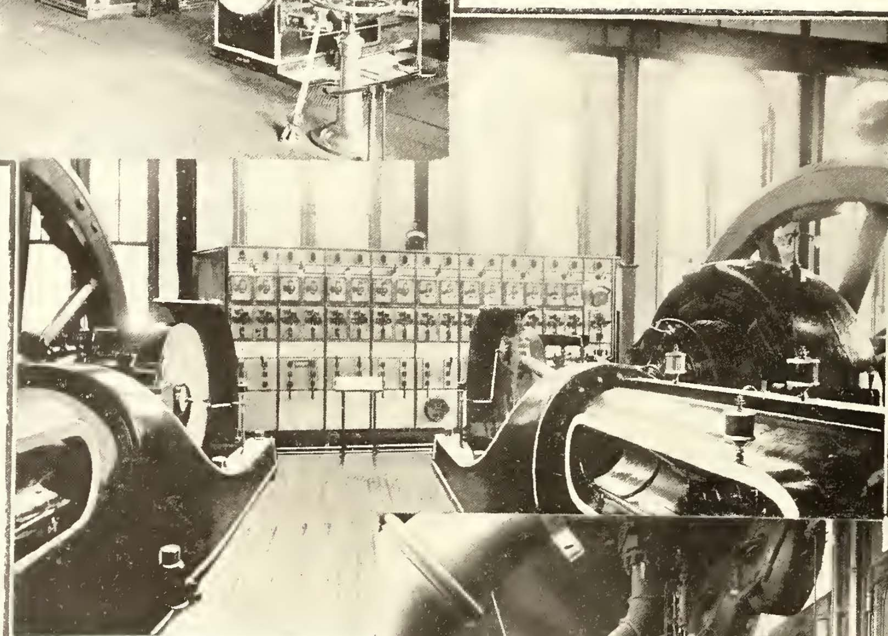


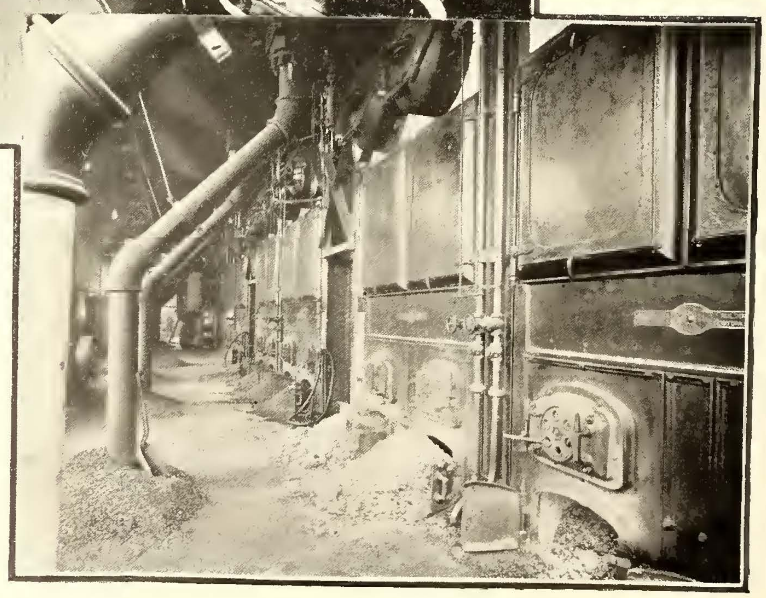
THE SOUTHERN POWER STATION

The Third Avenue Power Station, at Third Avenue and First Street, has a total capacity of 4400 kw, distributed among several different types of machinery. With the exception of two Walker generators of 800 kw each, which were installed in 1898, and are direct connected to Allis cross-compound condensing engines of 1000 hp each, the generators in this station are of the belt-driven type. Four Corliss tandem-compound engines, 22 ins. x 40 ins.

x 48 ins. stroke, 750 hp and 76 r. p. m. each, drive four No. 6 Westinghouse 400-kw generators. The engines were made by the C. & G. Cooper Company. Thre Cooper Corliss tandem-compound engines, 20 ins. x 36 ins. x 48 ins. stroke, 78 r. p. m., 550 hp each, drive three General Electric M. P. 400-kw. generators. A 16 ins. x 30 ins. x 48 ins. stroke Cooper Corliss tandem-compound engine of 75 r. p. m and 375 hp was installed in 1896 to drive a Westinghouse 230-kw booster, and a 16 ins. x 27 ins. x 16 ins. stroke Westinghouse compound automatic engine of 250 r. p. m. and 250 hp was installed in 1898 to drive a General Electric booster of 200 kw. All the engines in this station are connected to jet condensers. The boiler plant consists of twenty Babcock & Wilcox water-tube boilers of 250 hp each, all equipped with the Wilkinson automatic stokers. No economizers are installed in this station.







THE THIRTY-NINTH STREET POWER STATION

The Thirty-Ninth Street Station, at the foot of Thirty-Ninth Street, is the most poorly situated from a distribution standpoint of any of the company's stations, and is of the smallest capacity, the total output being but 3560 kw at the nominal rating. This station contains three Cooper Corliss cross-compound, direct-connected, 22 ins. x 40 ins. x 48 ins. stroke engines of 83 r. p. m. and 750 hp each, installed in 1895; two Cooper Corliss cross-compound, direct-connected 28 ins. x 52 ins. x 48 ins. stroke engines of 75 r. p. m. and 1500 hp each, installed in 1896, and Worthington surface condensers for these engines. The three smaller engines are connected to two M. P. Westinghouse 660-kw generators and one Westinghouse direct-connected booster of 560 kw, and the two larger engines drive two M. P. Westinghouse 1120-kw generators. The boiler plant consists of ten Babcock & Wilcox water-tube 250-hp boilers, which were installed in 1895, and which have no stokers or economizers.

GENERAL PLAN OF POWER IMPROVEMENTS

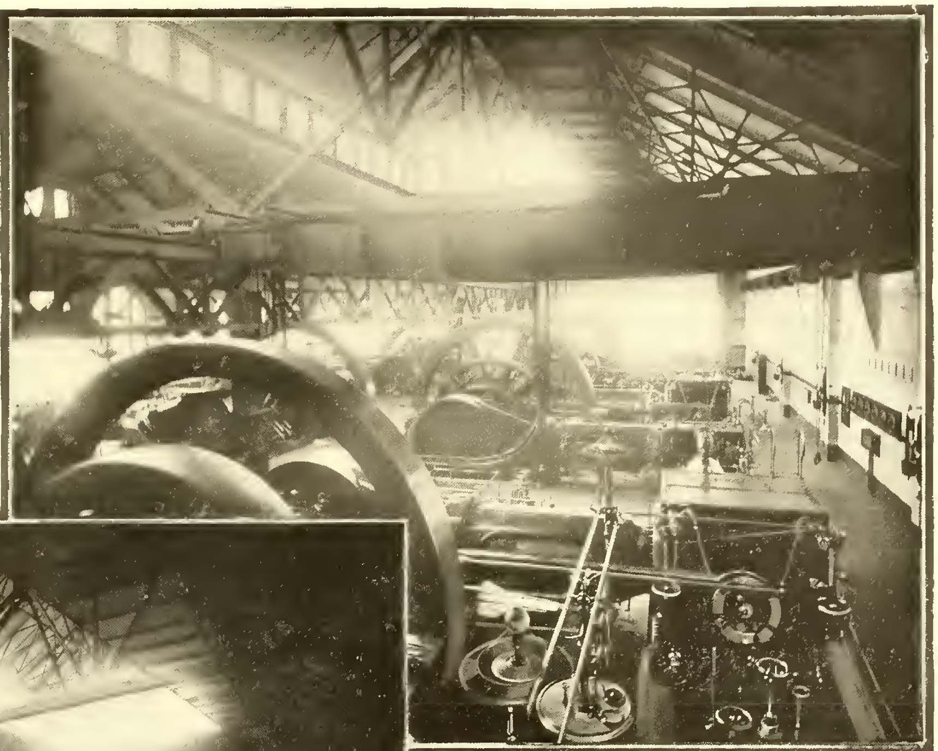
In the general plan of the power improvements which are contemplated the last station mentioned, that is, the Thirty-Ninth Street Station, will be dispensed with, and its territory will be supplied by the new station which is to be built at Third Avenue and First Street, adjoining the present Third Avenue Station. An addition of 36,000 hp in generator capacity will be made to the present installations, and of this increase eight-ninths will be located at the Third Avenue and First Street Station. The other 4000 hp will be added to the Eastern Power Station.

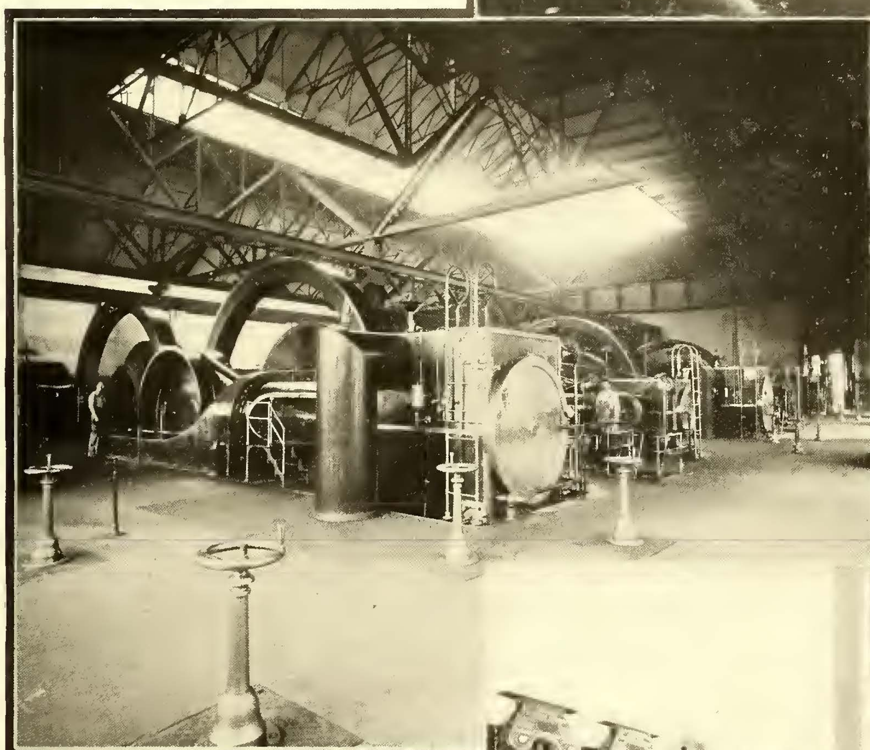
The Bridge Station, which is now equipped with steam for running the cable drums, will be completely transformed into an electric sub-station when the proposed improvements have been completed. This station at present contains one of the Brooklyn Rapid Transit's storage batteries, as well as an auxiliary steam plant for the city lighting plant and for heating the Brooklyn terminal of the bridge. There is a battery booster which, in the rearrangement of the station, will be moved from its present position to what is now used as the coal storage. In this room will also be placed 3000 kw in rotary converters for supplying the bridge lines. The bridge cable will be driven by induction motors receiving power from the Third Avenue Power Station. There will be two of these motors of 800-hp capacity each, and they will be wound for 6000 volts. The maximum electrical output of this station will be 8000 amps.

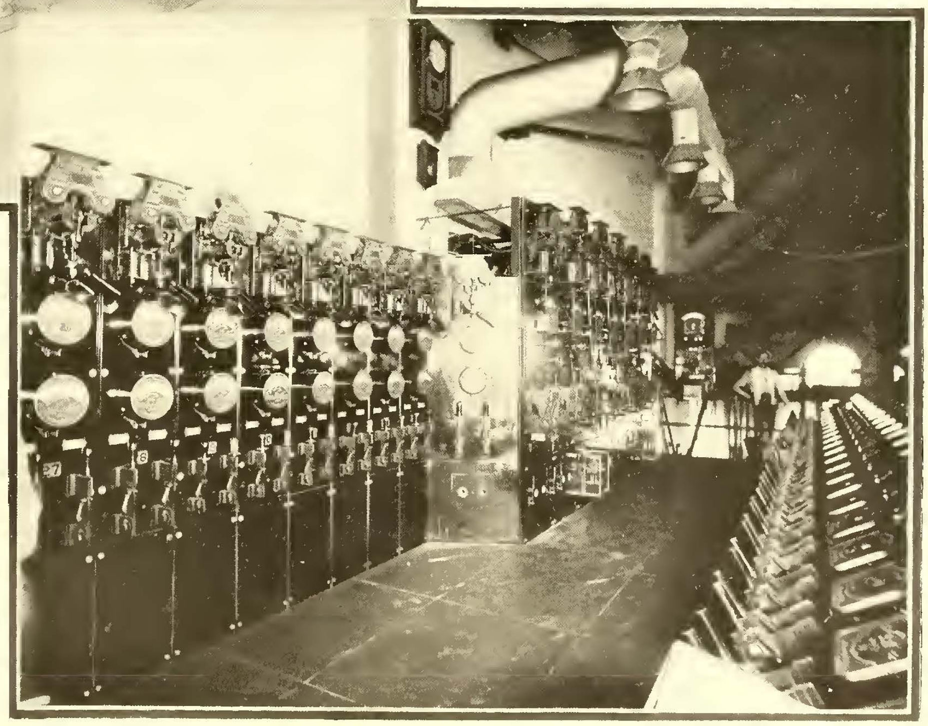
The Fifty-Second Street Station will be kept in operation as a combined steam and rotary station, its territory being increased by taking part of the district now supplied by the Thirty-Ninth Street Station, which, as mentioned above, will be shut down. In the Fifty-Second Street Station it will be necessary to install rotary converters, a sufficient increase being provided to enable the steam plant of the station to be closed down entirely during one watch and operated as a rotary sub-station from the new Third Avenue Station. On the other hand, during light loads it will be possible to convert direct current into high-tension alternating current for use at the various rotary sub-stations throughout the system. The output of this station will, therefore, be greatly increased by the addition of the rotaries, although the steam plant will furnish 8500 amps. as at present.

The capacity of the Eastern Power Station will be increased by the addition of a seventh direct-connected unit of twice the capacity of those now installed. This unit will consist of a 4000-hp Allis-Chalmers engine and a direct-current Westinghouse railway generator similar to those which will be installed in the new Third Avenue Power Station. This will bring the capacity of the Eastern Station up to 16,000 hp. The new unit will be installed in what is now used as a storeroom. In order to make the increase in steam distribution, the capacity of the boiler plant must be also enlarged, but the present station will admit of an increase of only 500 hp in boilers. The entire plant of thirty-six boilers will probably be equipped with mechanical stokers and a forced-draft system adopted on the boilers on the second floor. The maximum load on the enlarged station will be 26,000 amps.

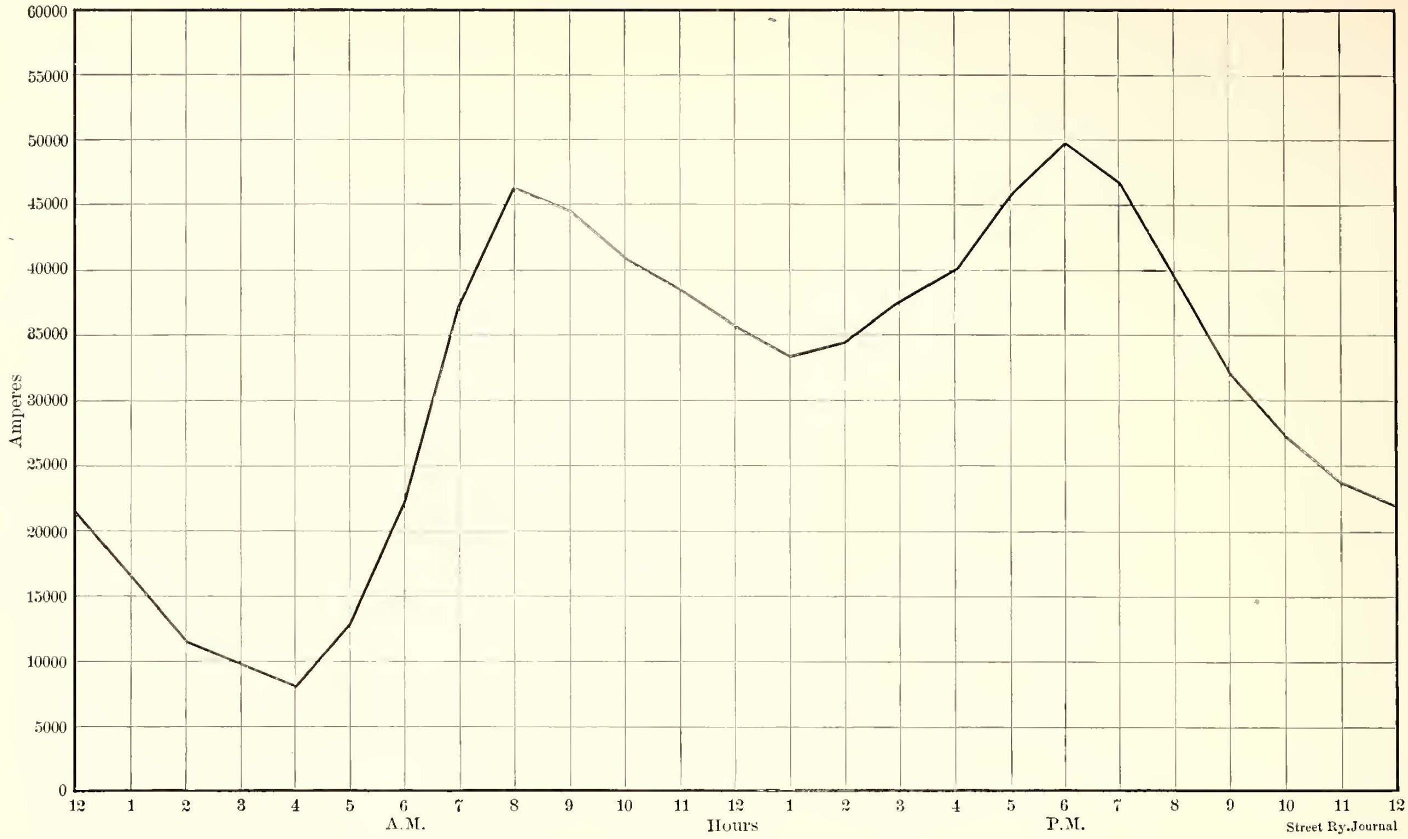
The new main 32,000-hp power station is situated at Third Avenue and First Street. The site of this station has been selected on account of its superior advantages as a distributing center, and the best facilities exist for obtaining coal, which can be received directly from canal boats from the Gowanus Canal. The

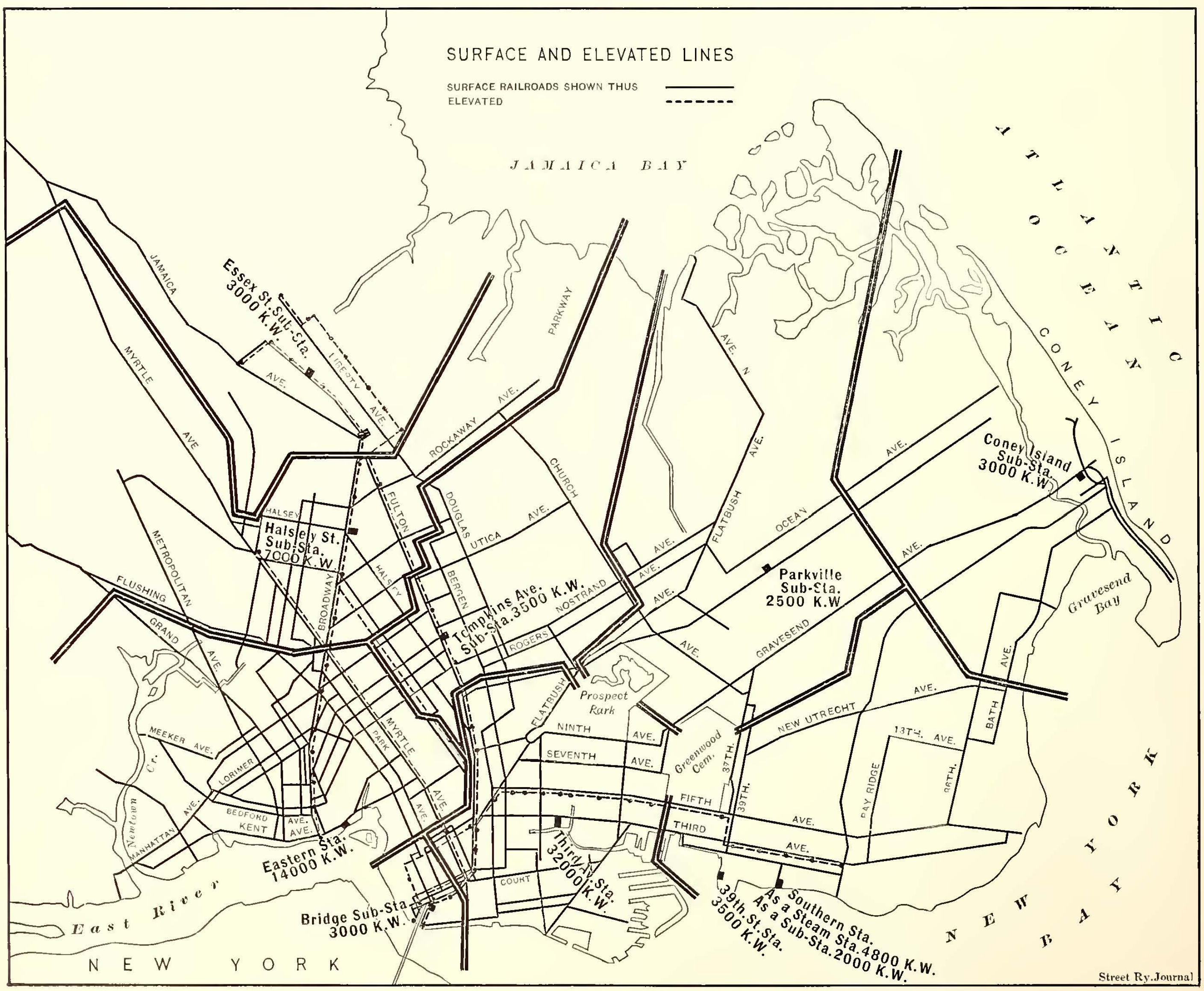






THE EASTERN POWER STATION



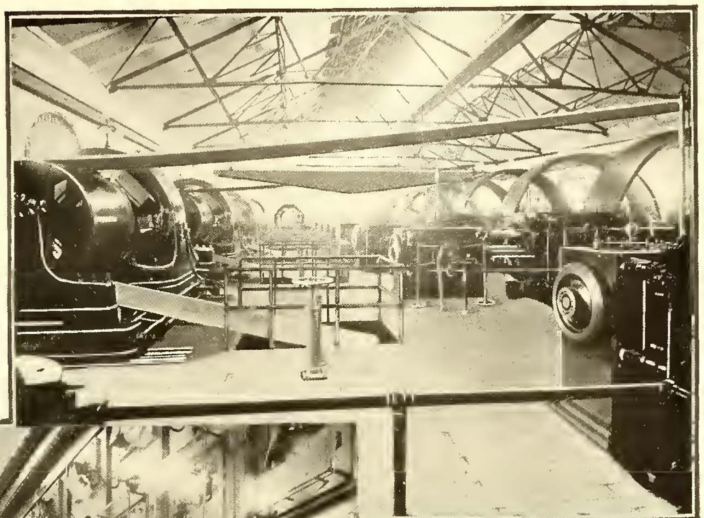
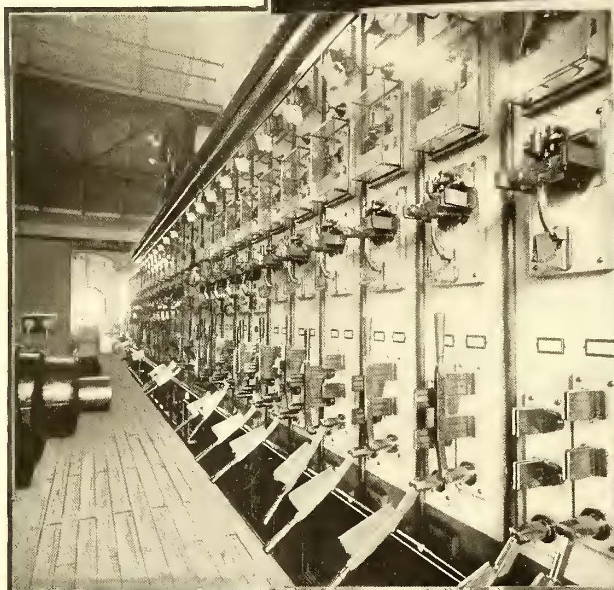
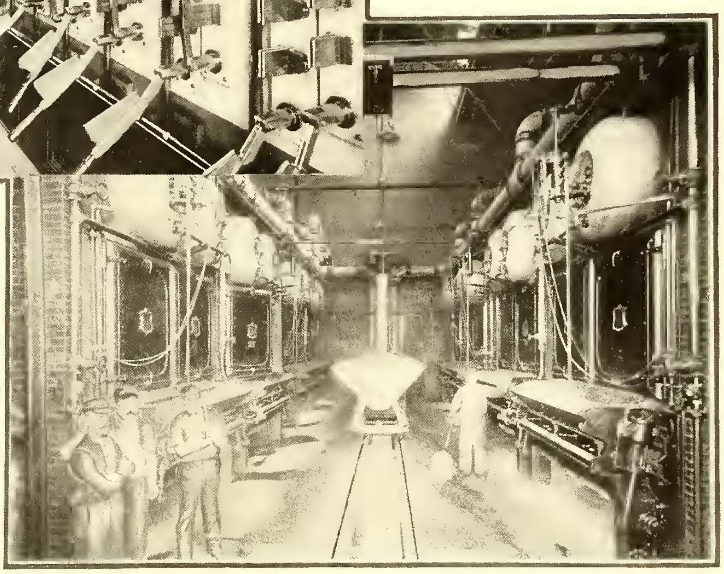


PLAN OF PROPOSED POWER DISTRIBUTION AND PRESENT TOTAL LOAD DIAGRAM plot of ground is sufficiently large to provide for all future growth, and at the same time there is an abundance of room for the storage of coal.

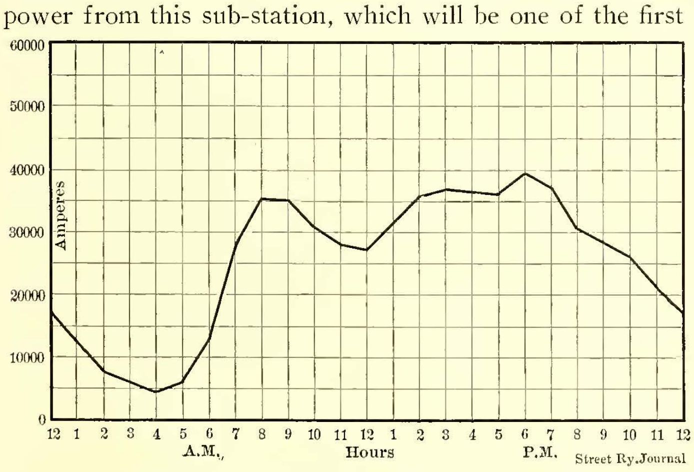
SUB-STATIONS

From this station will be operated the following sub-stations: Halsey Street and Broadway, Fulton and Essex Streets, Fulton Street and Tompkins Avenue, Coney Island, Brooklyn Bridge, Southern Power Station and Parkville. The Halsey Street and Broadway sub-station will require an ultimate capacity of seven 1000-kw rotary converters, and will also contain a booster for the Bowery Bay line. This booster is already installed and in operation, two of the old Ridgewood Station generators, which were saved from the recent fire, having been rewound for this purpost. The general scheme of improvements, however, is not formulated with the intention of employing boosters on the system, and it is the intention after the alternating-current generating station is completed and the rotary converters installed to do away with this machine. Before the ultimate demand on the station of 14,700 amps. is reached, therefore, the booster will be removed and a sub-station erected in the vicinity of Maspeth. The Essex and Fulton Street sub-station in East New York will be a combined rotary and storage-battery sub-station. It will contain two 1000-kw rotary converters and the two storage batteries already in use at East New York. Of these storage batteries one is the portable battery used at Brighton Beach, and removed in the winter time to East New York, which is installed on the elevated railroad cars, and was described in the Street Railway Journal a few months ago. These batteries, as well as that at the bridge, are composed of chloride accumulators, made by the Electric Storage Battery Company. There has been no provision made for increasing the storage battery capacity of the system in the intended development, the two batteries being allowed to retain their present size and position. The power from this sub-station, which will be one of the first new stations to be constructed, will be used principally on the Jamaica surface lines and the elevated lines, and the maximum load will be 6500 amps.

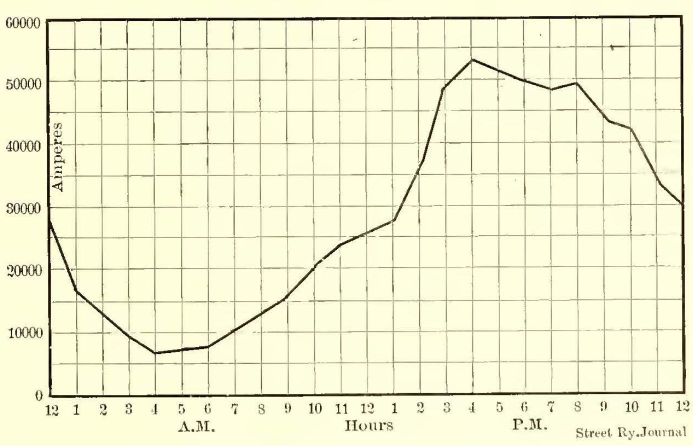
The Coney Island sub-station is located on the company's property at the Culver terminal, Coney Island, and its capacity will be four 500-kw and one 1000-kw rotary converters, giving a maximum load of 5850 amps. The station structure is now completed and the

THE PRESENT THIRD AVENUE POWER STATION



TOTAL LOAD DIAGRAM, SUMMER SATURDAY



TOTAL LOAD DIAGRAM, SUMMER SUNDAY

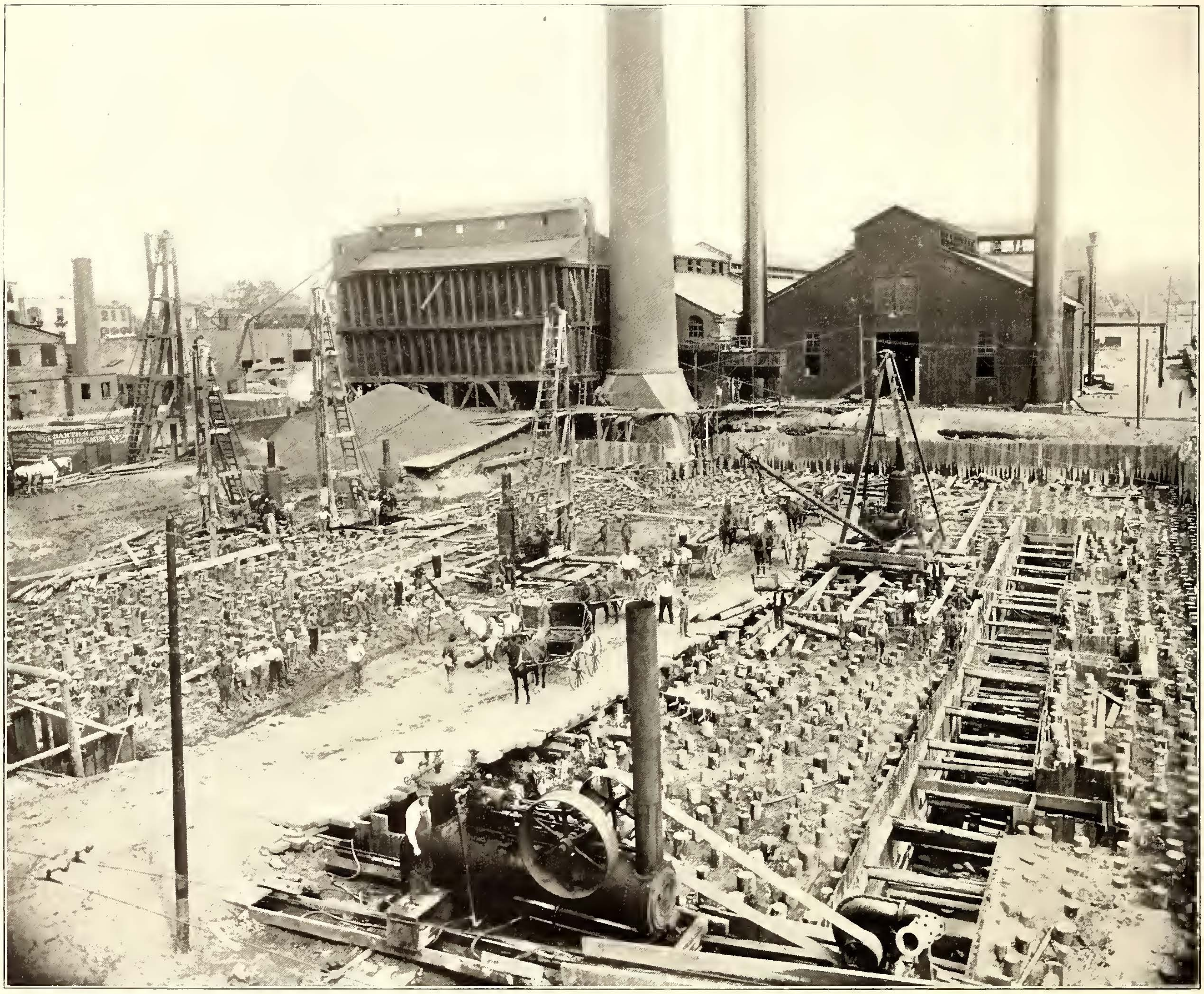
1000-kw rotary installed. This rotary was started on Aug. 31, 1901, using purchased high-tension current from the lighting station at Sixty-Fifth Street.

The Parkville sub-station will be located in the vicinity of the Brighton Beach line in Flatbush, and will furnish power to the district now supplied from the Thirty-Ninth Street Power Station. As the company does not own property at this point, the site will have to be purchased, and the exact position is therefore not yet determined. It will contain two 1000-kw and one 500-kw rotary converters, the maximum load being 5800 amps.

The Tompkins Avenue and Fulton Street Station will be located on the company's property on Fulton Street near Tompkins Avenue, in what was the old Tompkins Avenue depot. It will contain three 1000-kw and one 500-kw rotary converters, and the maximum load will be 7800 amps. This completes in a general way the entire intended power development of the Brooklyn Heights Railroad Company, but, of course, before it is entirely completed there may be minor changes made in the scheme and the possible underestimated augmentation in the traffic of certain sections may produce the necessity of larger additions at those points.

THE FEEDER SYSTEMS

Within the last year the company has inaugurated the new system with the placing of its feeders underground. The recent imperative demands for greater power than could be obtained from the company's stations has enforced the buying of current from other companies, and the most natural solution of the difficulties which beset the engineers was to take the 6500-volt high-tension alternating-current supplied by the Kings County Electric Light & Power Company. The railway company has adopted a standard size of cable for all its high-tension work. This is a triplex, paper-insulated, lead-covered cable, each conductor having a cross section of 250,000 circ. mils. These cables will be laid in terra-cotta ducts placed under the streets of the city.

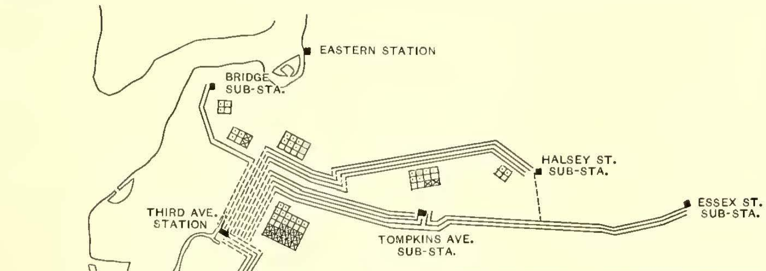


WORK ON THE FOUNDATION OF THE NEW THIRD AVENUE STATION, FROM A RECENT PHOTOGRAPH

The diagram on the next page shows in general the proposed arrangement and gives the number of ducts, loads in amperes, etc. A map is also given of the Borough of Brooklyn, showing the districts which will be supplied by the sub-stations, and giving at a glance the general features of load and location of stations. In the map the different districts are separated by heavy double lines.

THE NEW THIRD AVENUE POWER STATION

The new power station which is now being constructed is naturally the most important factor of the development. This station has been designed and is being built on what is accorded to be the very best lines of railway power house construction, and every attempt is being made to produce a model central station for railway distribution. The building will be placed on a plot of land owned by the company



SUB STATION	DISTANCE 3RD. AVE. STA. TO SUB STATION	NO. OF H.T.A.C. TRIPLEX CABLES	LOAD IN AMPERES
Halsey	23140	4	14725
Tompkins	16020	2	7780
Essex	33880	2	6480
Bridge	11650	3	7795
Parkville	Conduit 8030 Pole Line 15080	2	5820
Coney Island	Conduit 8410 Pole Line 27420	2	5845
Southern	15700		3610

EXPLANATION OF SYMBOLS.

Note: Each square represents one duct.

Ducts occupied by D.C. Feeders.

Ducts occupied by A.C. High Tension Triplex Cable.

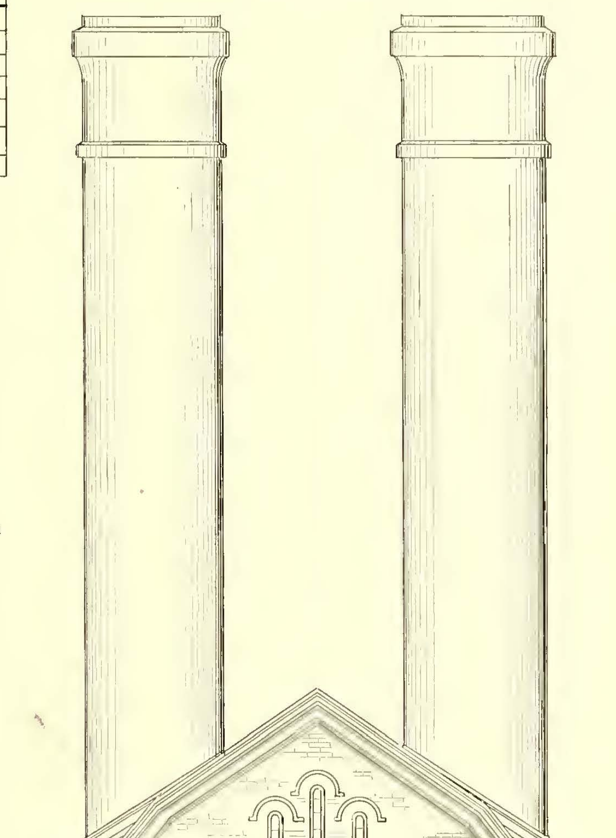
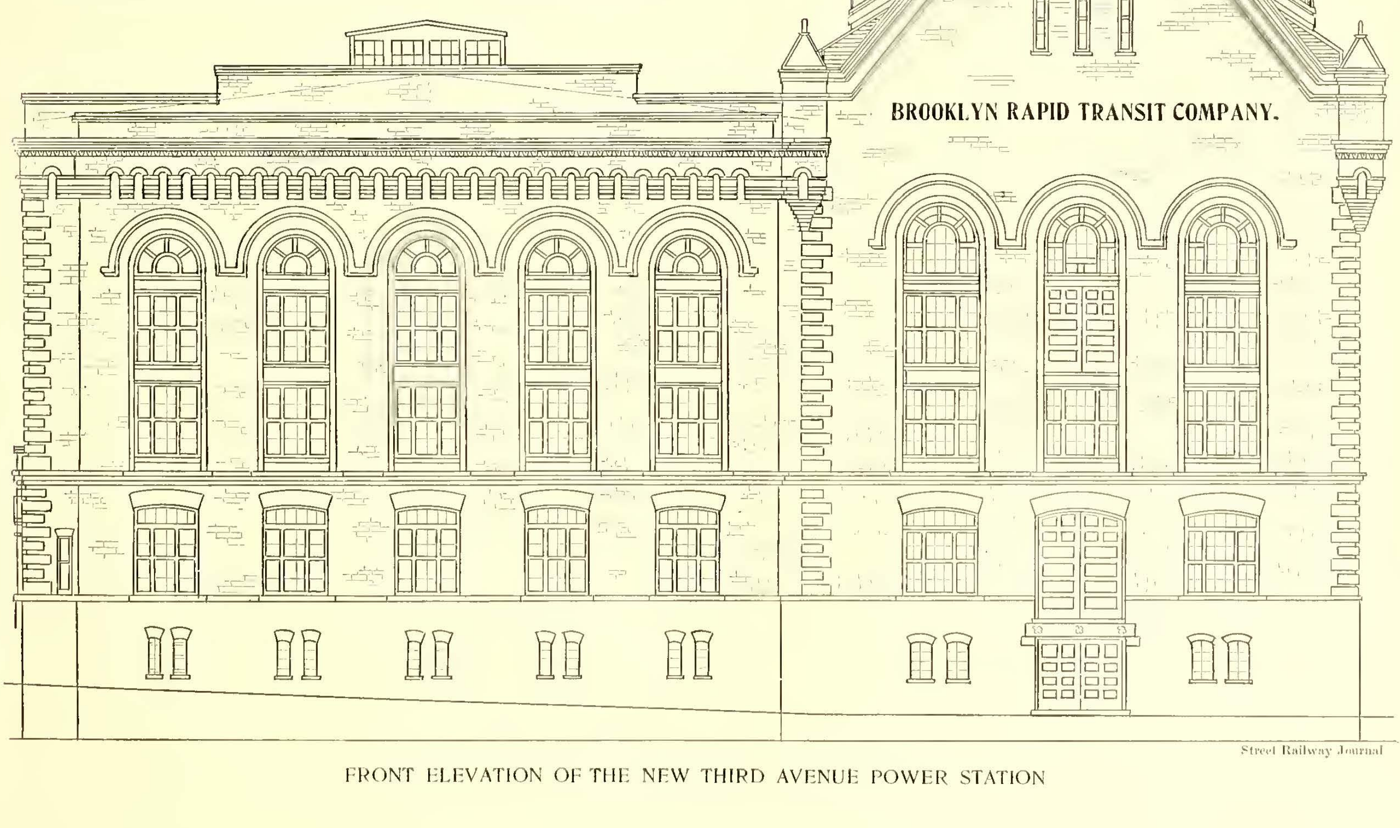
Ducts reserved for A.C. High Tension Triplex Cable.

MAP OF THE FEEDER SYSTEM

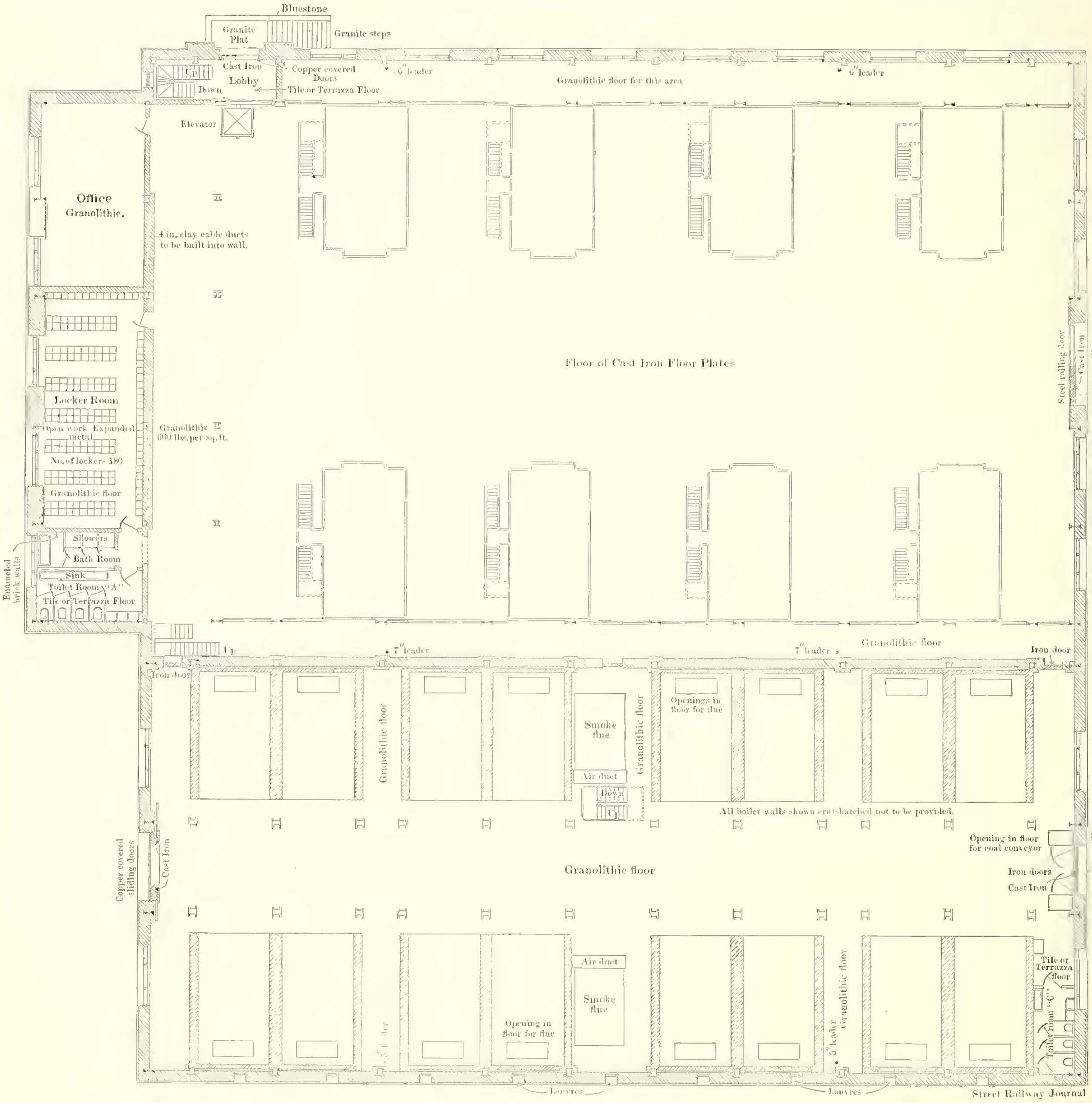
adjacent to the present station, and will be divided into two portions, as shown in the accompanying elevation. The southern portion is to be used for the engine and dynamo room, and the northern portion, which is considerably higher, will contain two stories of boilers, with coal storage above.

The building is built entirely on piles surmounted by concrete, that under both the boiler section and the engine room being about 6 ft. in thickness. It will be of red brick with bluestone trimmings, and will follow out in its architectural lines what is now the standard Brooklyn Rapid Transit style of appearance. The words "Brooklyn Rapid Transit Company" in large iron letters are placed on the upper portion of the Third Avenue front. This front of the building is 183 ft. 3 ins. in length. The depth of the part containing the engines and dynamos is 186 ft. 9 ins, and that which is to be occupied by the boilers is 20 ft. shorter, being but 166 ft. 9 ins.

The boilers are arranged in banks of two, each

FRONT ELEVATION OF THE NEW THIRD AVENUE POWER STATION boiler being of 650-hp capacity, and the first installation will consist of twenty-four boilers. These will be arranged on each side of the building in two stories, six boilers being placed in each tier. The boilers are of the Babcock & Wilcox type, made by the Aultman & Taylor Company, and will have 6500 sq. ft. of heating surface each. There will be no economizers in the first installation, but space will be left for equipping the plant with them if desired in the future. The feed-water will be supplied by Buffalo pumps and heated by enclosed feed-water, whose make is to be decided later.

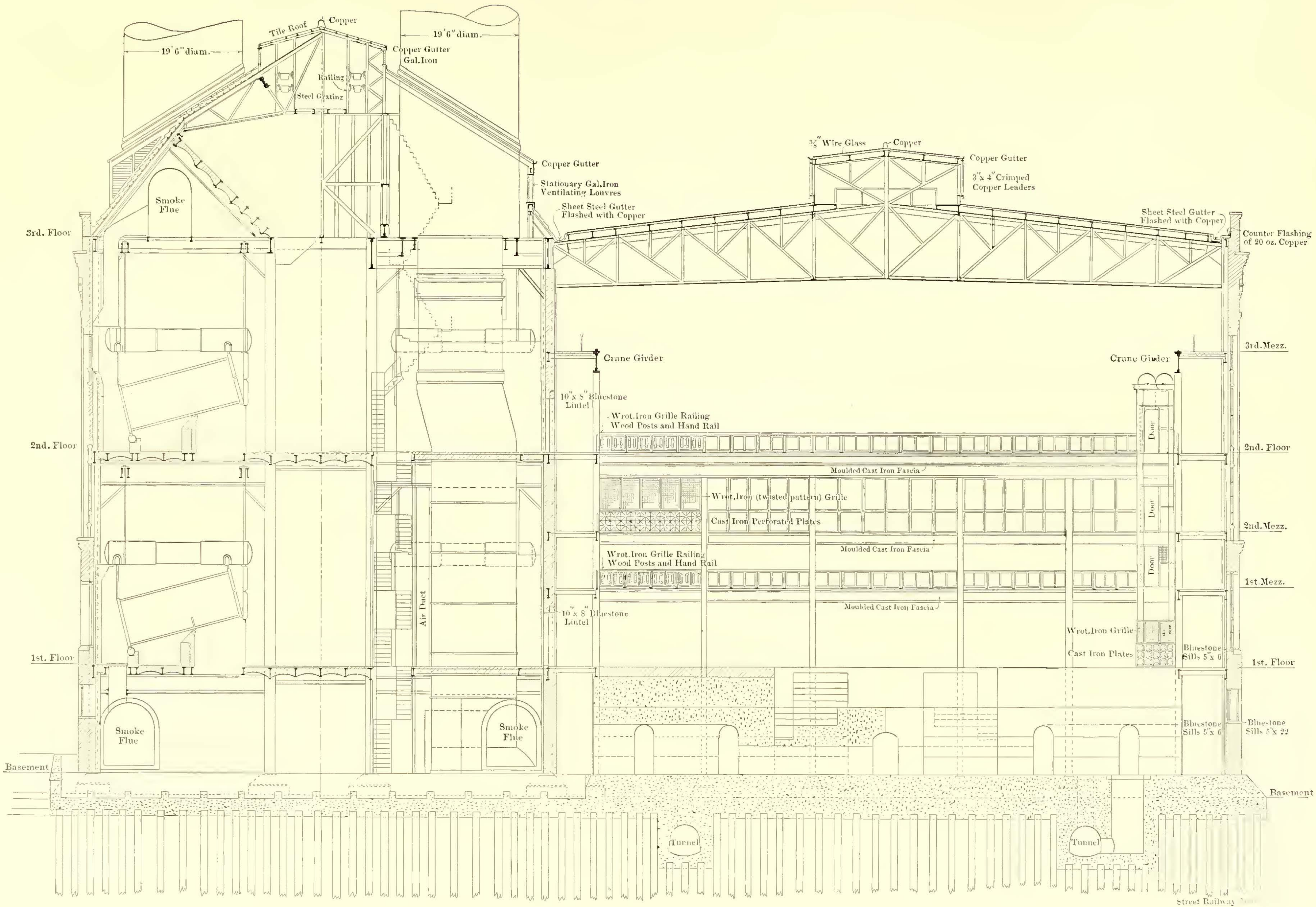


PLAN OF NEW THIRD AVENUE POWER STATION

There will be two stacks, one rising on each side of the boiler rooms. These stacks are of the self-supporting steel type, with brick linings, and are to be 217 ft. in height. The plan of the first floor, presented herewith, shows the arrangement of the boilers as it will be when the total capacity of the station has been installed. At present, however, the four units shown at the end of this floor and the corresponding four units immediately above them will be omitted on the west end of the building.

The boilers will be equipped with automatic stokers of a type not yet decided upon. There will also be installed a forced-draft system in order that the steam plant may be operated at its maximum capacity during rush hours. The coal and ash handling system will be most complete. The first installation of coal conveying apparatus will be capable of moving 125 tons of coal per hour, and provision has been made in the designs for duplicating this capacity if desirable. All coal will be weighed before going to the coal pockets. The ashes will be removed from the station by cars operated by an electric locomotive.

The engine room will contain at first but six 4000-hp generating units, placed in two rows of three each, leaving space at the western end for the symmetrical arrangement of the two other units which it is expected to install later on, one at the end of each row. These generating units consist of Allis-Chalmers vertical, marine-type condensing engines, direct connected to Westinghouse generators. Four of these generators will be of the three-phase, alternating-current, revolving-field type, generating current at

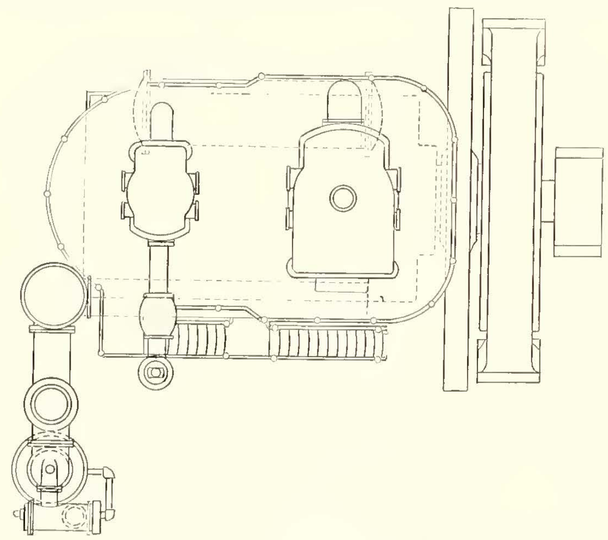


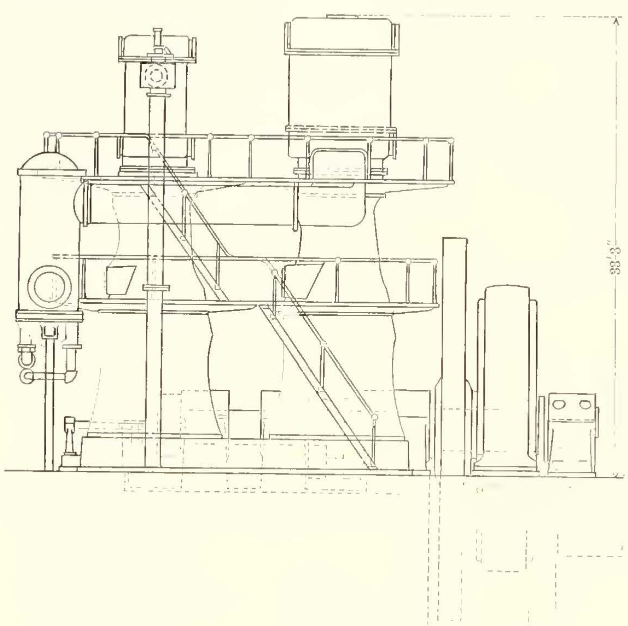
CROSS SECTION OF NEW THIRD AVENUE POWER STATION

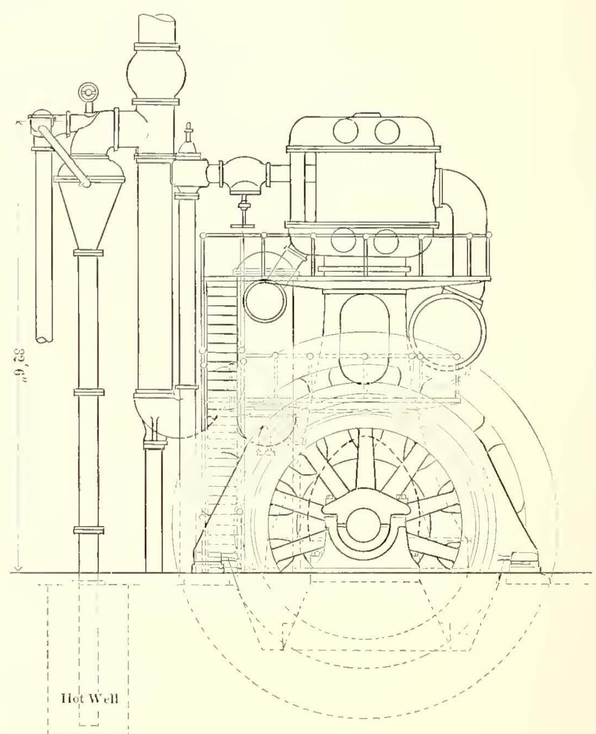
6600 volts and 25 cycles. The other two generators will be Westinghouse multipolar railway generators, delivering current at 575 volts. The engines and generators are similar in design to those furnished the Metropolitan Railway Company, of Manhattan, but the relative positions of the cylinders, fly-wheel and generator is somewhat different. The accompanying drawing shows the general arrangement. There are three bearings, one of which is an outboard bearing on the far side of the generator. The fly-wheel is placed between the generator and the middle bearing, and the low-pressure cylinder is the nearer to the fly-wheel and generator. The connecting rod of the high-pressure cylinder is connected to the shaft by a disc crank at its end. The sizes of the cylinders are 42 ins. x 86 ins. x 60 ins. stroke, and the engines run at a speed of 75 r. p. m. On both high and low-pressure cylinders the valve gear is of the Corliss pattern, and the steam pressure is 175 lbs. To each engine is connected a Worthington condenser. The diameter of the two engine bearings is 27 ins., and each is 42 ins. in length, the central bearing being divided as shown; the outward bearing is 30 ins. in diameter and 56 ins. long. In the generator the diameter of the shaft, which is of hollow-forged steel, is 35 ins. The weight of the 28-ft. fly-wheel is 240,000 lbs. The first installation of exciters will consist of two units. One of these machines will be engine driven, the other motor driven. In addition, space will be left for a storage battery to furnish exciting current in the future if deemed desirable.

The interior of the engine room is furnished with a series of galleries to provide accommodation for the switchboard apparatus and feeders. These galleries are constructed in a large part from wrought iron, and are reached by an elevator and iron staircases. The final arrangement of the switchboards, etc., has not yet been decided upon, nor have any contracts for this work been given out. The room will be lighted in a most efficient manner by large windows on the side away from the boiler room and on the ends, as well as from a glazed monitor in the center of the roof. A 50-ton traveling crane, furnished by Alfred Box, of Philadelphia, will span the entire width of the room, furnishing every facility for the erection of the engines and generators and their future repairs.

When the new station is completed, the adjoining Third Avenue Station will be kept as a reserve. This will give the company a large auxiliary supply of power which can always be called upon. The possibility of obtaining high-tension current from the rotaries at Fifty-Second Street will also serve to counteract the effects of any partial interruption of the alternating-current supply, and the flexibility of the distributing system will make it impossible for local disturbances on any part of the system to seriously affect traffic on a single division. It is confidently expected that the work as detailed above will be completed during the year 1903. Contracts have been let for nearly all the machines, and their early delivery is assured. Of the rotary converters sixteen have been ordered from the Westinghouse Electric & Manufacturing Company. Eleven of these are of 1000 hp each, and the remaining five of 500 hp each. With this order is one for a full equipment of static, air-blast transformers for installation with the rotaries.







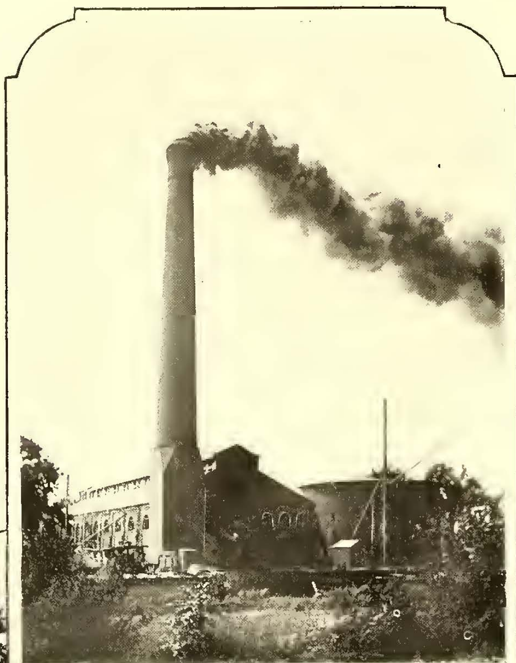
4000-HP. GENERATING UNITS FOR NEW THIRD AVENUE STATION

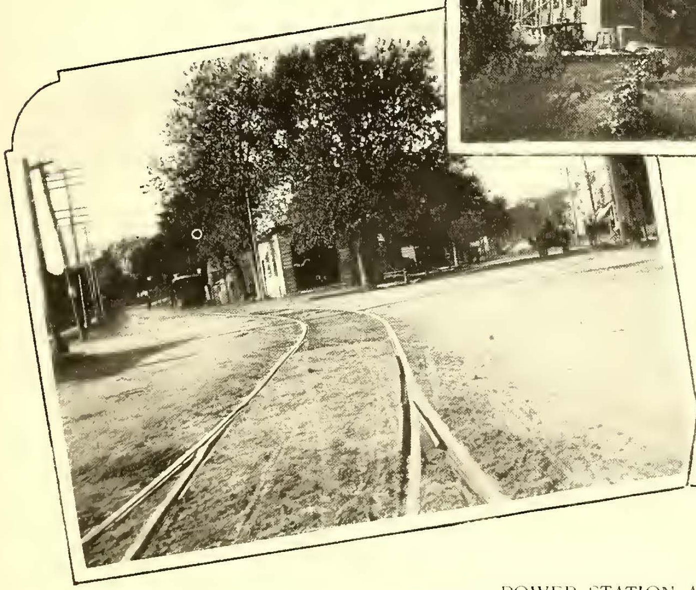
THE TROLLEY IN THE BRONX REGION

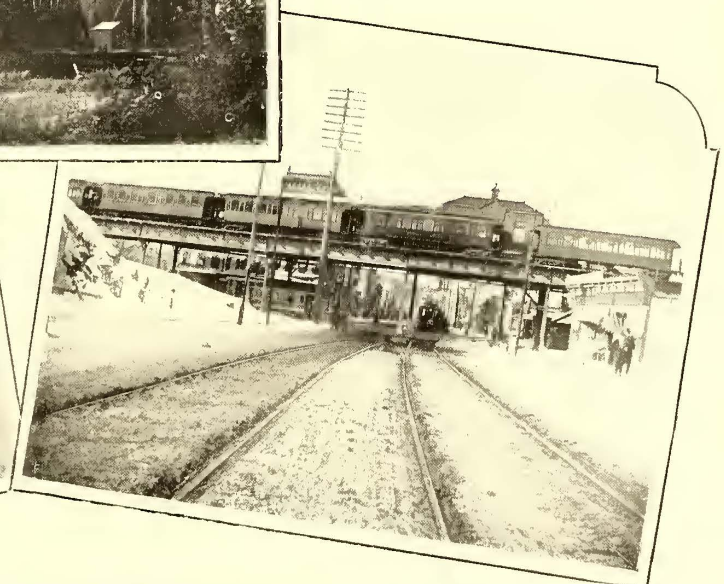
BY EDWARD A. MAHER

President, Union Railway Company

FOR many years, in fact during nearly the whole of the closing quarter of the nineteenth century, the overflow of the population of Manhattan Island was directed to the east and west. New Jersey throve upon the influx of Knickerbocker householders quite as much as upon the taxation of New York corporations ostensibly domiciled within her borders; while the completion of Brooklyn Bridge invited such a rush into Kings County that it will be a decade at least before additional bridges can give relief by overtaking the congestion. Thus checked in his acquisition of a home and elbow room by the Jersey ferries and marshes to the west, and by the Long Island lack of transportation facilities to the east, the average New Yorker would have confronted a serious problem had not the Union Railway system afforded him an escape to the fine plateaus and broad pastoral stretches of Westchester







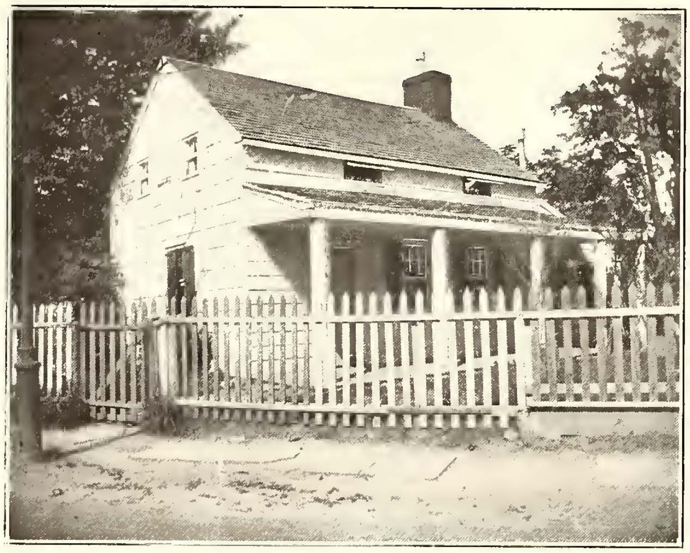
POWER STATION AT WEST FARMS

IN WESTCHESTER VILLAGE

TREMONT AVENUE LINE UNDER THIRD AVENUE L

County. In fact, when the enterprise of the company opened up that beautiful region to which the New York Central was never able to give more than a terribly limited commuter service, the exodus from Manhattan Island was so swift as to be one of the compelling causes for the creation of Greater New York. That which since 1874 had borne the rather deprecatory cognomen of the "Annexed District," had jumped by 1900 from 30,000 inhabitants to a residential population of 200,000, and from a valuation of $23,000,000 to at least $150,000,000; figures which again have now risen in a brief year or more to 250,000 inhabitants and an assessed valuation of $180,000,000. This fair land of ours, particularly out West, has given many startling examples of cities growing up in a night, but it may fairly be questioned whether the new Borough of the Bronx is not the most conspicuous instance of the kind, all things considered. Those who have striven to upbuild the Union Railway system have some pride in the share it has taken to develop a region which, if it were not now an integral part of the metropolis, would rank high in the list of the great cities of the Union. Lest this may sound like an exaggeration, let me premise by noting the fact that the forty odd Union Railway routes ramify through 42 square miles of territory—a proportion that in itself is eloquent as to the pioneer zeal with which the company under my administration has opened up the region in which it operates. Bounded by 32 miles of water front that are washed by the waters of the Sound, the Harlem River and the Hudson River, lie the districts within which the millions of New Yorkers must hereafter make their homes if they are to live in comfort and to travel pleasantly to and from their work.

The character of these districts has already been determined, and is remarkable for its diversity; but, as every street railway manager knows, it is not always easy to decide just where the public will head next in any new area of such size. The early stages of the history of the Union Railway Company, or its underlying corporations, were peculiarly harassed by this uncertainty. Added elements of doubt in the problem were contributed by what I may term the physical politics of the situation. It was clear to every observer, for instance, that population would be likely to cling from habit to the banks of the channel



EDGAR ALLAN POE'S COTTAGE, FORDHAM

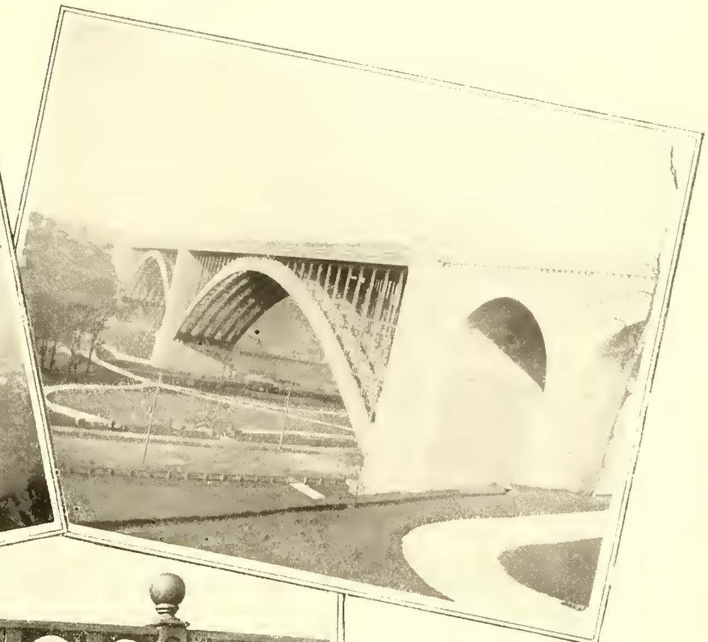
through which, now fenced in by walls of granite and steel, the great Vanderbilt trunk line touches its Atlantic terminal; and one could do some figuring on that. But it was also clear that while New York would have to reserve its future parks in the Bronx region, their topographical limits must be known before any kind of trolley network could be laid out scientifically. To-day, as the development of the last few years, the Union territory embraces in the region deservedly known as the "Great North Side" no fewer than 3849 acres of park and 212 acres of parkway. There is nothing like this anywhere else in the world in the way of breathing space for purposes of recreation, but to indicate the difficulties raised I need only point to the fact that in all these long years, with a very dense population along the east and west walls of Central Park, the street railways of New York have only succeeded in penetrating across that area by one short transverse line. As it is, the Union Company is making herculean efforts to render access to the parks and across them easy for everybody, but it will need intelligently liberal co-operation from the authorities in the grant of facilities for reaching central points within the parks if these vast new pleasure grounds are to become properly available. In this respect, moreover, the Bronx problem differs radically from that in Brooklyn, where the abnormal travel to the bays and beaches has to be dealt with for only a few summer months, and is practically without conflict at any time with the usual city traffic. But with us in the Bronx, the strain of providing for the pleasure traffic while maintaining all the regular facilities for the worker, is ever upon the management, the sole reason being that the parks are right "in our midst," and they never shut down, as do Coney Island and Bowery Beach or Far Rockaway. And this situation is complicated by the cemetery travel, which in Brooklyn touches only each flank of the city, whereas with us it is thrown on the middle main lines of our service.

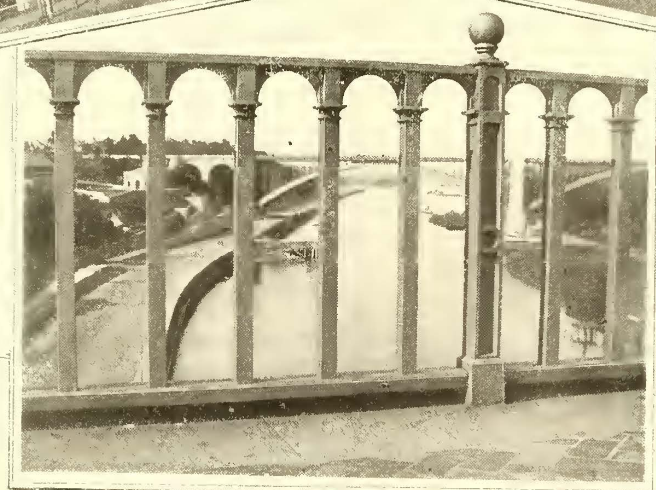
By way of emphasizing some of these points I may stop to refer for a moment to the general outlines of the region and some of its features of interest, as suggested above. Bronx Borough has $7\frac{1}{2}$ miles of frontage on the Hudson, 6 miles on the Harlem, and no less than $15\frac{1}{2}$ miles, from Port Morris to Pelham Bay and City Island, on the Sound. From this shore line it rises boldly in general, and nowhere in Greater New York are there heavier grades for the cars to climb than are encountered along the rocky ridges over which the chief routes of the system have been pushed as far as Mount Vernon and Yonkers. The area thus enclosed was once, as is well known, held largely by one or two families, such as the Morrises, Pells, and Van Cortlandts, but in reality the system of the company goes beyond these points, reaching far-off Hastings-on-the-Hudson and Tuckahoe and White Plains inland—"half way to Boston," as some of our passengers put it.

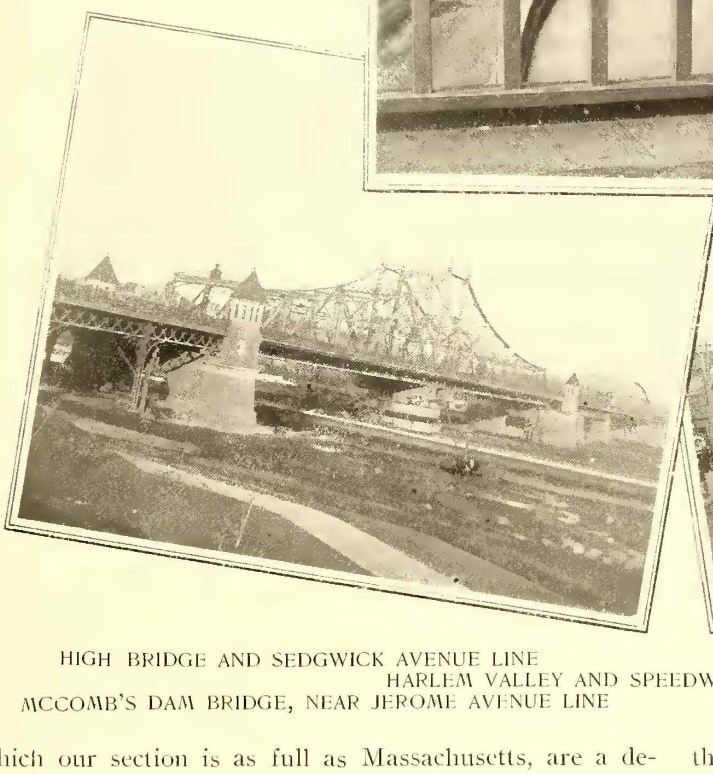
The borough is still extremely rural at different points, but it contains nevertheless three of the largest freight yards in the country, one of which, it may be noted for those who are interested in rails, has no fewer than fifty-four parallel tracks. Moreover, from its water front on the west have been launched additions to the United States Navy, and at Port Morris, on the east, there is 90 ft. of water at the piers, so that while the docking advantages are more than equal to those of Manhattan Island, the opportunities for dealing with trunk-line traffic are far beyond anything that was ever dreamed of south of the Harlem River. One thing again which has helped develop the Twenty-Third and Twenty-Fourth Wards, has been that many public institutions have been compelled by need of space to move into them; so that to-day we have, for example, the extraordinary number of seven colleges and universities, to which ninety churches and thirty-four public schools form a natural supplement, besides describing better than any words of mine can do the quality of our resident population. The academic and literary flavor has somehow always been noteworthy of the region, and is

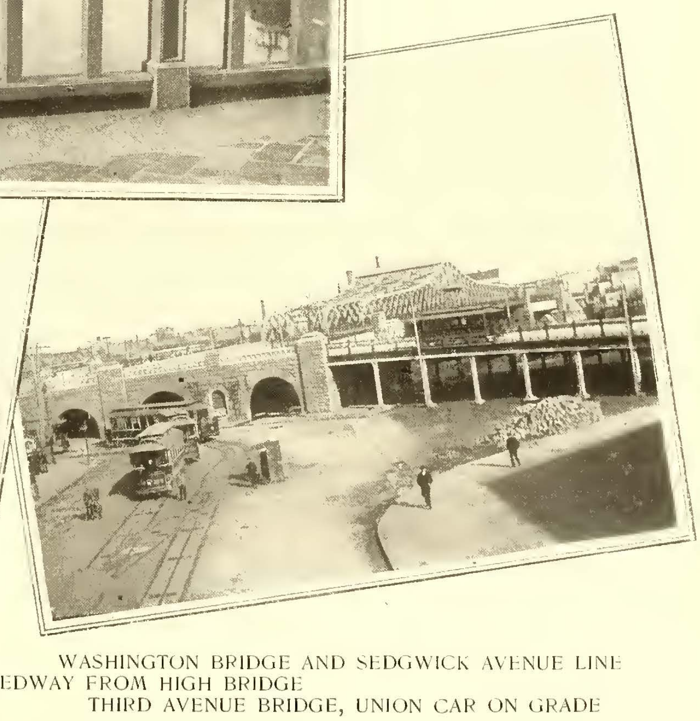
THE SOUND FROM CITY ISLAND

responsible for not a little of our traffic, there not being a season or a day in the year when our conductors are not asked by somebody as to the location of Edgar Allan Poe's pathetic little cottage at Fordham, where he wrote "Annabel Lee," or as to the home of Joseph Rodman Drake, the poet of the flag, or as to where Fenimore Cooper lived, or whether there are traces in Westchester of Samuel Woodworth, who wrote "The Old Oaken Bucket." I can not claim that we burden our new conductors by coaching them as to these things—they have enough on their minds as it is; but such spots and traditions, as well as those belonging to the earlier colonial and revolutionary period, of "downtown" do not even know the names of these pleasure grounds of the people. As a matter of fact, it is only in the future that the Union Railway Company will derive any real benefit from these public and private parks, for









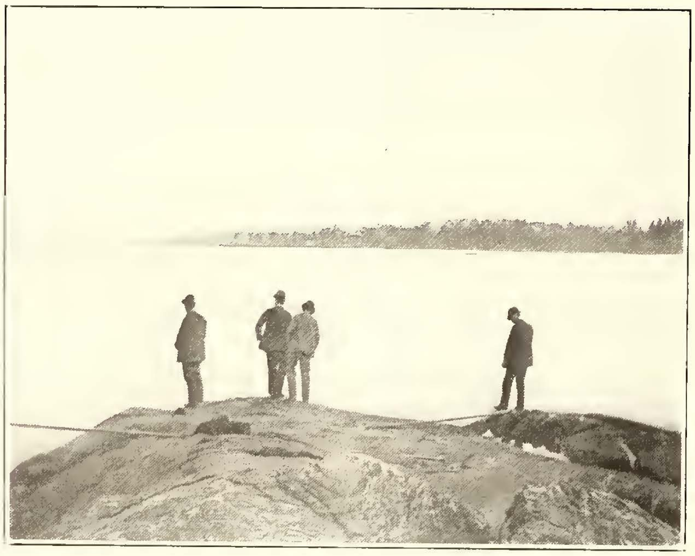
HIGH BRIDGE AND SEDGWICK AVENUE LINE — WASHINGTON BRIDGE AND SEDGWICK AVENUE LINE
HARLEM VALLEY AND SPEEDWAY FROM HIGH BRIDGE
MCCOMB'S DAM BRIDGE, NEAR JEROME AVENUE LINE — THIRD AVENUE BRIDGE, UNION CAR ON GRADE

which our section is as full as Massachusetts, are a decided asset, and continuously foster new travel. I am surprised the Ford Bill did not tax us for them. For the excellent photographs which accompany this article, giving an idea of the Bronx region and the Union system, I am indebted to G. E. Stonebridge, a well-known local artist in that line.

I have alluded to the park system, still so new that many friends of mine who are well-informed men of affairs their creation has necessitated a wholesale upheaval of the borough, blocking for long periods many of our important routes. Even now visitors to the American Street Railway convention can see the celebrated old Jerome Park, where the fastest horses in America have made and lost millions, being turned into a reservoir of the public water supply. So far as race tracks go, we still have the unsurpassed Morris Park for horses and Berkeley Oval for men, not forgetting the country grounds of the New York Athletic

Club at Travers Island, on the Sound, or the boat clubs on the Harlem; but the disruption of traffic by the breaking up of Jerome Park and Jerome Avenue, a main artery of commerce, can only be compared with what is now occurring on Manhattan Island. The fact that in spite of enormous obstacles of this kind the service has been well maintained is shown by the recent effort on our part to fling a spur from the southern end of our Jerome Avenue route across McComb's Dam Bridge to Eighth Avenue, with the object of saving our patrons a half-mile walk at a very exposed spot. The appiication of the company was voluntarily supported in person by at least 1500 Bronx residents. I doubt whether any street railway company ever before had such an evidence of support and appreciation from the community which it serves.

Referring once more to the parks, I was about to note the variety of tastes to which they appeal, giving us a traffic that must be steadily watched the year around, making a ceaseless demand on the executive for new facilities or the adaptation of old ones. Probably the last thing that Miss Helen Gould thought of when she added the beautiful Hall of Fame to the University of New York, at Morris, or "University," Heights, was that of presenting the Union Company with new conditions to meet in providing for the sightseers crowding up Sedgwick Avenue to the new Walhalla; but obviously we can not let that traffic go unnoticed or undeveloped, so that today one of our new lines is aiming that way, past Highbridge Aqueduct and under the graceful arches of the newer Washington Bridge. Not far beyond again lies Van Cortlandt Park, practically the only place where New York City can review its National Guard or mimic the conditions of battle. But the park has also long been a rendezvous for bicyclists, and is now a haunt of golfers. Ice forms there when the lakes in Manhattan and Brooklyn are still open, so that, for example, last year when there was no skating below Harlem Bridge, we had fifty-four days at Van Cortlandt and twenty-six at Crotona Park, drawing out no fewer than 300,000 people, for a great many of whom we gladly provided streetcar service. In Bronx Park the public has long been familiar with the magnificent Hemlock Grove, the grim Bear's Den, the lovely banks of the river, the dam and the ruined old snuff mill where the Lorillards laid the foundation of their fortune; but now we have to take crowds also to the new Botanical Gardens and the great Zoological Park, and the only complaint met is that we ought to be allowed to put the people down nearer the points of interest. A mother with a child in her arms or a father carrying a heavy lunch basket has some rights in such a matter as that. I have not mentioned Claremont Park or St. Mary's Park, for the travel to both of which resorts we must cater; nor, finally, have I named so far Pelham Bay Park, a region of great beauty, but which, as a center of homes, will not in any sense be opened up until the Union system encircles and pierces it. Those of us who have for some years been busy developing that system look back on a period of ceaseless activity, but the contemplation of what must still be done to round out existing lines and build the new routes does not reveal much chance to "rest and be thankful." On the contrary, it would be difficult to exaggerate the magnitude of the task. "The greater lies before."



TROLLEY TRIPPERS FISHING ON THE SOUND KILLS

The old horse railroad out of which the great Union Railway system has grown dates back to the early sixties, and was very much of the character of that which on the fringe of our territory still transports the weary fisherman with his catch at Bartow. The corporation chartered as the Harlem Bridge, Morrisania & Fordham Railroad Company established four branches, with terminals at Fordham, West Farms, Westchester Avenue and the Bronx, and Port Morris. The North Third Avenue & Fleetwood Park Railway Company also had a precarious existence about the same time, and the two were brought together in 1892, just at the beginning of the modern trolley regime, a date, moreover, from which it would also be but fair to reckon the great expansion of the North Side. It seems barely credible that where these two companies at the time of consolidation ran twenty horse cars of the primitive Bartow type, we now operate close upon 400 electrics, and keep them busy all the time. It is needless to say that all the original investments and equipments at once "went by the board," and we started out not merely to put in electric motive power, but to construct the new lines imperatively needed. Since 1892, breaking away from its "Huckleberry" name and period, the Union Company has thus constructed around the skeleton of its original system the following lines:

138th Street, across Madison Avenue Bridge to 135th Street, to Eighth Avenue.

150th Street, from Prospect Avenue to the Bronx River.

161st Street, from Third Avenue to High Bridge.

177th Street, from the Bronx River to Jerome Avenue.

Willis Avenue to Melrose Avenue.

Melrose Avenue to 161st Street.

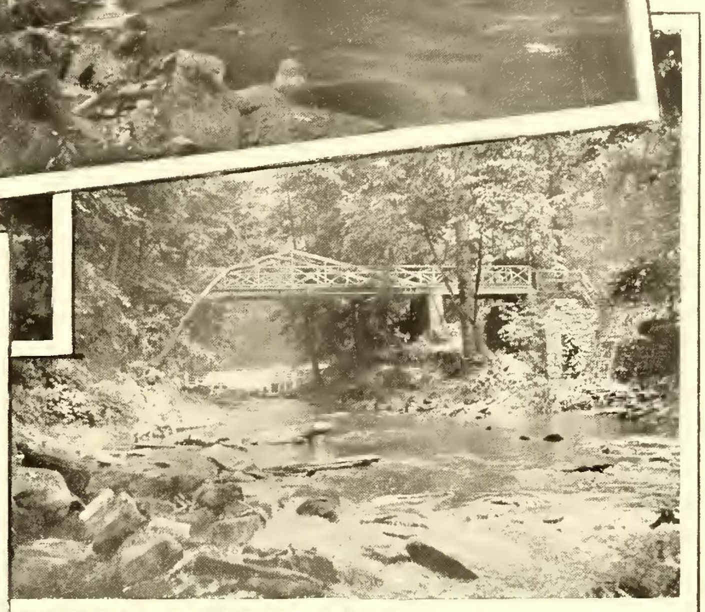
Jerome Avenue, from McComb's Dam Bridge to the northerly city line.

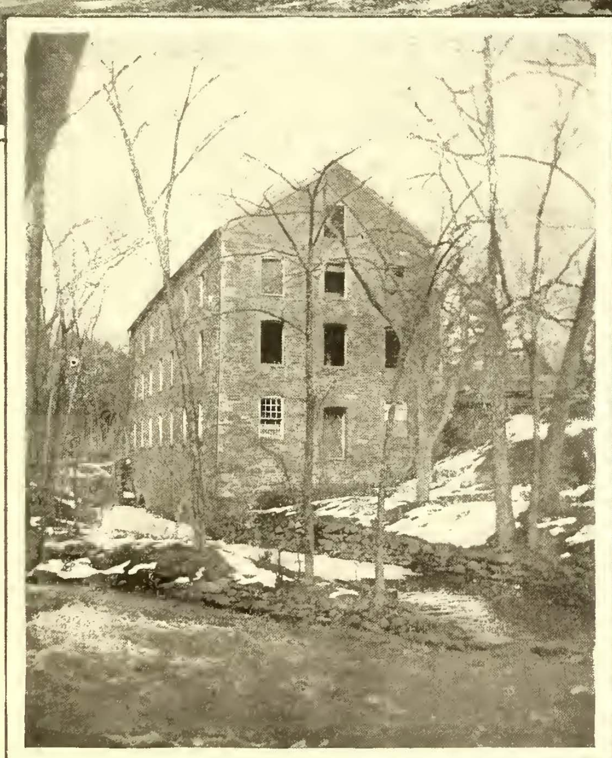
Upper Broadway, from Kingsbridge to Yonkers city line.

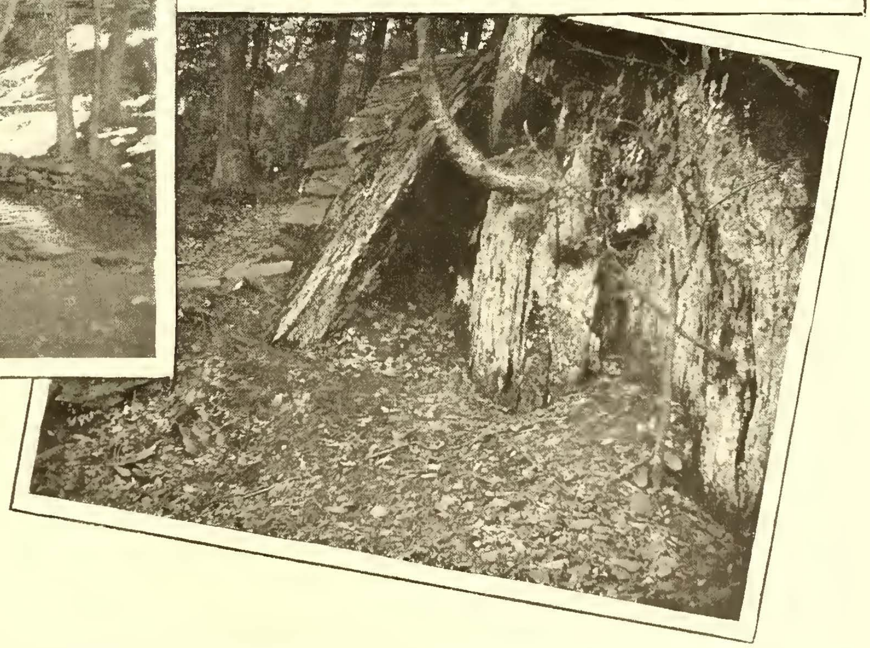
Webster Avenue, from Fordham to Williamsbridge.

All these lines have been completed and are now in operation, covering about 60 miles of street. In addition to the above, there have been built by the company lines extending from West Farms to Westchester Village and Unionport; also from West Farms to Williamsbridge, South Mount Vernon and Mount Vernon; in the city of Mount Vernon, along Fifth Avenue to the city line, along Fourth Avenue and Third Street to the city line at Pelham, and along North Fourth Avenue to the city line at

Bronxville. Extensions have also been built at Pelham, North Pelham, Pelham Manor, New Rochelle, and in the city of New Rochelle to Hudson Park and Glen Island; along the Boston Post Road to the village of Larchmont, at 165th Street, and an extension on Burnside Avenue from Jerome Avenue westerly to Aqueduct and Cedar Avenues, and thence to Morris Heights dock. It is intended in the near future to build an extension from Olin Avenue on







VIEWS IN BRONX PARK

and on North Street in said city, Rose Street, Webster Avenue, Huguenot and Main Streets. These latter lines cover about 30 miles of street. The Union Railway Company has recently constructed an extension on Webster Avenue from Fordham to Melrose Avenue across the new viaduct Webster Avenue to the city line at Yonkers. The construction of this line will give a double-track service between East 129th Street and the city of Mount Vernon. We have also laid out the construction of lines on St. Ann's, Morris and Boscobel Avenues. Our plans as to Sedgwick Avenue and the line across the McComb's Dam Bridge have already been noted above. There is also now under the control of the Union Company the Yonkers system, with transfer points in the city of Mount Vernon, at the Harlem station, and also from Jerome Avenue to Yonkers. The lines in operation in the city of Yonkers measure about 20 miles. The Union Railway system also controls the Tarrytown, White Plains & Mamaroneck Railway Company, which operates cars from Tarrytown to White Plains and to Mamaroneck, and also from White Plains to Scarsdale, making a total of about 30 miles. The Union Railway system also controls the Southern Boulevard Railroad Company, which operates its cars from 129th Street along the Southern Boulevard, a line of about 4½ miles.

I understand that another article in this issue of the STREET RAILWAY JOURNAL deals with the question of power in relation to the projected great new central plant at the Kingsbridge depot of the old allied Third Avenue Railway, now under Metropolitan control; but I may note in passing that we have available for our Union and Westchester companies' network current from four strategic points—West Farms, with 3850-kw capacity; New Rochelle, 1500 kw; Yonkers, 1025 kw, and White Plains, 1125 kw—a respectable aggregate of over 10,000 hp of generating capacity.

It is obvious to anyone who is informed as to the topography of Greater New York and Westchester County that our passengers easily get a long haul for their money, our transfer system being also very liberal. We have virtually twenty-three routes that our conductors have to memorize, and we have nearly forty different destinations. With his one nickel a passenger can, and often does, travel more than 15 miles from the Harlem up to Hastings-on-the-Hudson; or if his business takes him along the Sound, he can go a good 16 miles to Larchmont for the same trifle. Such distances make the newspaper discussions on Manhattan Island, as to whether the Metropolitan system or the Manhattan Elevated gets the burden of the "long haul," seem to us on the North Side rather foreign to the question; for our shortest haul must look a "long" one to managements below Harlem Bridge, and we can not help ourselves. There is, of course, no doubt that we suffer from the "transfer upon transfer" policy; while the saving from it to the public all over our scattered territory is enormous; although it naturally acts as a drag upon our extensions and improvements. In this respect a street railway manager is, unfortunately, different from the proprietor of a theater, who, if he has put a good piece on the boards at great expense, can cut out all his "deadheads." Our houses are always "papered." The extent to which our patrons

MILITARY EXERCISES AND WINTER SPORTS IN VAN CORTLANDT AND CROTONA PARKS use transfers is shown by the startling fact that this last year, 1901, they asked for and got on the Union system alone 12,496,870, or, as will be noted, as many as our total traffic in 1899, less than two years ago; while on the Westchester Electric Company division in 1900 the number of transfers was 3,273,751, or just 50 per cent of the total number of passengers.

This brings me directly to the question of our traffic, and I venture to submit that the figures of the Union Railway are a marvelous record of growth. They run thus, omitting transfers:

1891	3,240,726
1892	3,402,370
1893	6,492,126
1894	9,373,175
1895	8,573,944
1896	9,722,361
1897	10,754,320
1898	12,166,000
1899	12,711,412
1900	16,790,922

Our Westchester Electric Company makes the subjoined showing from 1895:

1895	1,968,457
1896	2,490,272
1897	2,589,961
1898	4,406,203
1899	5,046,843
1900	6,552,396

The short Southern Boulevard line, also an integral part of our main Union system, shows the following figures since 1896:

1896	552,663
1897	993,902
1898	1,744 903
1899	1,006,153
1900	1,203 478

Wherever a depression is indicated in the curve of these load lines it is not due to anything but the tearing up of our routes for paving, sewer pipes, water mains, and the other interruptions which I presume are incidental annoyances in the building up of any great new center of population; but no manager likes to see them, however well he can account for them to the owners of the property. I can also give a few figures for the Yonkers system and for the Tarrytown, White Plains & Mamaroneck division, each of which we own and operate. For the White Plains line the figures are:

1899	803 315
1900	1,024 317

While for Yonkers the following are the returns since 1898:

1898	1,316,620
1899	3,069 239
1900	4,930,138

The signs of growth are thus everywhere manifest, and, as will be seen, in 1900 these five divisions handled no fewer than 30,501,051 passengers. The 20 per cent rate of increase which, extraordinary as it is, we are easily maintaining, should give us not far short of 37,500,000 this year, or about twelve times what the Union system had at its inception less than ten years ago.

Comment on such development as is outlined above seems superfluous, but it is only right to add that the whole of the service given is metropolitan in its character as to comfort and convenience, while it is also suburban as to the high rate of speed maintained. We have the alert, quick, nervous New York public to deal with, and are thus helped to keep up an excellent running schedule in city limits proper, and where we strike some of the open country that still abounds in our territory, our motormen let their cars out for all they are worth. Hence, again, the distances are shortened up wonderfully, much to the satisfaction of those who go "all the way." Two or three years ago we established at the crest of the West Farms hill, not far from the power plant, a central car house, which is admitted to be one of the finest in the country, and thither the able superintendent, Mr. James Carrigan, moved his office. It is the operating heart of the system, and a busy scene at all times, for the Union Company has a force of over 700 motormen and conductors, sixty men at work on track repairs, etc., and eighty men similarly engaged on the maintenance of the rolling stock, besides the staff for the

HOME FROM THE DAY'S FISHING—BARTOW

power-generating plant. Man and boy, Mr. Carrigan has lived some forty years within a stone's throw of his office, and thus has that intuitive knowledge of his spreading territory without which a stranger could make many a costly mistake.

Down here, at the southern end of the Third Avenue Bridge, are the executive offices of the company, built specially for the purpose and used as the headquarters of the president, of Mr. T. W. Olcott, secretary and treasurer, etc. From the windows looking out on the plaza can be witnessed morning and evening, or on any great occasion setting the population in movement, one of the sights of New York City—a sight of peculiar interest to every street railway man. The cars come off the bridge with a sharp curve, very much like that at Fourteenth Street and Broadway, New York, and then run around a loop, of which that at Broadway and the New York Postoffice is a counterpart. Overhead is the elevated road, and close by are the terminals of the Third Avenue line, and the scenes rival in animation and bustle those at the New York end of the Brooklyn Bridge, except that in our plan of operation each car for our multitudinous routes comes up on the one line, and passengers do not, like the poor Brooklynites, have to peril life and limb in jostling across half a dozen tracks to reach a seat, in a manner that makes "looping the loop" seem a very safe amusement by comparison.

Here our finger is on the pulse of the whole system, but great tides of travel are also in evidence all the day long at such busy transfer points as 138th Street and Third Avenue; the Southern Boulevard, West Farms, West Mount Vernon, etc., where the cars coming up ceaselessly are like mere buckets dipping into a vast sea of humanity. In the operation of such a system there are many intricacies and features of interest that might be dwelt upon, but I believe enough has been said to enable the delegates to the New York convention to appreciate the operative conditions of the Union Street Railway system and all that it opens up in the Borough of the Bronx to the dwellers on Manhattan Island.

A THREE-YEAR COMPARISON OF CABLE, ELECTRIC AND HORSE TRACTION IN NEW YORK CITY

The accompanying table shows in detail the earnings and operating expenses for the year ending June 30, 1901, of the Metropolitan Street Railway Company, of New York. These figures have been secured through the courtesy of the officers of that company, and following a custom instituted in this paper two or three years ago, are presented herewith. The table possesses a particular interest at the present time, in view of the fact that cable traction has now been entirely abandoned by the company. So far, therefore, as that power is concerned the expenses have a historical interest only, except as they indicate some of the reasons which have led the company to adopt electric traction for all of its mechanically-operated lines.

The figures for cable traction necessarily are not for the complete year, as the final piece of cable track, that on Broadway, was changed to electricity during the first part of June, 1901. Nevertheless, the cable car mileage during the year, as will be seen, was less than 40 per cent of the cable car mileage for 1900. The horse car mileage also shows a decrease of about 15 per cent, while the electric car mileage shows an increase of 8.2 per cent. The total mileage for the system is less than last year to the extent of 1,266,967. This, however, does not represent either a diminution in passengers carried, which, in fact, are 11,062,978 more, or in carrying capacity, as the new electric cars are larger than either the cable or the horse cars which they have displaced.

Considering now each division separately, it will be seen that the cost of cable car operation has increased 0.83 cent per car mile. The largest factor in this is the cost of fuel and renewal of cables, both of which have increased 0 22 cent per car mile. The only other increase of importance is injuries and damages—0.2 cent.

In horse car operation there has been a reduction of 0.25 cent in maintenance of way, and 0.05 cent in transportation. The increase is almost entirely in cost of provender—0.39 cent. This reflects the increase in cost in grain, which, peculiarly enough, has increased in value in about the same proportion as the coal for the mechanically-operated lines.

Taking up now the electric division, the most important and most interesting, we find that the total increase in operating expenses is 0.4 cents, which is more than accounted for by the increase in charges for injuries and damages, which is 0.49 cents. Thus, it will be seen that mechanically the system is operating .09 cent per car mile cheaper than last year. In carrying the investigation further, it will be found that this reduction has been secured entirely in the transportation expenses; that is, in the wages of the engineers and firemen and in fuel. In fact, the maintenance of way expenses and those of maintenance of equipment were both higher than last year. The reduction in motive power is, of course, attributable to the operation of the new power house of the company, and it is interesting to notice that the greater part of the saving secured therefrom (0.21 cent) is just about equally divided between the expense of labor and that of fuel.

The reduction in transportation charges per car mile is attributable to the general employment of double-truck cars, which have become the standard for practically all the electric lines of the company. Single-truck cars are still in operation on Broadway, but they will be replaced by the long car just as soon as the Broadway tracks at the curves are so arranged that double-truck cars can pass each other with safety on curves.

The effect of the higher speed employed by the electric cars on operating expenses is shown in a very interesting way by comparing the transportation charges of the electric cars with those in the horse car and cable car columns. It will be seen that the total charge for transportation is considerably more than 1 cent less per car mile than the horse car charge and a little more than 1½ cents per car mile less than that in the cable car column. So far as conductors and gripmen or drivers are concerned, the cable cars show an economy over the horse cars, amounting to 0.78 cent, but the greater cost of inspectors (0.69 cent) and of car lighting (the cable cars are lighted by gas), 0.33 cent accounts for the difference. For a proper understanding of the figures contained in this table, and, indeed, of any comparison of street railway figures made out on the basis of the car mile as a unit, the reader should bear in mind the fact that the cars used are entirely different with each of the motive powers. The horse car will seat only from sixteen to twenty passengers, the cable car about twenty-eight passengers, while nearly all the electric cars now in use are double-truck cars and will seat from thirty to fifty passengers.

RECEIPTS AND EXPENSES OF THE METROPOLITAN STREET RAILWAY COMPANY, OF NEW YORK,

For the Years Ending June 30, 1899, June 30, 1900, and June 30, 1901,

SHOWING THE RELATIVE COSTS AND PROFITS OF CABLE, ELECTRIC AND HORSE RAILWAY OPERATION

ITEMS	Cable						Electric					
	Amount			Per Car Mile			Amount			Per Car Mile		
	1899	1900	1901	1899	1900	1901	1899	1900	1901	1899	1900	1901
GENERAL EXHIBIT												
Total passenger receipts	$3,690,615	$3,698,672	$3,177,510	35.43	34.86	36.31	$6,043,538	$8,125,112	$9,123,713	31.23	32.54	33.74
Passenger operating expenses	1,874,422	1,884,723	1,626,956	18.00	17.76	18.59	2,312,682	3,286,541	3,665,531	11.95	13.16	13.56
Earnings from passenger operation	1,816,193	1,813,949	1,550,554	17.43	17.10	17.72	3,730,856	4,838,568	5,458,182	19.28	19.38	20.18
OPERATING EXPENSES IN DETAIL												
MAINTENANCE OF WAY												
1 Repairs roadbed—track, labor	44.894	37,630	21,550	.43	.35	.25	25,796	57,780	66,588	.13	.23	.24
2 " " material	4,685	10,111	3,049	.05	.09	.03	4,223	8,869	13,451	.02	.03	.05
3 " " steel rails	375	*35	*50	....	....	....	28	*266	625	....	....	....
4 " " switches, castings, spikes, etc.	17,227	14,666	13,614	.17	.14	.16	10,083	19,983	28,411	.05	.08	.11
5 " " ties and timber	14	75	33	....	....	....	746	702	460	....	....	.
6 Repairs overhead and underground construction	82.411	88,582	80,829	.79	.84	.95	22,978	35,495	52,771	.13	.14	.20
7 Renewals of cable	239,481	262,992	236,174	2.30	2.48	2.70	....	....	....	....	....	....
8 Tube cleaners	11,824	11,216	9,568	.11	.11	.10	30,818	43,711	46,088	.16	.18	.17
9 Oilers	41,511	42,108	37,206	.40	.40	.42	....	....	16	....	....	....
10 Gearsmen and splicers	21,339	20,397	18,930	.20	.19	.22	....	....	10	....	....	....
11 Repairs of buildings	7,783	10,350	4,948	.08	.10	.06	11,853	16,516	22,093	.06	.07	.08
12 Removal of snow and ice, and street cleaning	17,045	14,968	12,060	.16	.14	.13	25,413	19,925	7,419	.13	.08	.03
Total	488,590	513,061	437,911	4.69	4.84	5.00	131,938	202,084	237,933	.68	.81	.88
MAINTENANCE OF EQUIPMENT												
13 Repairs of cars and vehicles	78,174	63.403	46,374	.75	.60	.53	134,339	197,873	221,428	.69	.79	.82
14 " " electrical or cable equipment of cars.	37,380	36,348	32,892	.36	.34	.38	90,320	153,490	245,030	.47	.62	.91
17 " " tools and machinery	1,974	1,053	1,025	.02	....	.01	2,562	2,007	463	.01	....	....
Total	117,528	100,804	80,291	1.13	0.94	0.92	227,222	353,371	466,921	1 17	1.41	1.73
POWER												
15 Repairs of steam plant	19,396	23,558	15,380	.19	.22	.18	8,148	12,904	20,398	.04	.05	.08
16 " " electrical or cable plant	9,252	10,363	12,133	.09	.10	.14	3,042	8,013	4,964	02	.04	.02
18 " " harness	219	110	477	....	....	....	1,057	1,461	1,528	....	...	....
19 Stable equipment, supplies, etc	113	....	114	....	....	....	642	808	809	....	....	....
20 Renewals of horses	250	....	51	....	....	....	750	....	1,012	....	....	....
21 Horse shoeing	352	161	336	....	...	....	3,175	4,034	3,936	.02	.02	.01
22 Cost of provender	4,081	3,933	4,412	.04	.04	.05	15,575	20,120	14,292	.08	.08	.05
23 " " feedmen—wages	270	331	355	....	....	....	2,228	2,491	1,868	.01	.01	....
24 " " removing manure	75	70	62	....	....	....	*137	*154	*99	....	....	....
27 Hostlers, hitchers and stable help	3,033	3,504	2,866	.03	.03	.03	15,847	18,137	16,396	.08	.08	.06
28 Engineers, firemen and power service	64,342	59,896	54,987	.62	.57	.63	63,480	100,605	80,293	.33	.40	.30
32 Fuel, power houses	112,428	106,424	106,283	1.08	1.00	1.22	188,455	270,644	265,620	.98	1.08	.98
33 Light and other supplies at power houses	16,383	17,967	17,829	.16	.17	.20	13,414	19,355	28,859	.07	.08	.11
34 Water tax	19,383	21,408	18,511	.19	.20	.21	27,300	37,438	40,341	.14	.15	.15
Total	249,577	247,727	233,796	2.39	2.33	2.67	342,974	495,856	480,215	1.77	1.99	1.78
TRANSPORTATION												
25 Conductors, drivers, gripmen and motormen	652,262	661,602	551,818	6.27	6.24	6.31	1,083,104	1,442,676	1,534,363	5.60	5.79	5.68
26 Inspectors, starters, switchmen, etc.	142,125	137,990	113,161	1.36	1.30	1.29	166,515	202,834	185,525	.86	.81	.68
29 Car house exp. watchmen, car cleaners, oilers, etc.	37,848	39,177	34,044	.36	.37	.39	93,205	136,722	133,174	.48	.54	.49
30 Car service—car lighting	33,814	38,642	36,600	.33	.36	.42	2,306	5,144	9,152	.01	.02	.03
31 " " oil, waste, etc.	11,634	11,433	10,600	.11	.11	.12	19,991	32,331	36,862	.10	.13	.14
Total	877,683	888,844	746,223	8.43	8.38	8.53	1,365,121	1,819,708	1,899,075	7.06	7.29	7.02
GENERAL EXPENSES												
35 Salaries of officers and clerks	28,123	25,583	22,007	.27	.24	.25	35,831	53,461	55,164	.19	.21	.20
36-40 Injuries and damages	59,474	59,353	66,890	.57	.56	.76	101,968	179,753	326,214	.53	.72	1.21
41-48 Other general expenses	53 446	49,351	39,838	.51	.47	.46	107,628	182,311	200,009	.56	.73	.74
Total	141,043	134,287	128,735	1.35	1.27	1.47	245,428	415,525	581,387	1.27	1.66	2.15
Total operating expenses	1,874,422	1,884,723	1,626,956	17.99	17.76	18.59	2,312,682	3,286,544	3,665,531	11.95	13.16	13.56
Car mileage run	10,416,079	10,610,091	8,750,956	....	....	....	19,347,978	24,968,196	27,035,040	....	....	....

ITEMS	Horse						Total					
	Amount			Per Car Mile			Amount			Per Car Mile		
	1899	1900	1901	1899	1900	1901	1899	1900	1901	1899	1900	1901
GENERAL EXHIBIT												
Total passenger receipts	$3,085,559	$2,531,622	$1,893,068	25.72	25.80	22.70	$12.819,712	$14,355,406	$14,194,291	30.70	31.63	32.17
Passenger operating expenses	2,154,969	1,862,766	1,600,694	17.96	18.98	19.19	6.342,073	7,034,033	6,893,182	15.18	15.50	15.62
Earnings from passenger operation	930,590	668,856	292,374	7.76	6.82	3.51	6,477,639	7,321,373	7,301,109	15.50	16.13	16.55
OPERATING EXPENSES IN DETAIL												
MAINTENANCE OF WAY												
1 Repairs roadbed—track, labor	58,810	62,810	40,592	.49	.64	.51	129,499	158,220	128,730	.31	.35	.29
2 " " material	14,462	26,085	15,900	.12	.26	.20	23,370	45,065	32,400	.06	.10	.07
3 " " steel rails	711	*919	1,177	....	....	....	1,114	*1,220	1,752	....	..	....
4 " " switches, castings, spikes, etc.	4,936	4,583	8,263	.04	.04	.10	32,247	39,232	50,288	.08	.08	.11
5 " " ties and timber	1,093	1,717	1,023	.01	.02	....	1,854	2,494	1,516	....	...	....
6 Repairs overhead and underground construction	....	....	....	....	....	....	105,389	124,078	133,600	.25	.27	.30
7 Renewals of cable	....	....	....	....	....	....	239,481	262,992	236,174	.57	.58	.54
8 Tube cleaners	....	....	....	....	....	....	42,642	54,927	55,656	.10	.12	.13
9 Oilers	....	....	....	....	....	....	41,511	42,108	37,223	.10	.10	.08
10 Gearsmen and splicers	....	....	....	....	....	....	21,339	20,397	18,940	.05	.05	.04
11 Repairs of buildings	13,695	23,659	16,355	.11	.24	.20	33,331	50,525	43,396	.08	.11	.10
12 Removal of snow and ice, and street cleaning	24,864	10,159	3,868	.21	.10	.04	67,322	44,422	23,347	.16	.10	.05
Total	118,572	128,095	87,178	.99	1 30	1.05	739,099	843,239	763,022	1.77	1.86	1.73
MAINTENANCE OF EQUIPMENT												
13 Repairs of cars and vehicles	50,950	57,245	51,962	.42	.59	.62	263,463	318,521	319,763	.63	.71	.73
14 " " electrical or cable equipment of cars.	....	....	296	....	....	....	127,701	189,839	278,218	.31	.42	.63
17 " " tools and machinery	74	266	691	....	....	....	4,610	3,326	2,179	.01	....	....
Total	51,024	57,511	52,949	.42	.59	.63	395,774	511,686	600,160	.95	1.13	1.36
POWER												
15 Repairs of steam plant	....	....	593	....	....	....	27,543	36,462	36,371	.07	.08	.08
16 " " electrical or cable plant	....	....	297	....	....	....	12,293	18,376	17,394	.03	.04	.03
18 " " harness	13,964	15,298	14,581	.12	.15	.18	15,240	16,868	16,586	.04	.04	.04
19 Stable equipment, supplies, etc	8,594	8,555	7,611	.07	.09	.09	9,349	9,363	8,535	.02	.02	.02
20 Renewals of horses	23,925	27,000	31,551	.20	.27	.38	24,925	27,000	32,614	.06	.06	.07
21 Horse shoeing	62,737	53,191	45,262	.52	.54	.54	66,264	57,390	49,534	.16	.12	.11
22 Cost of provender	377,736	357,129	336,246	3.15	3.64	4.03	397,392	381,181	354,950	.95	.84	.80
23 " " feedmen—wages	28,516	24,293	23,529	.24	.25	.28	31,014	27,115	25,752	.08	.06	.06
24 " " removing manure	6,637	6,526	4,552	.06	.07	.05	6,575	6,442	4,514	.01	.01	.01
27 Hostlers, hitchers and stable help	271,283	222,874	182,659	2.26	2.27	2.19	290,163	244,516	201,921	.70	.54	.46
28 Engineers, firemen and power service	....	....	....	....	....	....	127,822	160,502	135,280	.31	.35	.31
32 Fuel, power houses	....	....	393	....	....	....	300,883	377,068	372,296	.72	.85	.84
33 Light and other supplies at power houses	....	....	143	....	....	....	29,797	37,322	46,831	.07	.08	.11
34 Water tax	8,691	6,823	7,116	.07	.07	.09	55,374	65,669	65,968	.13	.14	.15
Total	802,082	721,690	654,534	6.69	7.35	7.85	1,394,634	1,465,273	1,368,547	3.34	3.23	3.10
TRANSPORTATION												
25 Conductors, drivers, gripmen and motormen	837,390	695,859	591,563	6.98	7.10	7.09	2,572,756	2,800.137	2,677,743	6.16	6.18	6.07
26 Inspectors, starters, switchmen, etc.	93,411	65,072	49,854	.78	.67	.60	402,051	405,896	348,539	.96	.89	.78
29 Car house exp. watchmen, car cleaners, oilers, etc.	44,829	35,029	29,998	.37	.36	.36	175,882	210,929	197,216	.42	.46	.45
30 Car service—car lighting	9,305	8,667	7,671	.08	.07	.09	45,425	52,454	53,423	.11	.11	.12
31 " " oil, waste, etc.	3,574	3,849	4,336	.03	.04	.05	35,198	47,612	51,798	.08	.10	.12
Total	988,508	808,476	683,421	8.24	8.24	8 19	3,231,312	3,517,027	3,328,719	7.73	7.74	7.54
GENERAL EXPENSES												
35 Salaries of officers and clerks	29,308	21,579	18,014	.24	.22	.22	93,262	100,624	95,185	.22	.22	.22
36-40 Injuries and damages	50,711	38,392	30,034	.42	.39	.36	212,154	277,498	423,128	.51	.61	.96
41-48 Other general expenses	114,764	87,024	74,565	.96	.89	.89	275,837	318,686	314,420	.66	.70	.71
Total	194,783	146,995	122,612	1.62	1.50	1.47	581,253	696,808	832,734	1.39	1.53	1.89
Total operating expenses	2,154,969	1,862,766	1,600,694	17.96	18.98	19.19	6,342,073	7,034,033	6,893,182	15.18	15.49	15.62
Car mileage run	11,996,799	9,812,031	8,337,355	....	....	....	41,760,856	45,390,318	44,123,351	....	..	....

*Credit Balances.

Recent Developments in the Traction Field

Electric Train Equipment of the General Electric Co.

The great increase in traffic in the past few years upon all suburban and elevated roads which daily move large bodies of people to and from the crowded business centers of the country has called for a system of traction which is capable of rapidly accelerating a train and maintaining a high maximum speed; there should also be a suitable brake for quickly bringing the train to a stop. The requirements of such operation are admirably met by the use of the electric motor, and the object of this article is to explain the apparatus now placed on the market by the General Electric Company to accomplish such results.

To accelerate a train rapidly it is necessary to make use of as much of the weight of the train for traction purposes as possible. This can be readily done by mounting two or more electric motors upon each of several or all cars of the train. For the proper operation of the train it is necessary that all of these motors be simultaneously controlled from one point on the train, and such a method of control is embodied in the train control system.

For such rapid acceleration and maintenance of high speed while running, motors are required which are capable of delivering a large amount of torque with a small degree of heating, since the frequency of starts and the high-accelerating rate call for an intermittent input of energy which will result in dangerous heating of the motors if they are not properly proportioned to minimize and dissipate the losses. The conditions under which such motors must operate call for the most modern and carefully developed design, an example of which is found in the G. E. 66 motor.

In order to maintain the highest speed schedule between terminals, there is needed not only a quick acceleration and high-maximum speed, but a very rapid and perfectly controllable rate of braking. This is accomplished by means of the quick-acting air brake, which has been fully developed for steam traction purposes. The only problem incident to its use on electrically-propelled trains is the supplying of air to operate the brakes. This requires an electrically-driven pump started and stopped by a never-failing governor, so as to be entirely automatic in its action. It is for these requirements that the C. P. 14 General Electric pump and governor is built.

The electrical equipment of a train for this service is then, as outlined above, a set of controllers which will operate all motors upon all motor cars of the train from any one of a number of points in the train, these points being the ends of all motor cars; a number of motors capable of supplying tremendous power for accelerating purposes, but so designed that they will dissipate their losses without injurious heating; and an air-brake system automatically supplied with air from one or more reliable sources. For high-speed suburban or elevated service these are the three essentials from the electrical point of view, and their embodiment in copper and steel is best illustrated by the apparatus now being installed on the Manhattan Elevated Railway, New York City, by the General Electric Company. A brief description of the main features outlined above follows:

TYPE M CONTROL

The General Electric Company's type "M" control is adapted for use on motor cars in service which requires that any car be operated alone, or that two or more cars be coupled together as a train and have their motors operate simultaneously. When combined as a train system, the individual motor controllers of the several cars are so interconnected that the motors on all of the motor cars are similarly controlled from one point, which may be either end of any motor car. The cars may be coupled into a train without reference to their relative positions, and either end of any car may be coupled to any other car on the train.

This controller consists in general of two parts: First, on each car are a number of electrically-operated switches, or contactors, constituting the series-parallel controller for the motors on that car, which effect the different combinations of the motors and vary the starting resistance in the circuit with them; second, on each motor car are two master controllers, one located at each end of the car, either of which serves to control the contactors

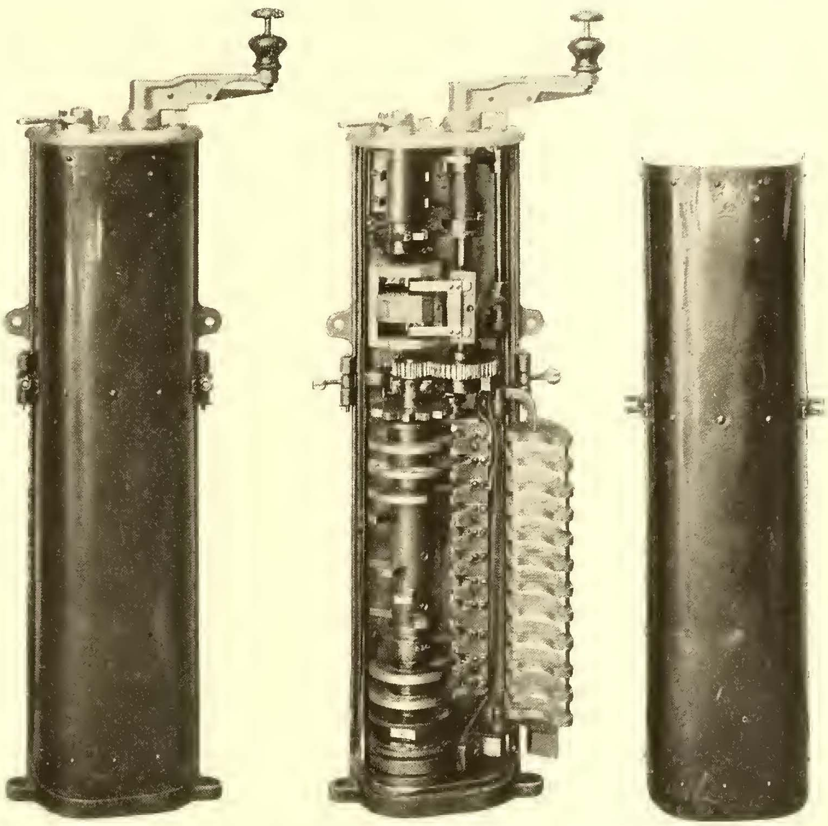


FIG. 1—MASTER CONTROLLER CLOSED AND OPEN

on that car and on all others in the same train. A cable connected to each master controller and to the contactors runs the entire length of the train, with suitable couplers making necessary connections between the cars.

The current to the motors does not pass through either the master controller or the train cable, these parts carrying only the currents which operate the contactors. Each motor car collects its own motor current from the trolley, or third rail, and controls this current in its own contactors. The movement of any master controller sends current to the contactors, since these are wired in parallel to the train cable, thus causing simultaneous movements of all contactors in the trains.

The synchronous action of the motor controllers of all cars simultaneously with the movement of the master controller handle insures similar resistance connections and motor combinations on all the cars. The operator knows by the position of the master controller handle the exact position of the motor controllers on all of the cars and the rate of movement of the motor controllers, and consequently the amount of current taken by all of the motors is under his immediate control, just as it is with ordinary hand-operated controllers. The motorman is able at will almost immediately to utilize the full power of the motors in either direction in an emergency.

In case the supply of power to the train is momentarily interrupted for any reason, the contactors all open the motor circuits, but the motor and resistance connections which were in effect immediately preceding such interruptions are instantly reset upon the restoration of power, provided the master controller position is unchanged.

The interruption of current to the motors in the off position of the master controller is insured by providing three separate contactors connected in series, any of which is capable of opening the circuit. If the train breaks in two, the current is automatically and instantly cut off from the motors on that part of the train which is not under the control of the motorman, while his ability to control the front part of the train is not affected.

When the master controller is thrown off, both "line" and

The control operating current at 550-volt line potential is about 2.5 amps. per car for an equipment of two 125-hp motors, and the total weight of the control apparatus for this equipment is approximately 2200 lbs.

The master controller (Figs. 1 and 2) is similar to the ordinary street car controller in method of operation and appearance, although of considerably smaller dimensions. Separate power and reverse handles are provided, as experience has shown this arrangement to be preferable to the movement of a single power handle in opposite directions to reverse the motors.

All current for the operation of the several motor controllers passes through the single-master controller in use, which takes current directly from the line. A magnetic blow-out is provided, similar to that used on standard street car controllers.

An automatic open-circuiting device is provided in the master controller, whereby, in case the motorman releases the master-con-

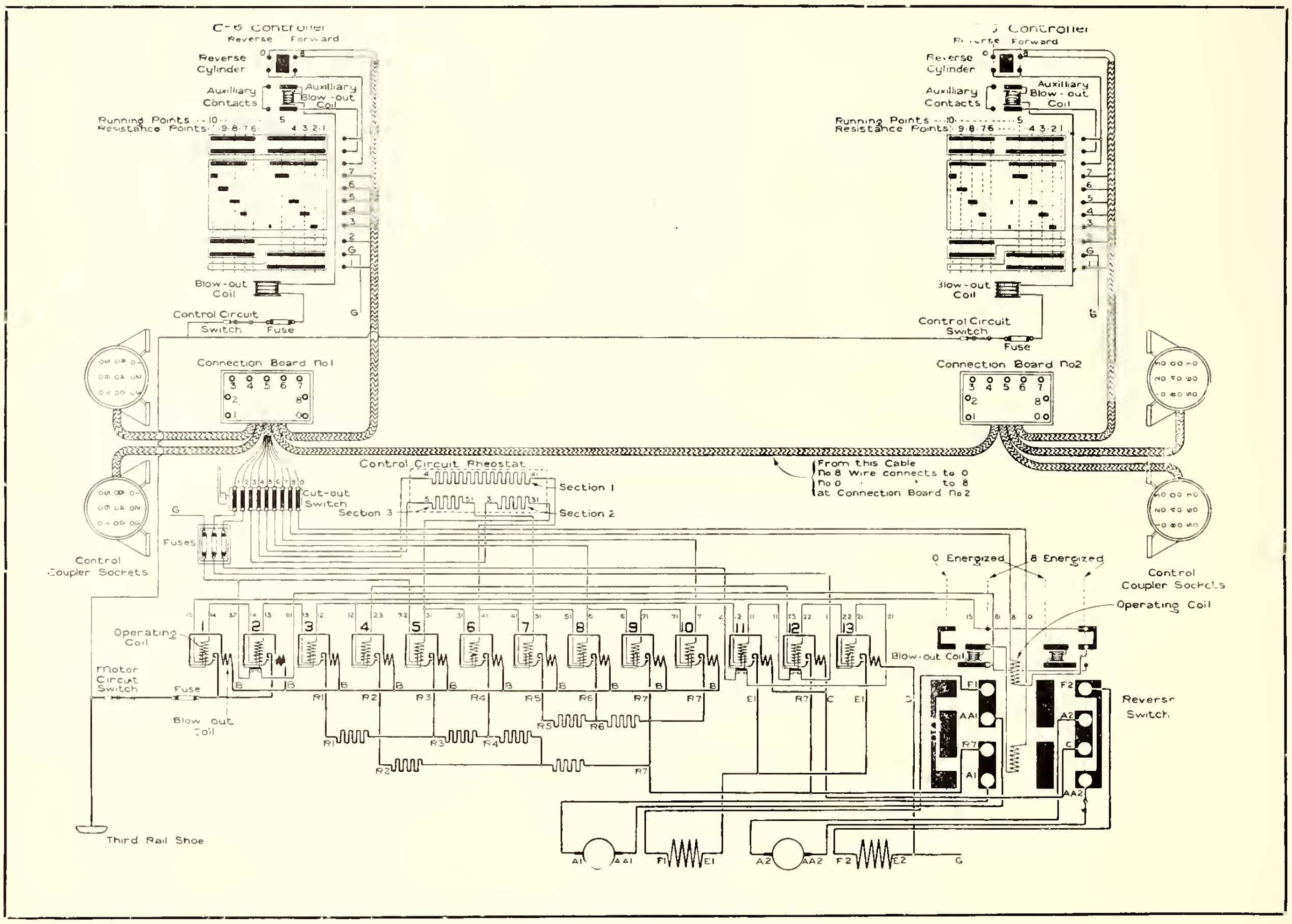


FIG. 2.—TYPE M CONTROL, SHOWING CONNECTIONS OF C-6 CONTROLLERS AND TWO 160-HP MOTORS

"ground' connections are cut off from the operating coils of important contactors, and none of the train wires, or any of the wires in the train line cable, are "alive."

For reversing the motors the master controller is provided with a separate reversing handle, and a mechanical interlocking device prevents this reversing handle from being thrown unless the main handle is in the off position. Moving this reverse handle either forward or back makes connections for throwing an electrically-operated reverse switch either "forward" or "reverse." This main reversing switch is electrically interlocked, so that it can not be thrown when power is "on."

The operating circuit is so arranged that, unless the reverse switch on any car is thrown in the direction indicated by the master controller reverse handle in use, it will be impossible to operate the contactors on that car so as to get any current in the motors on that particular car.

A cut-out switch is provided on each car, so that in an emergency all of the contactors on that car may be disconnected from the control circuit.

troller handle in any "on" position, the control circuit to the motor controllers is instantly opened on auxiliary contacts. This result is obtained by mounting the operating mechanism for the auxiliary safety device loosely on the main shaft and returning it to the "off" position when released, by a spring, without necessitating movement of the entire cylinder or handle; thus the device is entirely separate and distinct in its action from the main cylinder.

The handle for operating the reverse switch is located on the left-hand side, and can only be removed in the intermediate or "off" position of the reversing switch. As the power handle is mechanically locked against movement when the reverse handle is removed, it is only necessary for the motorman to carry the reversing handle when changing from car to car.

The motor controller for each car consists of thirteen electrically-operated switches, called contactors (electrically equivalent to the cylinder of any ordinary controller by which the necessary rheostatic and motor combinations are made), and an electrically-operated reversing switch, which reverses the armature leads of the motors.

Each contactor (Figs. 3 and 4) consists of a movable arm carrying a finger, which makes contact with a fixed terminal finger, and a coil for actuating the arm when supplied with current from the master controller. The contactor is so designed that the motor circuit is closed only when current is flowing through the coil. Gravity, combined with spring action of the finger, causes the contactor to open immediately the master-controller circuit is interrupted. The contactor has an efficient and powerful magnetic blow-out, which will effectually disrupt the power circuit under conditions far exceeding normal operation. The different contactors are practically identical, and the few parts which are subjected to burning and wear are so constructed as to be readily replaced. They may be conveniently located under the floor, along one side of the car, where they will be easily accessible for inspection.

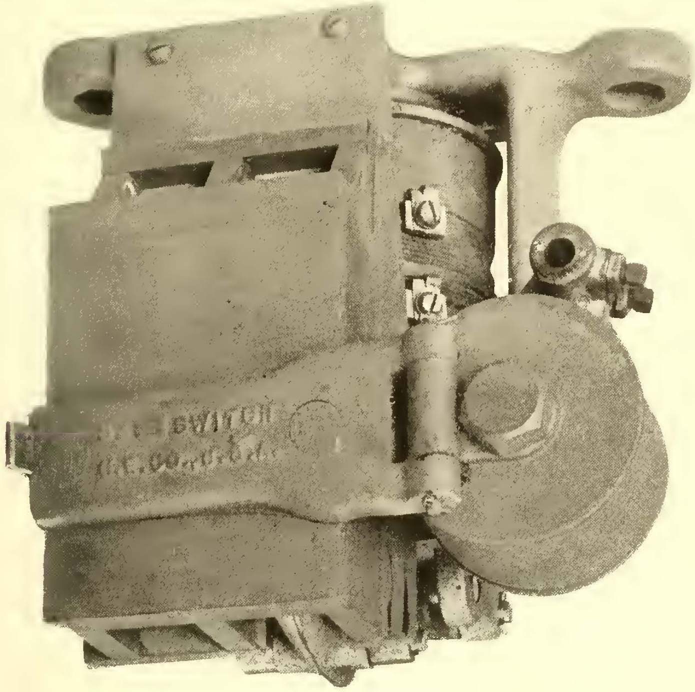


FIG. 3.—CONTACTOR

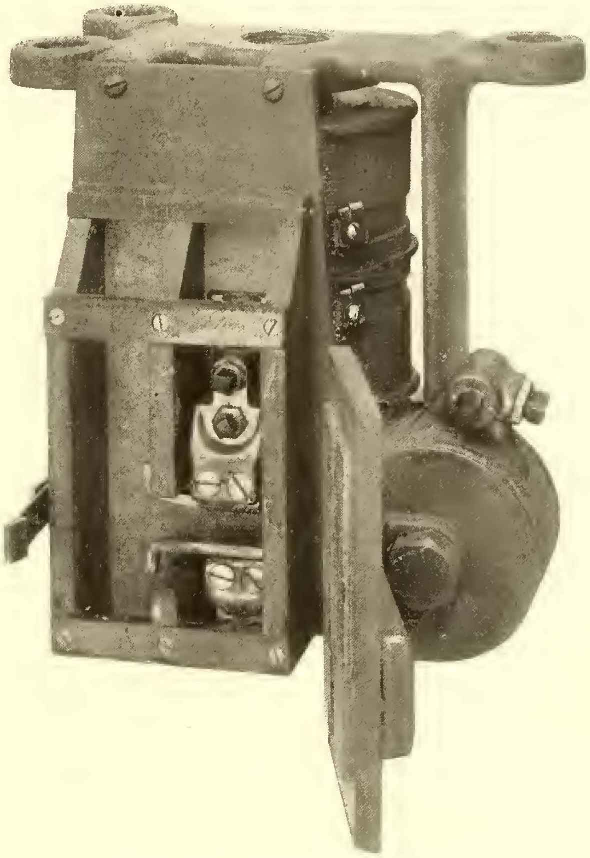


FIG. 4.—CONTACTOR POINTS OPEN FOR INSPECTION

The general design of the motor-reversing switch (Fig. 5), or reverser, is somewhat similar to the ordinary cylindrical reversing switch, with the addition of the electromagnets for turning it to either the forward or reverse position. The operating coils are similar to the ones used on the contactors, and the reverser may be placed under the car floor.

A switch is provided, so that it is possible to cut out on any or all of the contactor-operating coils, and it may be located in any position desired on the car. A small, quick brake single-pole switch and an enclosed fuse are also provided in the supply circuit for the protection of each master controller. When this switch is "open," all current is cut off from the entire control system through the particular master controller.

The coupling making the necessary connections between cars (Fig. 6) consists of a socket on the end of each car and a short cable or jumper with a plug at either end. The sockets on the cars contain a number of insulated metallic contacts, which are the terminal of the various wires in the train line. This socket is shaped to receive the plug on the end of the jumper. The plug contains the necessary insulated contacts to make the required connections, and is so shaped that it can be inserted in the socket in only one way, thus insuring the same series of connections each time two cars are coupled together. The couplers are provided with spring catches, which maintain contact under normal conditions, but permit them to release immediately in case the train breaks in two.

A special cable made up of different colored individual insulated wires is used whenever possible to make control circuit connections between the various pieces of apparatus, a similar cable being used for the connection between the coupler plugs.

The resistance portion of the C. G. starting rheostat consists of open cast-iron grids, which are assembled in an iron frame interchangeable with the P. R. rheostats, as regards location of bolt holes for attaching to the car. The grids are insulated from each other and from the supporting frame by mica insulation, making the entire resistance fireproof.

THE G. E. 66-A RAILWAY MOTOR.

The G. E. 66 railway motor (Figs. 7, 8 and 9) is specially designed to meet the requirements of elevated or heavy suburban railway work. The magnet frame is of steel cast in one piece in approximately the form of a cube with well-rounded corners, and in each end of the frame is a bored-out opening large enough to allow the removal of the armature, pole pieces and field coils. Into these openings frame heads are fitted and held in place by four bolts. The axle-bearing caps are bolted to a vertical planed tongued surface on the frame. The four-pole pieces are built up of soft iron laminæ, and are bolted to the top, bottom and sides of the magnetic frame by through bolts with nuts on the outside of the frame.

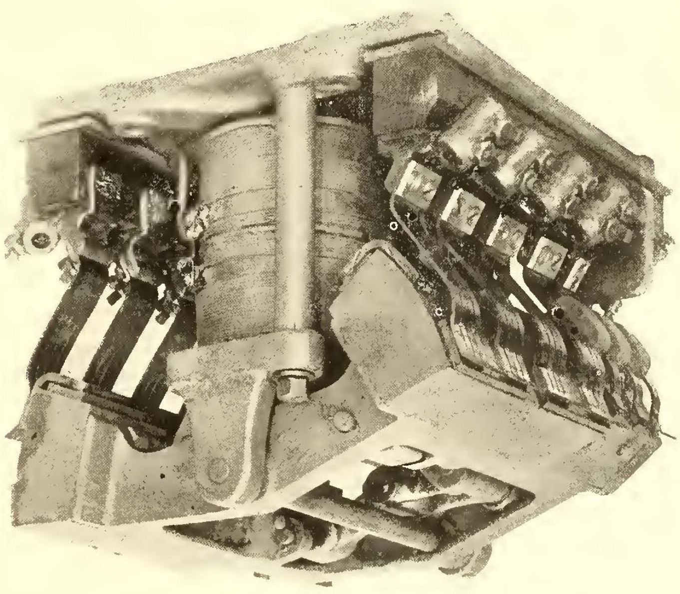


FIG. 5.—REVERSER

A large opening in the frame just over the commutator affords a means for the inspection of the commutator and brush holders and replacing of brushes. In the bottom of the frame, directly under the commutator, there is a large hand-hole, and in addition, for the purpose of ventilation, large openings are provided at the top, bottom and sides of the frame at the pinion end of the motor, and also on the front side of the commutator end. Covers are provided with which these holes may be closed.

The armature is wound with coils in series connection, the armature bars being of special construction, which prevents eddy currents. The conductors are connected up in thirty-nine quintuple coils, each consisting of five single coils of one turn each. The conductors are separately insulated and assembled in sets of five, the sets as a whole having an outside protective insulation. The insulation consists of mica, with an outside covering of specially prepared tape for protection from mechanical injury. This method of insulating the conductors makes the windings semi-fireproof, and they will withstand a high temperature without injury to the insulation.

The conductors are soldered directly into ears forming a part of the commutator segments, avoiding the use of connecting leads. At the back end of the armature the top and bottom bars are connected together with tinned-copper clips riveted and soldered, but easily removed in case it is desired to replace the top bars without disturbing the bottom bars. The conductors are held in the slots by tinned-steel wire bands imbedded in the core beneath the periphery, the wires being soldered together and held by tin clips.

The commutator has 195 segments of copper insulated entirely with mica, and clamped in a cast-steel shell. The diameter of the commutator is 14¾ ins.

There are four field coils, one for each pole, wound on metal spools, held in place by the laminated pole pieces. The windings are thoroughly insulated from the spools with mica, asbestos and cloth, and between turns with asbestos. This construction makes a practically fireproof spool impervious to moisture. It it not easily injured mechanically, and is specially well designed to radiate heat.

The armature bearings are supported in the frame heads which extend inside the armature and commutator. Lubrication is effected by the use of oil and waste in a manner somewhat similar to the ordinary car box bearing. The brasses are made in the form of a sleeve with the sides cut away so as to expose the shaft to the oily waste, which is packed in the oil wells cast in the frame heads. This form of bearing has proved in practice to be entirely satisfactory. Oil deflectors are provided which make it impossible for oil to get inside the motor. Under the armature shaft bearings drip cups are cast in the frame heads to catch the waste oil. The axle bearing caps contain oil wells into which are packed oil and waste. The brasses are cut away on the under side, leaving an ample surface on the axle exposed to the oily waste.

All leads are brought out through rubber-bushed holes in the magnet frame in such a way as to be easily removed if necessary. The brush holders are two in number, with two carbon brushes per holder. The brushes slide in finished ways and are pressed against the commutator by independent fingers which give a practically uniform pressure throughout the working range of the brush. The brush holders are adjustable and are clamped on mica-insulated studs sliding in finished supports bolted to the magnet frame.

The motor is single reduction, the gear and pinion being made of steel with 5-in. face and No. 3 pitch.

Special attention has been given to the matter of ventilation, and there are six large openings in the magnet frame giving practically a free circulation of air between the exterior and interior of the motor. The construction of the armature is such that a large volume of air is drawn into the interior of the core, and after passing through longitudinal ducts is expelled through large radial ducts. The armature is so designed that without sacrificing essential protection of the coils it practically becomes a powerful centrifugal blower when at full speed and the large volume of air pressing through it in connection with the small electrical losses in the motor keeps it unusually cool.

The insulation of the armature, commutator and field of the motor is subjected to a variety of tests, among which is an alternating test of the armature winding between copper conductors and core of 3500 volts, between commutator segments and shell

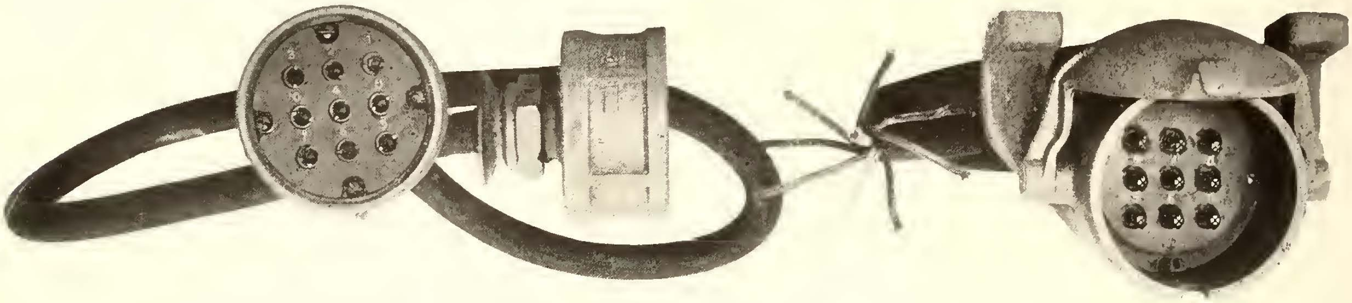


FIG. 6.—CONTROL CIRCUIT JUMPER AND SOCKET

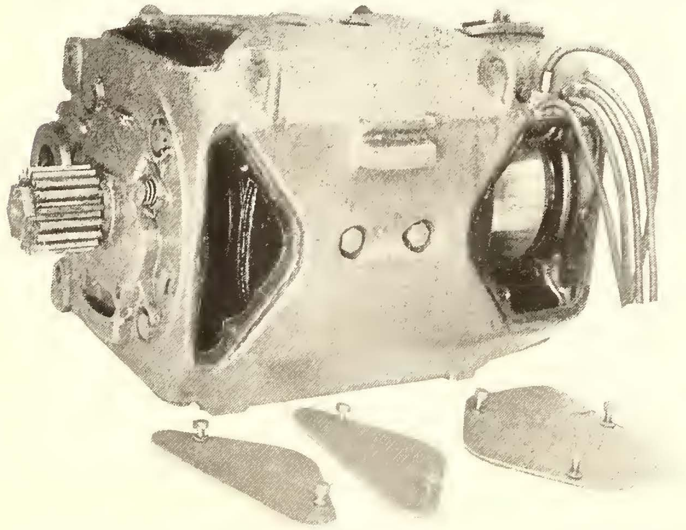


FIG. 7.—G. E. 66 MOTOR, FRONT VIEW WITH COVERS REMOVED

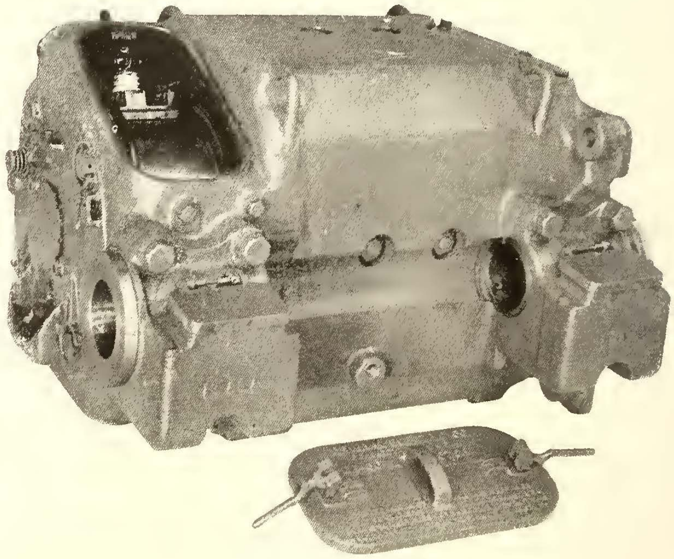


FIG. 8.—G. E. 66 MOTOR

of 4500 volts and between adjacent segments of 500 volts, and between field windings and frame of 4500 volts.

The approximate weights of the motor are as follows:

	Lbs.
The weight of the armature and pinion is	1,342
Gear	212
Gear case	120
Frame and other parts	2,606
Making complete weight of G. E. 66-A motor, including gear and gear case, but exclusive of covers for openings in motor frame	4,280

THE CP 14 AIR COMPRESSOR

This compressor (illustrated in Figs. 10, 11 and 12) is designed to supply air for train brakes, and is so shaped as to be conveniently attached to the under side of the car body. The compressor consists of a two-cylinder pump direct-driven by a series-wound four-pole motor. The motor is similar in general design to the G. E. 66 railway motor which has already been described. Its magnet frame is made up of a single piece of cast steel having large openings at the ends of the frame to permit the removal of the armature, pole pieces and field coils. Into these openings are fitted frame heads which carry the crankshaft bearings. The motor is provided with laminated pole pieces bolted by through bolts to finished surfaces on the magnet frame, and the field coils are insulated with varnished cambric, the whole being made waterproof by dipping in japan.

The armature is wound with twelve turns per coil and six coils per slot, the coils being bound in place by steel wire bands imbedded in the core beneath the periphery. The commutator has 149 segments insulated with mica and clamped in a malleable-iron shell.

There are two brush holders, with one carbon brush per holder. The brushes slide in finished ways, and are pressed against the commutator by a spring finger, which gives practically a uniform

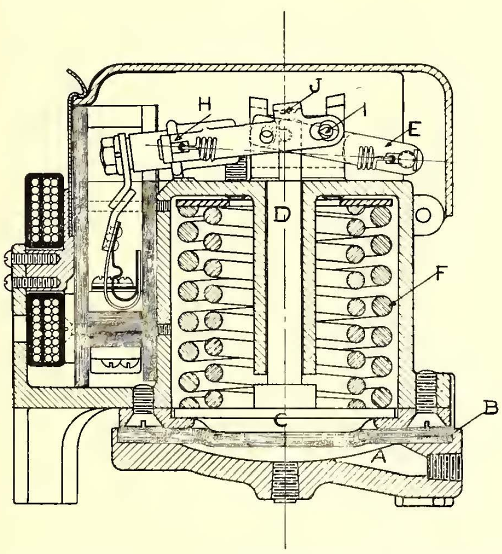


FIG. 10 —SECTION SHOWING CONSTRUCTION OF MOTOR REGULATOR

pressure throughout the working range of the brush. The holders are adjustable to the wear of the commutator, and are clamped on mica insulated studs, which, in turn, are clamped in finished supports bolted to the frame.

The armature or crankshaft is turned from one piece of forged steel. The crankpin is formed on the shaft outside the bearing, which is purposely made large so that the crankpin comes inside the diameter of the bearing, thus permitting the cylinder and crank end frame head to be drawn off without otherwise taking apart the compressor.

A hole is drilled into the commutator end of the shaft and extends nearly the entire length, and at right angles to this hole and leading into it are smaller holes which lead into passages in the armature extending to the periphery of the core. Excellent ventilation is obtained with this construction without any material increase in the dimensions of the compressor.

The commutator end frame head and also the combined crank end frame head and cylinders are made of iron cast in one piece, fitted into openings in the ends of the magnet frame and each held in place with four bolts.

Large oil wells are cored out for lubricating the piston, shaft, crank and wrist pin bearings. The two cylinders are horizontal and at right angles to the shaft. They are in direct line with each other, being cast in one piece, and completely enclose the crank chamber with the exception of an opening at the end of the

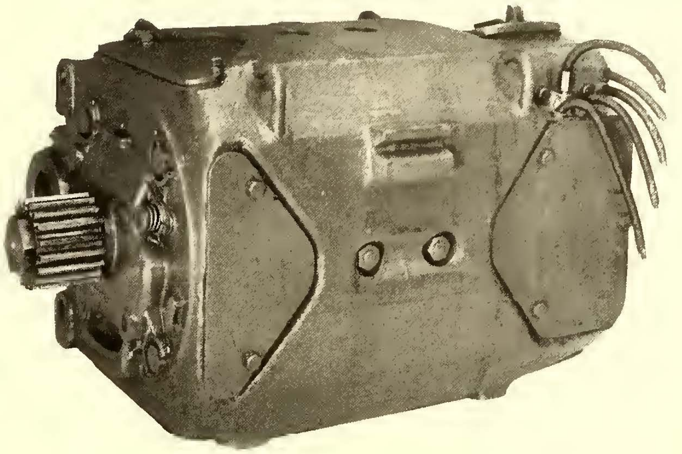


FIG. 9.—G. E. 66 MOTOR, FRONT VIEW

crankshaft to allow easy access to the crank and wrist-pin bearings, and to permit the removal of the connecting rod. The oil wells and the openings in the side of the crank chamber are provided with covers held in place with suitable fastenings. An air passage directly over the top of the cylinders and extending from end to end is cored in the casting, thus connecting the two outlet parts in the cylinder heads, and from this passage is led the main outlet or reservoir pipe. Each cylinder is single acting, and is provided with radiating fins, which tend to considerably increase the strength of the cylinder walls and to reduce the cylinder temperature.

There are but four bearings all told, including armature or crankshaft and connecting rod bearings. The shaft bearings are lubricated with oily waste packed in oil wells and pressed against the shaft, similar in construction to the G. E. 66 motor. The connecting rod bearings are self-lubricated by a special device which conducts a small quantity of oil to the bearings at each revolution of the armature. The same device lubricates the piston.

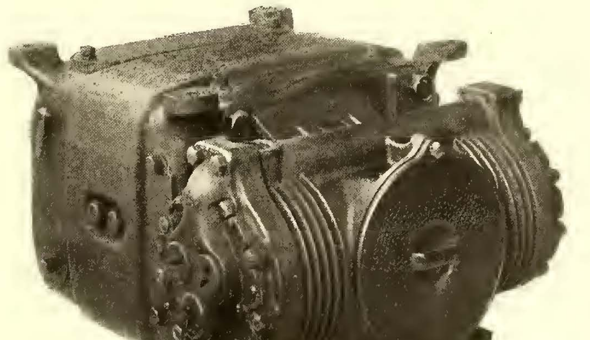


FIG. 11.—AIR COMPRESSOR AND MOTOR

The two pistons are rigidly connected together in the form of a hollow cylinder, with a head at each end and the sides cut away. One piston carries the wrist pin, and by this means both pistons are operated with one connecting rod. This double piston is provided at each end with two cast-iron spring packing rings.

The connecting rod is of gun metal, cast in one piece, of an I-beam section, and ribbed in such a manner as to provide greatest strength with the least weight. It may be taken out by removing the wrist pin without disturbing any other portion of the compressor.

There are two cylinder heads, one bolted to each of the cylinders and each head is provided with finished places for the inlet and outlet valves. A chamber is cored around the outlet valve for the free escape of air to the connecting passage in the cylinders. For the purpose of making the valves easily accessible, the chamber containing the outlet valve is covered with a large plug screwed to a copper, and the whole head is well ribbed to increase the radiation of heat.

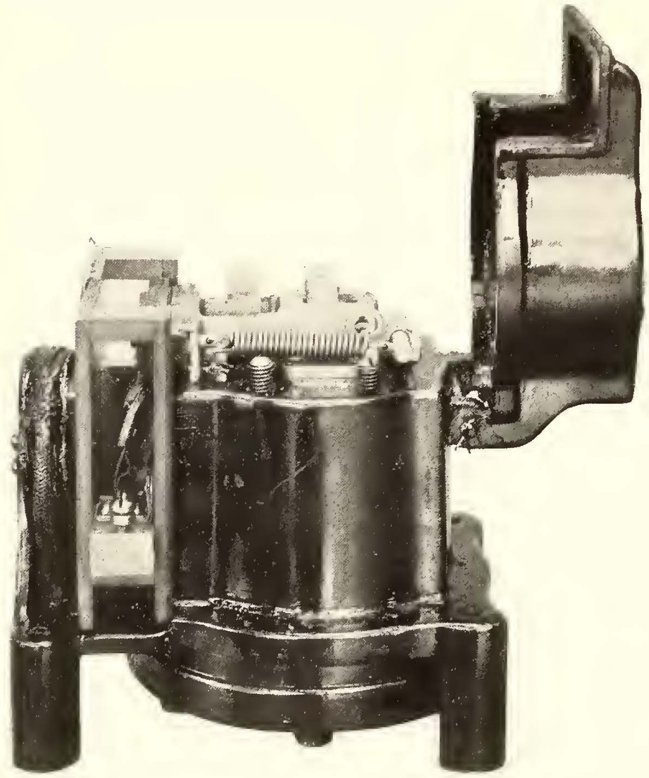


FIG. 12.—AIR PUMP GOVERNOR

The valves are designed to reduce the noise to a minimum, and the clearance and proportions are such as to give maximum efficiency. Simplicity of construction, liberal area in air passages and cheapness of renewals are the points which have been given especial consideration in the design of this compressor.

THE AIR COMPRESSOR. GOVERNOR.

This governor consists of a piston working in a cylinder and operating by means of its piston rod, a system of levers which open and close the switch of the pump motor circuit. The governor can be adjusted to operate at any pressure between 80 lbs. and 100 lbs., and will close the circuit on a reduction of 10 lbs. from the opening pressure.

Referring to Fig. 10, the air pressure is admitted to the lower side of the cylinder head at *A*, and acts against a 5-16-in. rubber diaphram *B*, which in turn bears against a piston *C*, to which is attached a piston rod *D*. This piston rod extends through the governor to the top, engaging with a lever *E*, which is pivoted to a bracket. As the piston is forced up by the air pressure in the main reservoir, it overcomes the mainspring *F*, raises the lever *E*, carrying with it the two springs *G*, which are attached to the main contact arm *H*. The contact lever *E* has no connection with the parts operated by the piston, except through the spring *G*, and is, therefore, free to fly open when the springs *D* are carried over the center. The arm *H* carries the contacts which finally open the pump motor circuit.

If from any cause the governor should fail to operate the opening of the pump motor circuit is positively assured by a continued movement of the governor piston, which would be forced up by the increase of air pressure until its rod engages with the set-screw *J*, thereby forcing the arm *H* upward, thus breaking the circuit.

A magnetic blow-out is provided, which assists in extinguishing the arc. Pipe taps are provided in three different places, in order that the governors, which will operate in any position, may be readily piped to suit the location. An insulated pipe bushing is used with each governor. Each governor will operate six of the C. P. 14 pumps operating in parallel.

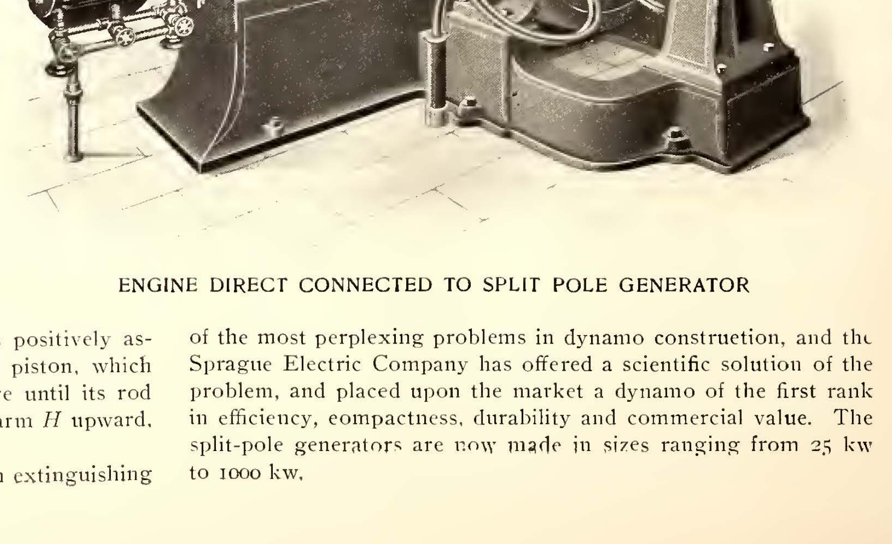
Durability of Gears and Pinions

Among the manufacturers who have made rapid progress in street railway supply lines since the last convention is the United States Projectile Company, of Brooklyn, N. Y., which makes the well-known "Projectile Brand" cast-steel cut gears and patent pressed pinions for electric railway and other purposes.

The durability or life of gears and pinions is a most important matter with every master mechanic, and to this problem the United States Projectile Company has given much attention, its experience of the past ten years in working up steel of varying hardness for the severest tests for the United States government aiding it materially in this work. The result of its labors and experiments is the .30 carbon special steel pinion, solidified under a pressure of over 1,000,000 lbs., which, it claims, is the most durable pinion produced. The carbon in the average cut pinion is stated to be .12, and very seldom, if ever, over .15, as it is too costly to cut a higher carbon (and thus harder) steel. It will, therefore, be seen that the "Projectile Brand" pinions have 100 per cent more carbon than cut pinions, which, with the great compression to which the steel is subjected, accounts for the increased mileage and longer life. This company also makes cut pinions, but it strongly recommends the pressed pinions as being much more durable. The "Projectile Brand" motor gears are made of the best open hearth steel castings, cut on the latest and most improved gear cutters, and their construction is of the very best. Many large contracts have been closed during the past few weeks, and the present output of the works is more than double that of any time in its history. Special attention is given to export trade.

Split Pole Generators

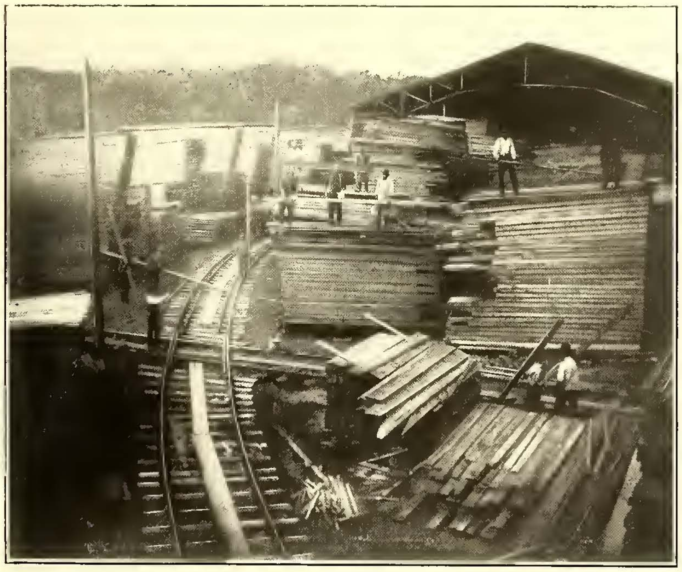
The split-pole generators manufactured by the Sprague Electric Company have been in operation for several years, and their success marks a new era in dynamo construction. They derive their name from the ingenious construction of the pole pieces, by which sparking, one of the principal factors limiting the output of all dynamos, has been overcome. The method employed is a very simple one, and results in a fixed point of commutation and a reduction in the total weight and dimensions of the generators. Overcoming the distorting effect of the field current has been one of the most perplexing problems in dynamo construction, and the Sprague Electric Company has offered a scientific solution of the problem, and placed upon the market a dynamo of the first rank in efficiency, compactness, durability and commercial value. The split-pole generators are now made in sizes ranging from 25 kw to 1000 kw.



ENGINE DIRECT CONNECTED TO SPLIT POLE GENERATOR

The New Regime at the Stephenson Works

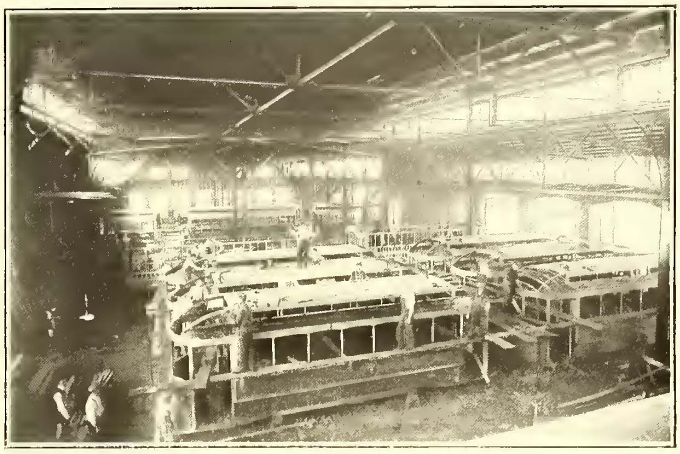
The name of John Stephenson, during the great number of years in which it has been connected with the street car industry, has always stood for excellence in every detail. Notwithstanding the various financial vicissitudes which have overtaken the Stephenson companies, this reputation for honest material and workmanship has remained a distinct feature of the establishments, and it is, therefore, a subject for congratulation that the excellent mechanical department has at last been supplemented by a sound financial directorate. About a year ago, as is well remembered, the John Stephenson Company, Ltd., was reorganized under the name of the John Stephenson Company, with Joseph C. Willetts for president and Peter M. Kling, general manager. Under Mr. Kling's direction the works have rapidly increased their business until it has been found necessary to double the capacity of the buildings as they were found by him a year ago. This greatly increased business has afforded opportunity for the manufacture of several new types of trucks and other car accessories which are meeting with great success on numerous roads, especially in the East. It has also awakened a lively interest in the many specialties of car construction with which the name of Stephenson has been associated, which, though during the semi-inactivity of the manufacturers have more or less been removed from active competition in the field, are well remembered by street railway engineers.



A PORTION OF THE LUMBER STORAGE

The illustrations presented herewith show the manner in which the shops have been increased in size. The layout of the buildings is such that the woodworking mill, erecting shop, paint shop and varnish shop are placed in a row, with the constructing tracks running parallel to the direction of the row. The number of these tracks has been doubled and the capacity of the paint shop and varnish shop has also been increased by 100 per cent, one or two of the tracks in these shops being necessarily used for the storing of material, etc. In this way, the additions which have recently been made have doubled the amount of space which the company can use for building purposes, and there is now room on the floor for one hundred cars under construction. The number of orders on hand will, however, keep the extra room furnished quite up to its greatest capacity. About five months ago W. J. Maekle, formerly with the American Car Company, of St. Louis, left that company to accept the position of superintendent for the John Stephenson Company, and it has been under his supervision that the recent marked improvements in the works have been taking place. The necessary increase in machinery which has resulted by the facilities for greater output are being rapidly made, and the smooth working of all departments is assured by the excellent system of order and checking systems which are employed throughout the entire works.

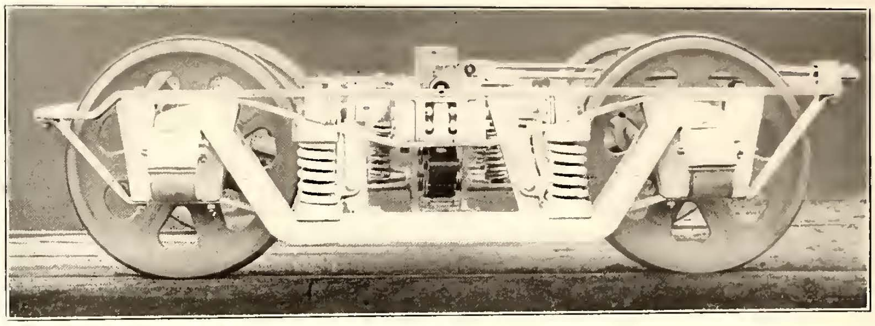
All of the ironwork about the cars, except the castings, is made in the blacksmith and machine shops, which are placed near the row of woodworking buildings. Several steam hammers, a bulldozer and oil furnaces for heating the iron are installed in these shops, and enable the Stephenson Company to watch closely the quality of the wrought ironwork found upon its cars. The various styles of trucks which have been perfected are here made. Already four different types of trucks have been designed, which are well illustrated in the accompanying engravings. These trucks are intended for high-speed, four-motor work, and are built on lines originated by the company, although they contain all the important features of the M. C. B. construction, such as equalizing bars, swing bolsters and perfect accommodation for the brake mechanism. In two of the trucks the motors are hung inside of the axles, while in the others they are hung on the outside. The bolster is held at each end by helical springs, which give it a resilient transverse play, and is hung in links and carried on strong steel-webbed elliptical springs from the equalizing bar connecting the journal boxes, as shown. In this way a very easy-riding construction is produced. In the illustrations the bolster beam is shown somewhat higher than the position it would occupy when placed under the car body, the weight of the car body compressing the elliptical springs and lowering the beam into place between the firmly fastened iron guides upon each side of it. The No. 6 truck is intended particularly for interurban work, and is copied after the M. C. B. standing, except that the frame is of wrought iron, and set low enough to allow of the truck being used on a one-step car. On account of the superior distribution of the springs, the No. 20 truck is claimed to be superior to any other 4-ft. wheel-base truck in the market. Heretofore the springs have been located over the oil boxes, but in the Stephenson truck they are extended beyond the oil boxes, giving a better support to the truck frame and easier riding.



THE ERECTING SHOP—NEW EXTENSION AT BACK

THE WOOD WORKING MILL

The No. 10 truck is designed especially for close work on cars and streets which are narrow, and where the curves have a short radius. There is no interference of any kind above the oil boxes, enabling the truck to swing in a very small space. The main support is a strong double wrought-iron frame suspended on four spiral springs at each side, with the railway swing bolster mounted on elliptical springs. The truck is made in the 4-ft. wheel-base size only, with motors mounted outside the axles, and the brake mechanism hung between the wheels. The No. 12 truck is of exceptionally heavy design, intended especially for the severest interurban service. It will accommodate the largest motors built, such as G. E. 55 and Westinghouse 76. The main truck frame is supported on equalizing bars beyond the oil boxes, which insure steady riding at a high rate of speed, and the brakes are exceptionally powerful. The truck frame is extra heavy and very strong, the M. C. B. principles being carried out with the improvement that the equalizing bars have been extended so as to give additional spring support to the truck frame. It is claimed that this truck will ride as easy as the six-wheel Pullman. All the above-mentioned pivotal trucks are made with M. C. B. journals with large, roomy oil boxes, insuring the least possible trouble from hot bearings and kindred troubles.

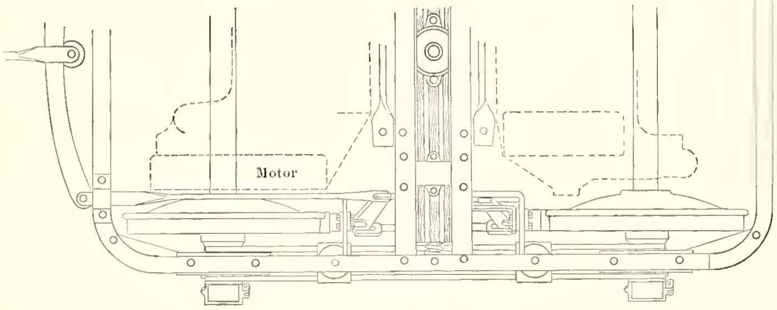


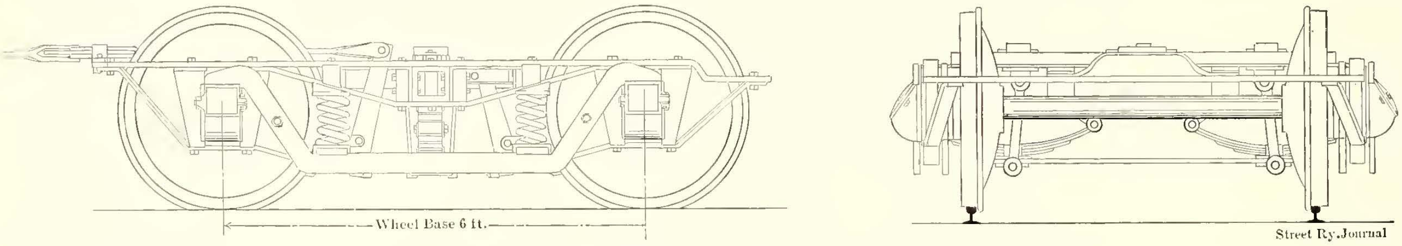
STEPHENSON NO. 6 TRUCK

Among the interesting features, and one, perhaps, of greatest importance to the purchaser who desires a first-class car in all respects, is the immense wood storage owned by the company. Between 5,000,000 ft. and 6,000,000 ft. of all kinds of lumber, including a large stock of oak, ash, etc., for constructing purposes, and of mahogany, cherry and other finishing woods for interior decoration, are found in the yards back of the shops. Most of this lumber is from eight to ten years old. Additions, however, are being constantly made to the stock, so that the supply of well-seasoned timber will always be retained.

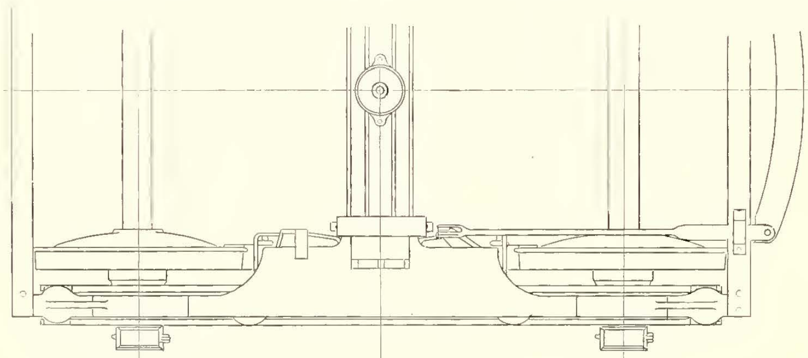
The Stephenson Company has recently completed an order for fifty open cars for the Brooklyn Rapid Transit Company, and has another order from the same company for fifty cars of its combination chair type. Another order recently completed is seventy-five open cars for the Consolidated Traction Company, of Pittsburgh, Pa. All of these cars are built in accordance with the specifications of the railway companies, and are of their standard style and finish.

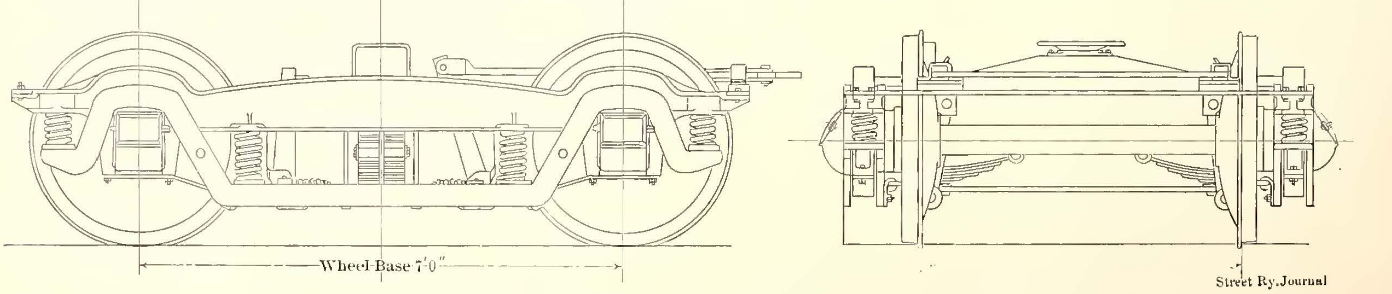
Another order for cars in which the Stephenson principles will show to advantage comes from Schenectady for the new Schenectady-Albany line. These cars are 36 ft. 2 ins. over the body, and are divided into two sections, consisting of a smoking and a passenger compartment, separated by swinging doors. The cars are to have cross seats of the "walkover" type, made by the American Car Seat Company. These cars will be fitted with No. 6 trucks equipped with General Electric motors. The cars are of the semi-convertible type, large window openings being provided when the windows are opened. An order for ten convertible cars is also being filled for the Utica Railway. In these cars the sash are divided, the upper half sliding to the roof and the lower half





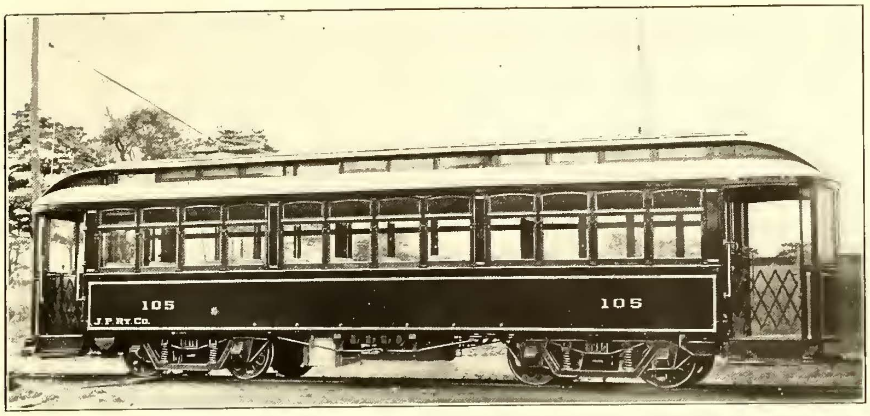
HIGH-SPEED TRUCK NO. 6



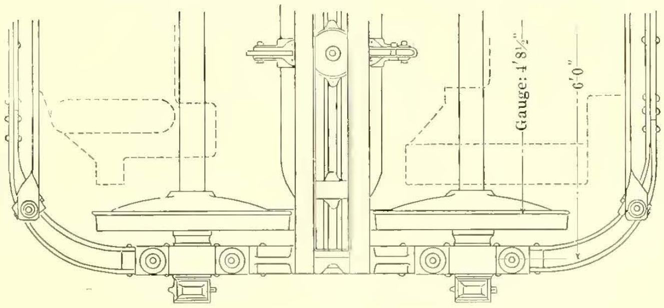


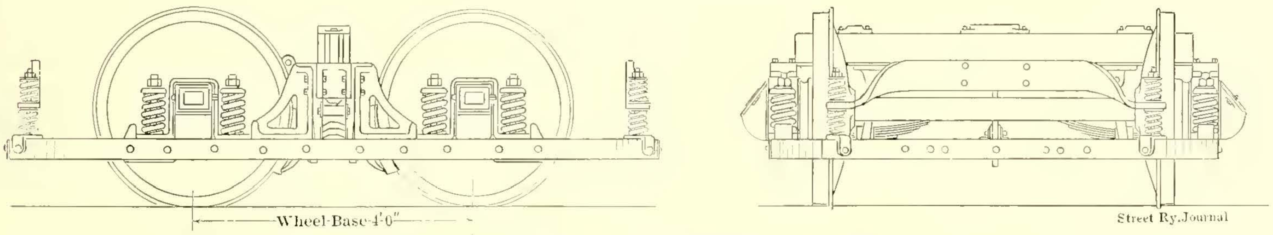
DOUBLE-MOTOR TRUCK NO. 12

dropping into the sides, which are in this case made slightly concave. As these cars are intended to run always in one direction on a looped track, there will be a vestibule in front alone, furnished with curtains to prevent the lights of the car interfering with the motorman's view of the track. The cars will be fitted with Brill trucks No. 27 and Westinghouse No. 47 motors. A number of large, straight-sided cars have been ordered from various parts of the country. Twelve 28-ft. body cars are to be sent to the interurban line at Doylestown, Pennsylvania, two of which will have 10-ft. baggage compartments. These cars will be fitted with the new No. 20 truck, illustrated in the engraving. Twenty-five 32-ft. body cars of the same general style, but having smoking and toilet compartments, are to be sent to the Pittsburgh, McKeesport & Connellsville Railway Company. These cars will be furnished with Brill trucks and four Westinghouse No. 56 motors. The handsome cars, of which both the interior and exterior are illustrated in the accompanying engravings, and which are to be sent to Lexington, Mass., are fitted with the Stephenson spring bumpers, Stephenson draw-bars and other Stephenson appliances. The spring bumpers are especially designed to prevent the car from receiving severe shocks in collisions, etc., and by their use a great improvement over the ordinary rigid construction is made. The bumper extends 8 ins. in front of the car, and is held out by the pressure of strong helical springs. When an obstruction is encountered by the bumper these springs will collapse for a distance of 3 ins. or 4 ins., greatly relieving the strain on the car-body superstructure and rafters. The John Stephenson draw-bar is of strong spring design, so as to greatly relieve jerks and strains on either the motor car or trailer. The springs of this draw-bar are contained in a box made of a malleable-iron casting, and placed sufficiently far underneath the car to give an easy sweep to the draw-bar when going around curves. These Lexington cars are fitted with Bemis trucks, and there are four cars in the order.



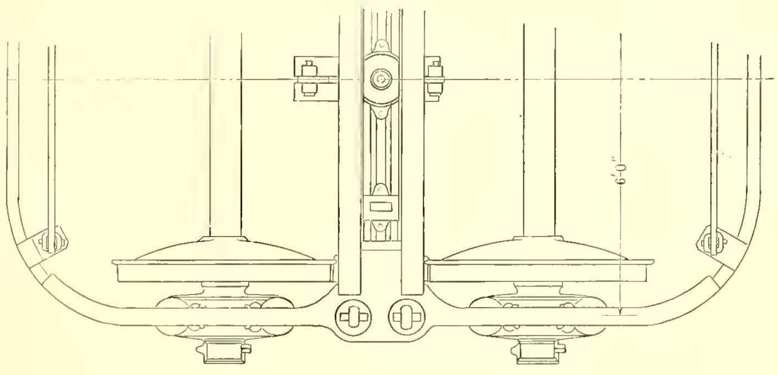
LONG CAR FOR JOHNSTOWN, PA., WITH NO. 6 TRUCKS

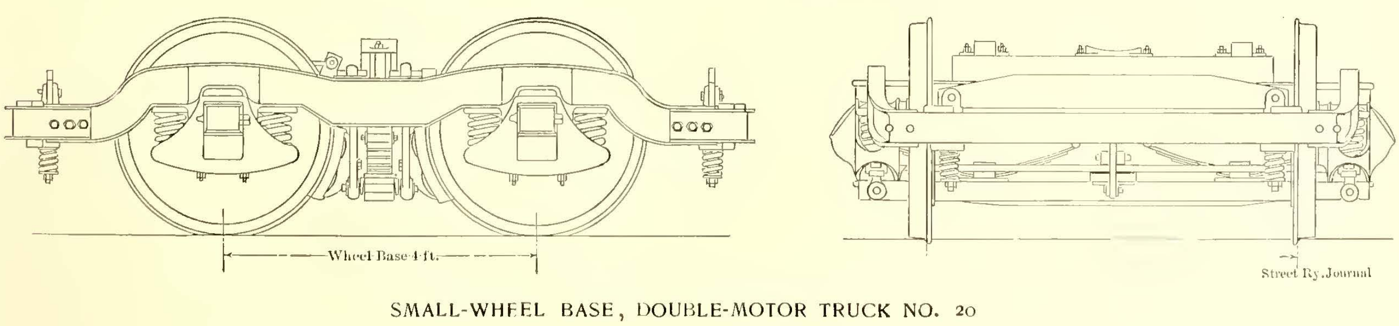




SMALL-WHEEL BASE, DOUBLE-MOTOR TRUCK NO. 10

The John Stephenson Company's Works, as an example of an up-to-date manufactory, are of great interest. All the latest improvements, including numerous labor-saving devices and much apparatus of the most improved type, have been introduced for preventing inconvenient delays and annoyances, and everything about the operation of the factory which would tend to confusion has been carefully eliminated. The comfort of the workmen has been provided for by excellent wash-room facilities, good ventilation of the various rooms, and all the shops are lighted by electricity and heated by a hot-water system. All shavings, sawdust, etc., are removed from the machines as soon as made, by pneumatic suction tubes, and are blown by electric fans directly to a bin over the boiler house, where they are afterward burnt under the boilers. All the machinery is operated by electric motors, one motor





SMALL-WHEEL BASE, DOUBLE-MOTOR TRUCK NO. 20

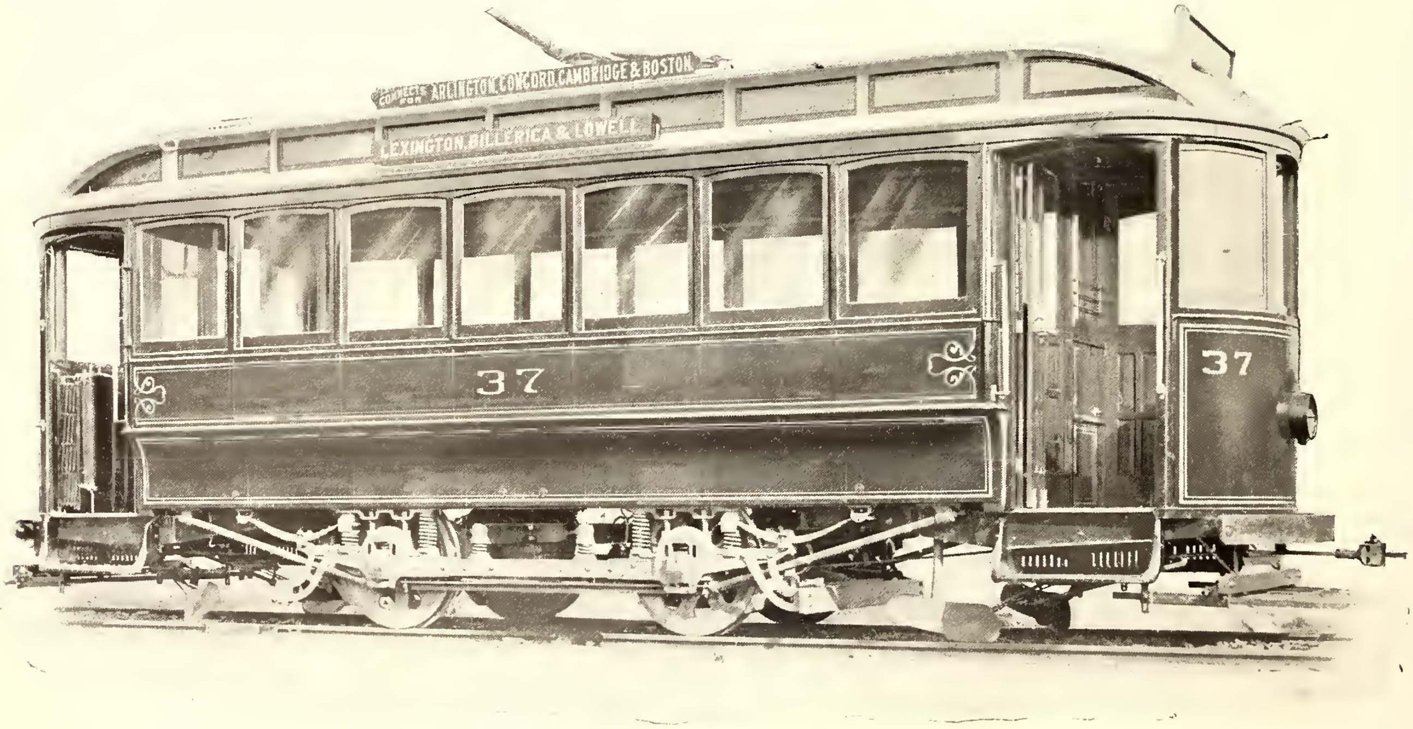
in many cases operating two or three tools. A complete electric transmission system is installed throughout the works, which operates these motors as well as the transfer tables and switching dummy by which all railroad cars are moved about the yard.

INTERIOR OF JOHNSTOWN, PA., CARS

The plant is equipped throughout with a sprinkler system and most perfect hydrant system for protection against fire. The arrangement of the erecting, painting and varnishing shops in line, with transfer tables between, makes the handling of the cars when passing from one to another extremely easy, and the great rapidity with which work can be turned out is made possible by the excellent manner in which the many minor details of operation have been looked after. At present the plant is producing two cars per day.

The situation of the works at Elizabeth places them in a most advantageous position from both standpoints of transportation facilities and labor supply, and was selected after a large amount of careful investigation of possible sites. The plant occupies a plot of ground which is eighty-two acres in extent. At Elizabeth, or more properly the suburb, Bay Way, where the works are situated, the company can draw labor from Elizabeth, Cranford, Rahway, Elizabethport, Newark, Bayonne and the north shore of Staten Island, all attractive living places, not only from their proximity to New York, but from their local advantages. A large water front is here provided and two railroads—the Central Railroad of New Jersey and the Baltimore & New York Railroad—have direct connection with the Stephenson property, while indirect connections are obtained through these lines with the Lehigh Valley and Pennsylvania Railroads. The officers of the company, besides President Willetts, General Manager Kling and Superintendent Mackle, already mentioned, are William Duryea, vice-president, and Leander M. De Lamater, secretary and treasurer. E. J. Lawless is general sales agent for the company, and it is due to his well-known ability to secure orders that the shops are working up to full capacity. With such a personnel, both on the financial and technical sides of the business, the John Stephenson Company is placed in the foremost ranks of the car-building industry.

INTERIOR OF LEXINGTON CARS



ONE OF THE HANDSOME CARS FOR LEXINGTON, MASS.

Large British Generators

The English Electric Manufacuring Company, Ltd., it will be remembered, began the manufacture of electrical machinery at the new works at Preston in June of last year, since which time it had completed and shipped to various customers, up to July 3 of this year, nearly 1200 tramway motors, varying in size from 25 hp up to 100 hp in capacity each. In addition to this the company has supplied the necessary controllers, rheostats and car equipment for the equipment of about 600 cars. The company has not, however, confined itself entirely to the production of tramway equipments, in fact this is only one department of its enormous business. A much more important part of the factory is now fully employed in the production of direct-current generators, both for lighting and power. The company has received, during the year, orders for a large number of these machines, varying in capacity from 100 hp to 1200 hp. Some three months ago the first of these generators was shipped, and since that time machines of varying sizes have been forwarded from Preston, not only to several cities and towns in England, but to South Africa and India. The Preston generators are peculiar in their construction, because of their extreme simplicity in design and the very few parts which constitute a complete machine, as may be seen in Fig. 1.

The magnet frame is circular in form and is made of a special quality of cast iron, having a very high magnetic permeability. It is provided with inwardly projecting pole pieces, and is divided horizontally so that half of the frame can be removed for the inspection or removal of the armature. The lower half of the frame is provided with two large feet, to insure a firm footing upon the foundation girders. The poles, Fig. 2, are made of the finest quality of laminated steel, cast into the magnet frame with a cast-welded joint, thus insuring a very low reluctance in the magnetic circuit. They are also provided with detachable pole shoes, which act as keepers or supports for the field magnet spools. Test pieces are taken from every frame casting, and submitted to the most careful test, to determine its magnetic qualities; the sheet steel

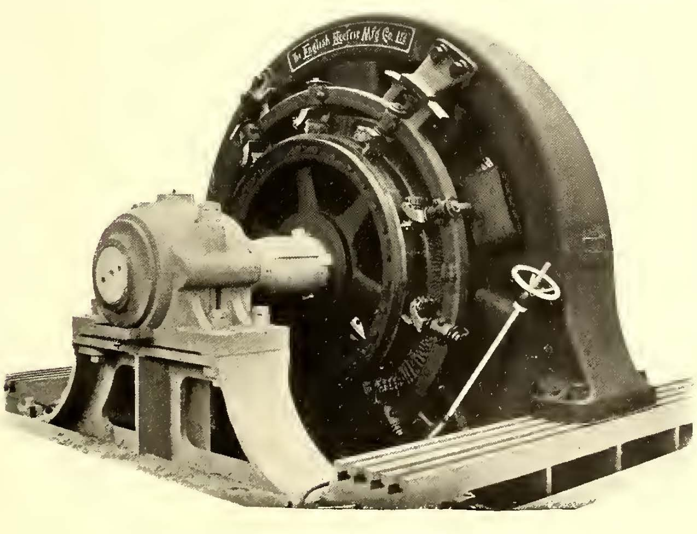


FIG. 1.—STANDARD GENERATOR

which is used in making laminated pole pieces is also submitted to the same test, and any material which does not come up to the required standard is rejected.

The field coils are wound upon spools made of steel, with brass ends, one portion of the spool being occupied by the shunt winding, which consists of double cotton-covered copper wire of 100 per cent conductivity. The other portion of the spool contains the series winding of ribbon copper, there being only one turn per layer, insulated most thoroughly with mica and cloth.

The shunt coils and the series coils are insulated from each other by a combination of mica and red rope paper, and both coils are insulated from the spool by at least ¼ in. of the same insulation. After the winding is completed the surface of the coil is carefully covered with a heavy paper wrapping, secured with a layer of braided rope covering, filled with insulating varnish. The finished coils are placed in a large baking oven, where they remain for several days, the temperature being high enough to take the last vestige of moisture out of the coils, rendering them perfectly dry. The varnish in the insulation and that in the covering hardens during the baking process, so that there is no opportunity for moisture to re-enter. These coils, while hot, are subjected to an alternating presssure of 2500 volts between the windings and the spool, or frame, of the machine. No joints are made in either the shunt wire or series copper, except at the surface of the coils, where they can be examined and kept tight. The pole faces of the magnet cores and pole shoes are bored out after the coils are in place, and the machine set in the position in which it is to run.

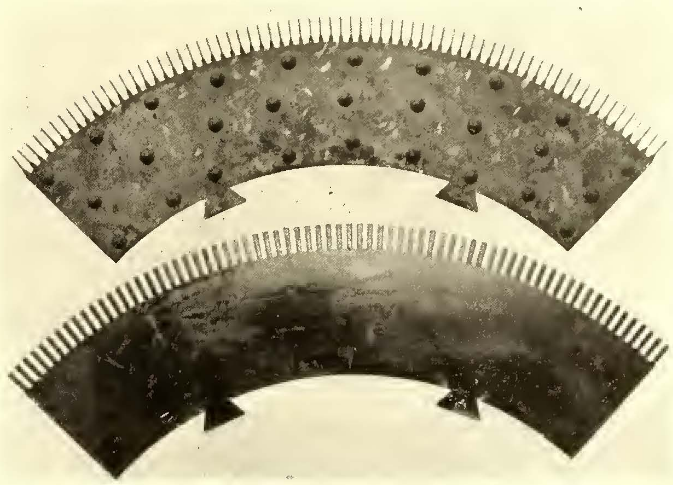


FIG. 3.—ARMATURE LAMINATIONS

This permits the frame to take on the form which it will have when finished ready for service, and insures the bore being exactly circular to receive the revolving armature.

The armature, or revolving part, of the generator is, of course, the most interesting. It consists of an armature spider, cast from the best quality of strong, tough iron, and is provided with a long-bearing surface for the shaft of the engine to which it is to be fitted. It is bored accurately to a gage supplied by the engine builder, and is made slightly smaller than the diameter of the shaft,

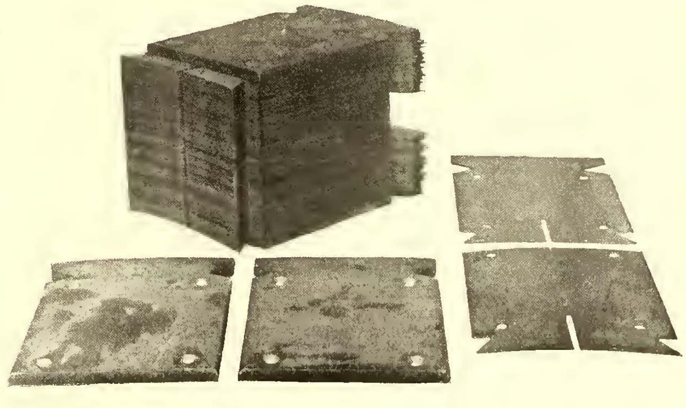


FIG. 2.—POLE PIECES

so that it requires about 100 tons pressure to force it into position; it is then secured with two keys.

The armature core is built on the ends of the arms of the hub and consists of punchings made from the best electrical steel. Before assembling, the armature laminations are thoroughly annealed and japanned to reduce hysteresis and the formation of eddy currents. At intervals of 3 ins. or 4 ins. spacing discs are inserted between the laminations to form ventilating ducts for cooling the interior of the core and the windings. The lower view in Fig. 3 shows the ordinary lamination used with projections punched out on one side of it; the upper view shows how the teeth are twisted at right angles to their former position, thereby forming an excellent spacing disc. After a sufficient number of these armature laminations, or discs, are built together to form the armature ring or core, they are clamped in place by cast-iron flanges, which are also made to support the armature windings which extend beyond the ends of the armature core. Figs. 4 and

5 show the armature in this stage of completion. The first shows clearly how the supporting flanges of the armature cores are left open and ventilated, so that the air may pass freely through the end windings of the armature. Fig. 5 also shows the front end plates of the armature without any flanges, there being no supports to the end windings of the armature next the commutator. In fact, the company is using, as far as possible, air insulation for these machines instead of the old methods. Fig. 6 shows an armature partly wound, and illustrates how the windings at the back

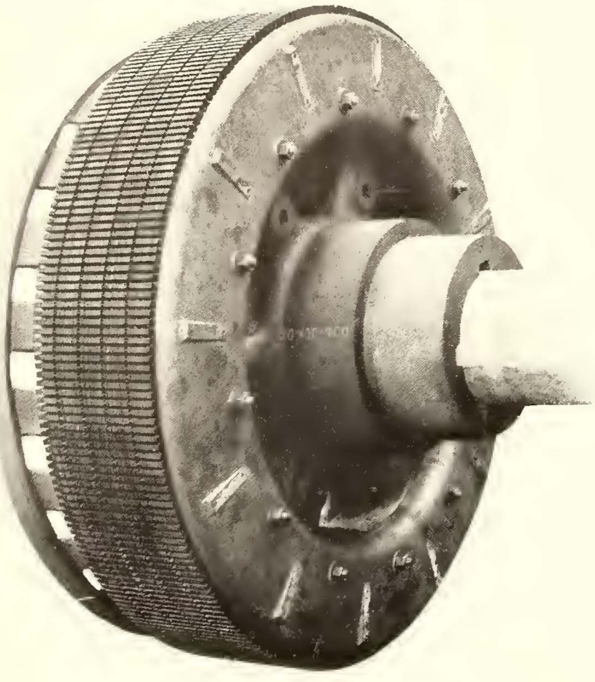


FIG. 4.—ARMATURE CORE BEFORE WINDING

end are supported only at their extreme points, while the winding at the front end is supported only by the commutator leads. These windings are supported, as can be seen, in such a way that the air passes freely through these end windings without obstruction of any kind. Between the commutator and the armature core are

mica, rendered impervious to moisture by a superior varnish. Like the field coils, the armature coils are subjected to a baking process, which renders them perfectly dry. The insulation of the entire armature circuit is subjected to a high pressure alternating-current test while hot. Fig. 7 shows a complete armature banded.

An extension of the armature spider carries the commutator hub, to which it is securely keyed, thus preventing any relative motion between the commutator bars and the armature windings. On the periphery of the cummutator hub the hard-drawn copper commutator bars are firmly clamped by means of steel end rings. The insulation between the bars and the hub is made from the purest India mica, while that between the bars is made from a peculiar quality of silver mica. This insulation is so carefully made that in testing between the commutator bars and the hub, the alternating pressure may be made so high that the current will creep over the edge of the mica rings, a distance of from 1 in. to 2 ins., without puncturing. To the back end of the commutator bars flexible copper leads are riveted, extending ardically up to and connected with the armature windings. These joints are all exposed, and can be inspected at any time, so that if repair is required it is only the work of a few moments.

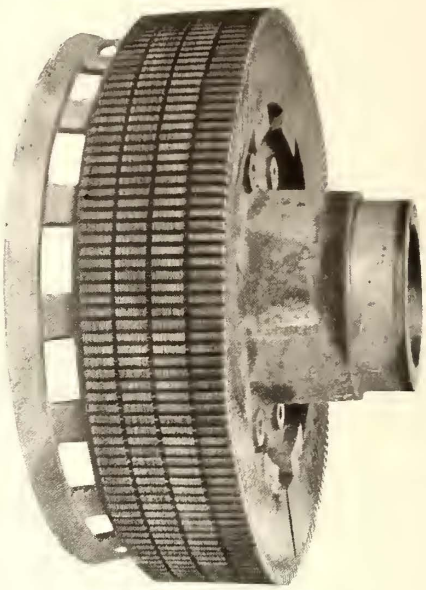


FIG. 5.—ARMATURE CORE BEFORE WINDING, END PLATE REMOVED

Fig. 8 shows how the commutator rings are manufactured, all in one piece, some of them being made 7 ft. or 8 ft. in diameter. It

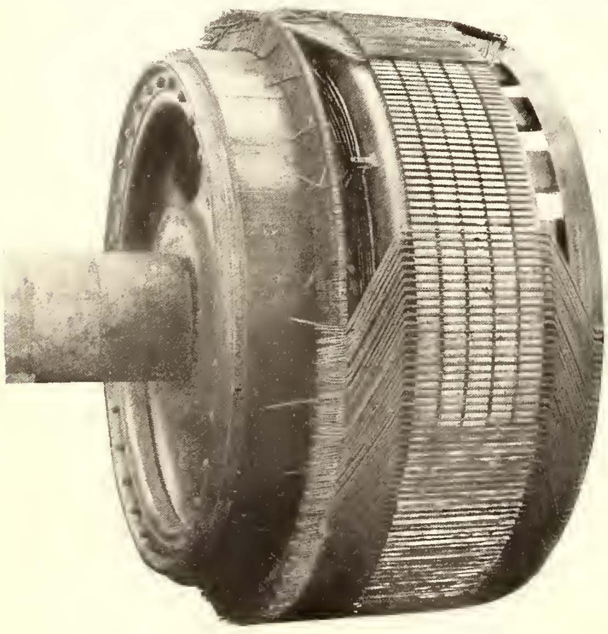


FIG. 6.—ARMATURE PARTLY WOUND

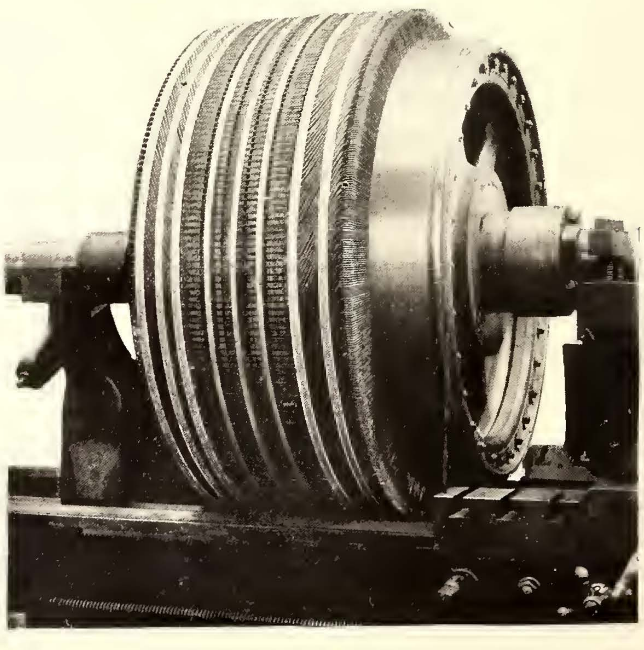


FIG. 7.—ARMATURE WITH BANDS IN PLACE

mounted the balancing rings, which are used on all the parallel-wound machines made by this company.

The coils are made by bending copper ribbon over a suitable former, making them all alike and interchangeable. It is, therefore, easy to wind the armature and to replace injured coils. The armature inductors are thoroughly insulated from the core and from each other with a special material, consisting largely of

also shows a number of armature coils in various stages of completion, and a field magnet spool wound and unwound.

The electric pressure between adjacent commutator bars is kept under 10 volts, so that there is no possibility of an arc standing between the bars over the 1-32 in. space between them. A balancing device is attached to the commutator to equalize any slight difference in the magnetic reluctance of the various magnetic circuits of the multipolar machine, thus checking the slightest tendency to spark.

The brushes used to collect the current from the commutator are made from the purest carbon. They are held in position by brush holders, carried on laminated copper strips, having an easy, adjustable pressure, which will follow any regularities in the commutator. The brush holders are so designed that no moving joints carry the current, and are mounted on a massive rocker ring, supported by four brackets, attached to the generator frame. All of the brushes can be rocked simultaneously by means of a hand wheel

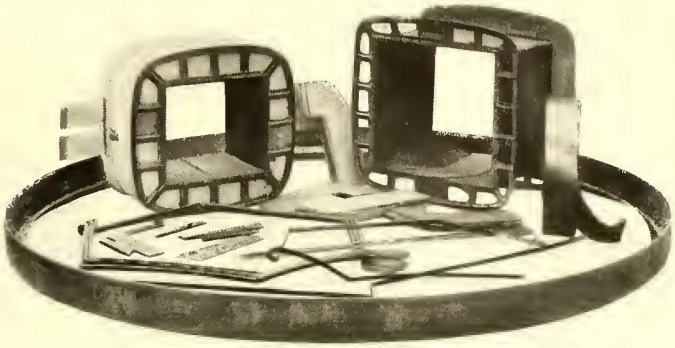


FIG. 8.—COMMUTATOR RING, ARMATURE COILS AND FIELD COILS

and screw, geared to the brush rocker ring. Two massive copper cross connecting bars, concealed inside the brush rocker ring, collect the main current from the brush holders, and deliver it to a connection board at the bottom of the machine. The view of the rocker ring in Fig. 9 clearly shows this arrangement of

run for ten and sometimes twenty-four hours continuously, at full load, and are subjected to from 30 per cent to 50 per cent overload

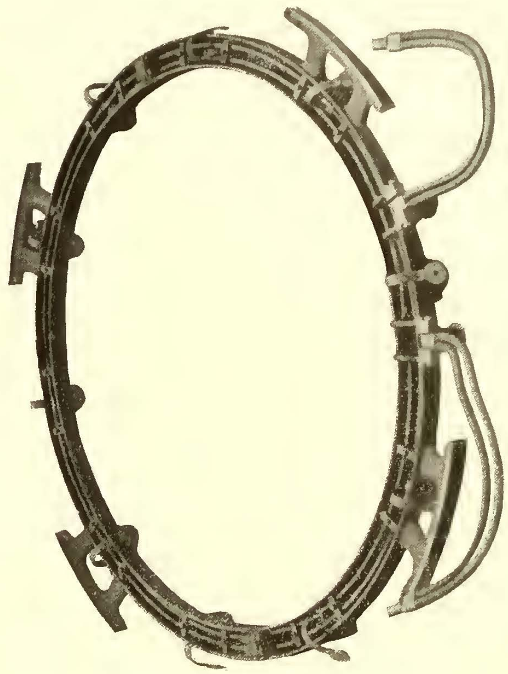


FIG. 9.—ROCKER RING

in addition to the all-day run at full load. The remarkable performance of these machines is illustrated by the low temperature

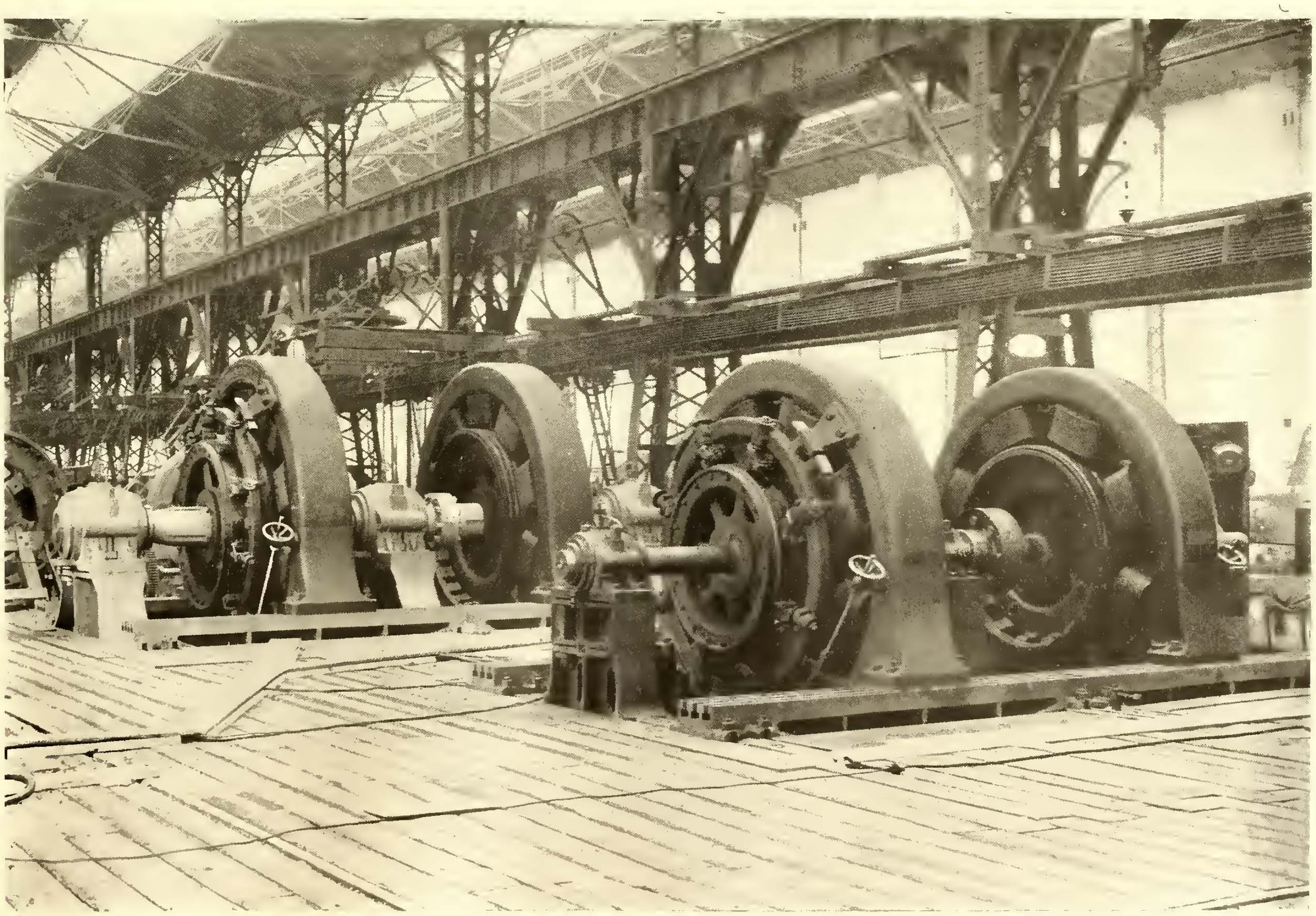


FIG. 10.—SHIPPING DEPARTMENT, SHOWING GENERATORS UNDER TEST

cross connecting rings inside the box-shaped casting of the rocker, so that they are not visible from the front of the machine.

The company has provided two large testing pits near the shipping department (Fig. 10), where these large machines are erected and submitted to the severest possible test. They are

rise and high efficiency which they show. A 400-kw machine which was tested a few days since, after running for ten hours at full load, was made to carry 50 per cent overload for two hours and only showed a rise in temperature of 57 degs. F. above the surrounding air, as illustrated by the accompanying temperature

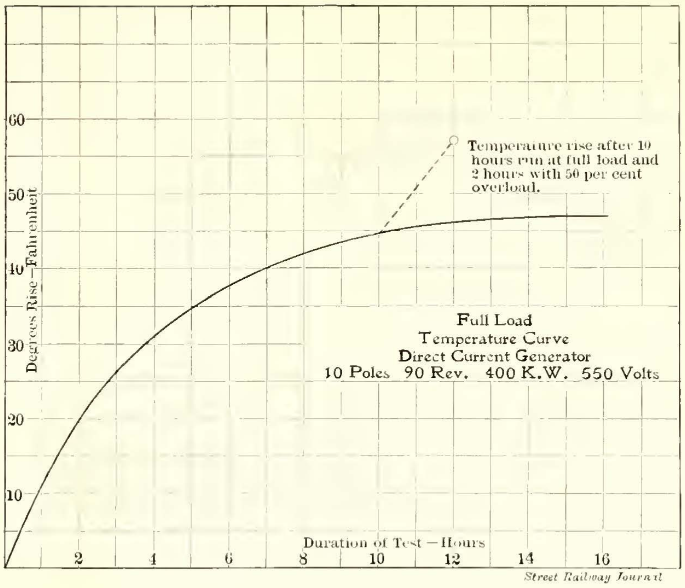


FIG. 11.—TEMPERATURE CURVE OF 400 KW GENERATOR

curve (Fig. 11). The commutators at the end of the severe test did not even feel warm to the hand. The performance at the commutator is also remarkable in that there is absolutely no sparking under any condition of load, and without the slightest movement of the brushes from no load to any load that can be put upon the machines; in fact, the longer the commutator runs the more beautiful the polish which it assumes, due to the action of the carbon brushes upon the surface of the hard-drawn copper. The tests made upon this machine were by the Hopkinson method, as shown in Fig. 12, so that the losses in the various parts of the machine were determined and the efficiency arrived at most accurately. The curves showing the losses and efficiency are shown in Fig. 13. An open circuit magnet curve (Fig. 14) was also secured, which shows the excellent quality of the material used in the construction of these machines.

These qualities in a generator will be appreciated particularly by engineers in charge of railway power stations, where the fluctuations of load will one moment require the generator to work to nearly double its capacity and the next moment the load will be entirely off. With machines of this kind the great irregularity in the demand for power will not in any way make it more difficult to operate a station than if the load were absolutely constant, because the machine will perform just as well under these great variations as they will under constant load.

Another great advantage in having generators which will carry a very heavy overload for several hours at a time without injurious heating is that they will take care of heavy tramway loads on holidays and in the mornings and evenings, when everything is taxed to its fullest extent.

New Jewett Car Works

The new works of the Jewett Car Company, Newark, Ohio, occupy 10 acres traversed by the Pennsylvania and Baltimore & Ohio Railroads. The buildings cover a space of nearly 5 acres. The company is now building 60-ft. excursion cars for the Columbus, Buckeye Lake & Newark electric road. These are the largest electric cars yet constructed. The Jewett Car Company has also extensive contracts with the Metropolitan elevated road of Chicago and with the Brooklyn Rapid Transit Company for the Brooklyn elevated lines of New York. The cars of the latter, being 48 ft. 11 ins., are the largest cars built for elevated lines. Peckham trucks are used throughout. All of these cars are models of elegant, serviceable, commodious construction. The company is running overtime, and would use two sets of operators if they could be procured. A. H. Sisson is manager and salesman, and the prosperous condition of the company is due largely to his skill and energy.

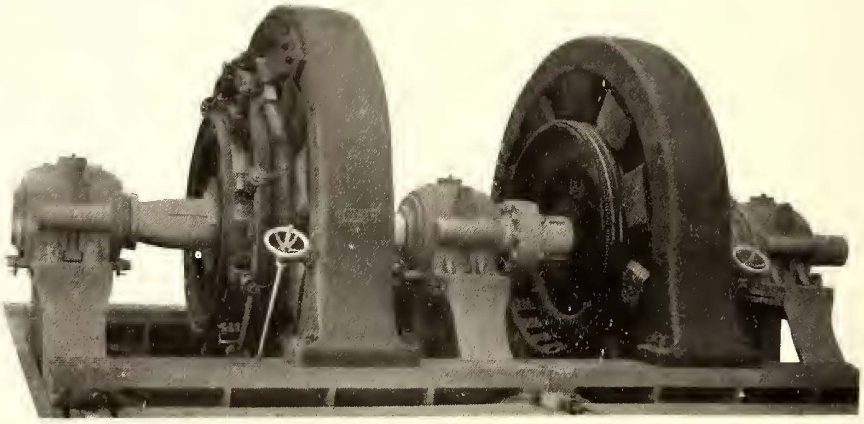


FIG. 12.—TESTING SET

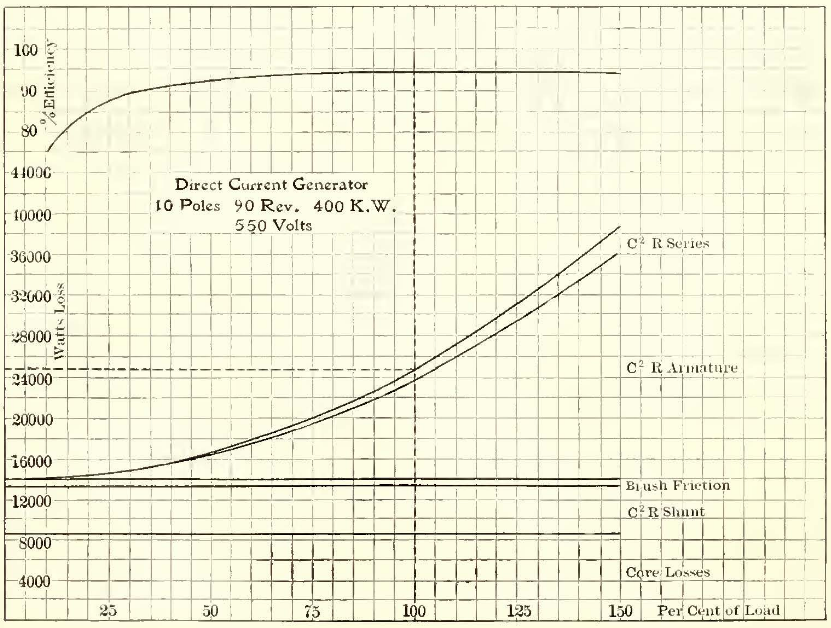


FIG. 13.—CURVES OF LOSSES AND EFFICIENCY

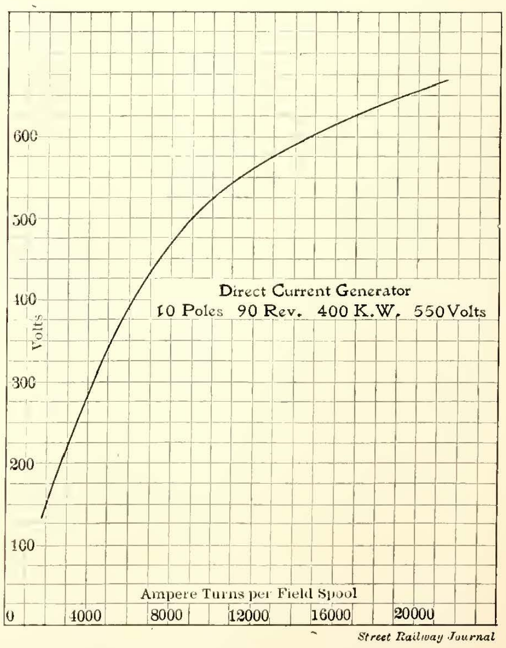
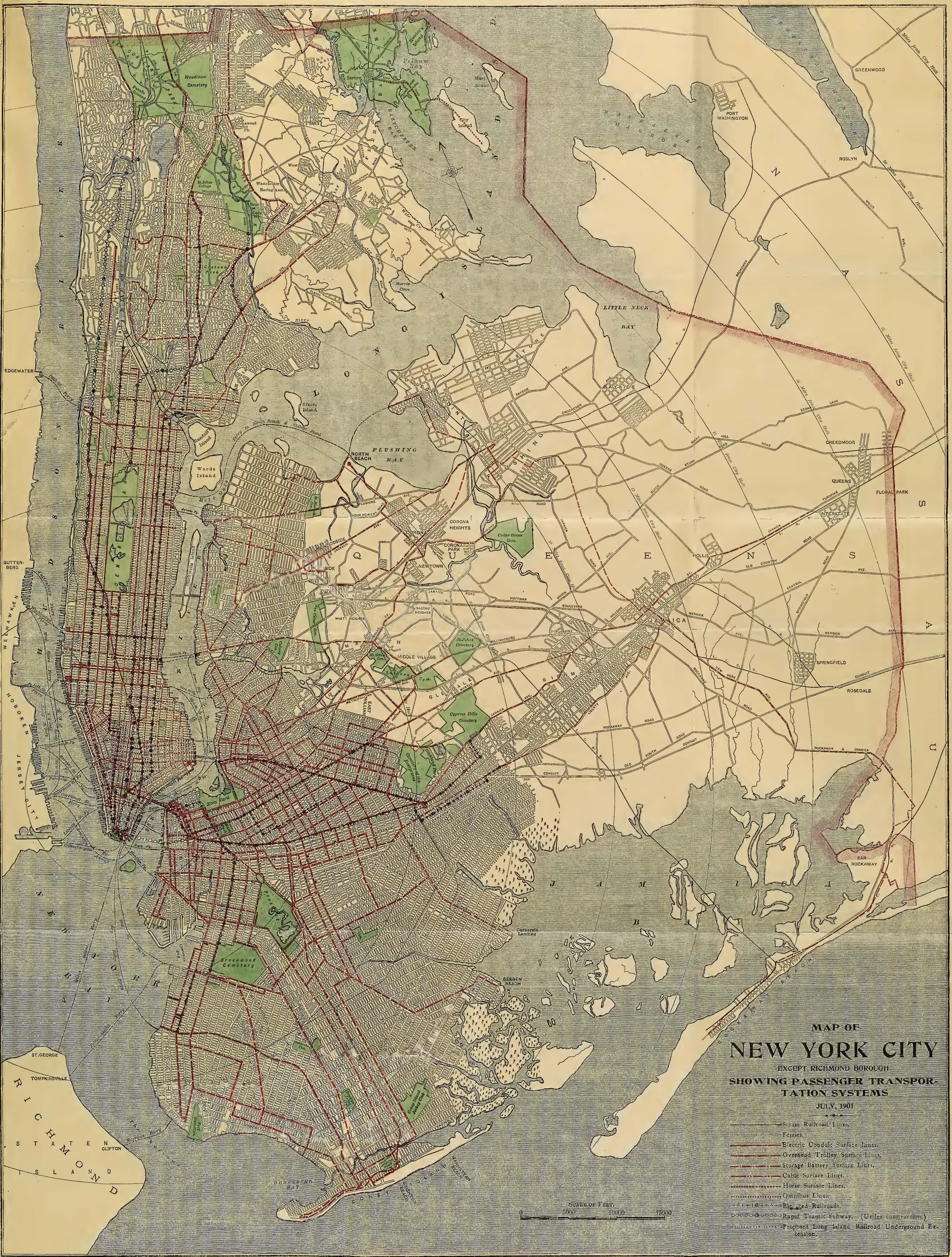


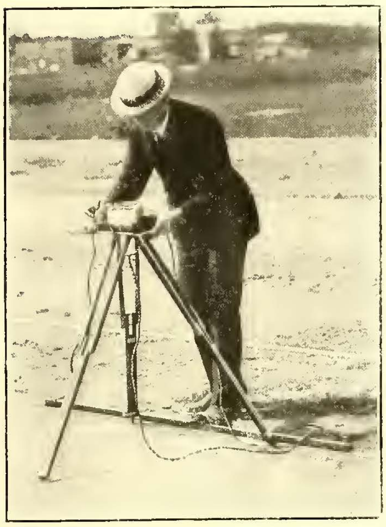
FIG. 14.—OPEN CIRCUIT MAGNET CURVE



Accompanying article on "Traffic Conditions of New York City," by Frank R. Ford, in October 5, 1901, STREET RAILWAY JOURNAL.

A Rapid Bond Testing Outfit

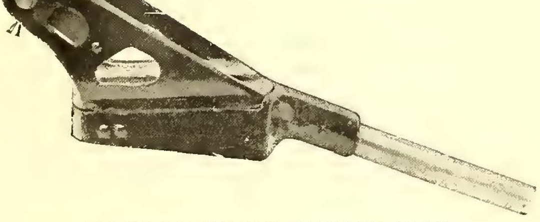
Some time ago mention was made in these columns of the bond-testing device which Michado & Roller, New York, general selling agents for the Whitney instruments, are putting out for the use of electric railway companies. The instrument proper, as then described, consists of two millivoltmeters, one of which is connected to show the drop of 5 ft. of rail at the same time that the other instrument shows the drop across the rail-bond. The two millivoltmeters are put in the same case. The advantage of this bond tester over others is that it can be used by one man. The method of its practictl use, not heretofore illustrated, is shown by the accompanying engraving. The instrument is mounted on a heavy tripod of the kind used for cameras. A folding stick 6 ft. long has its rail-contact points mounted upon it. When a reading is to be taken, the stick is put down on the rail with one foot put on it to secure good contact, as seen in the illustration. The middle contact is spring-mounted, so as to allow the end contacts to have a firm bearing. A feature which appeals strongly to the smaller companies is that one of the millivoltmeters can be supplied with shunts, so it can be used as a voltmeter and an ammeter, and is, therefore, useful for all the testing done on the road.



BOND TESTING OUTFIT

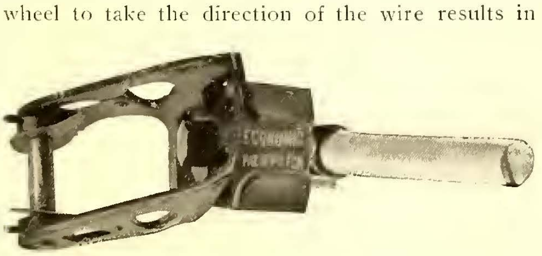
Swivel Trolley Harp

The "Economic" trolley harp, which is illustrated in the two accompanying cuts, is a harp which is arranged to be free to turn on a swivel so that the wheel can adapt itself to the direction of the wire on curves and turnouts. The arrangement of the swivel



THE "ECONOMIC" TROLLEY HARP

can be easily seen by inspection of the two engravings. It has been demonstrated many times that a swivel which allows the trolley wheel to take the direction of the wire results in much



VIEW OF HARP, SHOWING SWIVEL MOTION

saving of the wear on the trolley wheel flanges. The tendency for the wheel to leave the wire at special overhead work is also decreased because the wheel is free to adopt any curve or angle which the wire may take. Not only does a swivel harp decrease the wear on the trolley flanges and the liability of the trolley running off, but it saves the side strains on the wheel, which tend to make it wear through the sides of the harp, and lessens the wear on the trolley wire at the very points where there is the most wear, and where it is most desirable to decrease the wear. The harp is designed with the idea of preventing the accumulation of rust, and its wearing qualities are assured by case-hardened rollers. The harp is made of malleable iron ribbed, and sells for about the price of the ordinary harp. The device is made by the Economic Manufacturing Company, of Springfield, Ohio.

Laboratories for Feed-Water and Oil Analysis

The recently extended laboratories of the Dearborn Drug & Chemical Works in the Rialto Building, Chicago, one view of which is shown herewith, make a specialty of testing work for steam users. Special attention is given to the analysis of boiler feed-waters, lubricating oils, fuels, cements, iron, steel and brass. They are in a position also to give any problem in chemistry the most careful attention. For twelve years past they have given special study to the treatment of boiler feed-waters. The analysis of the waters is made and a treatment to overcome the exist-

IN THE DEARBORN LABORATORIES

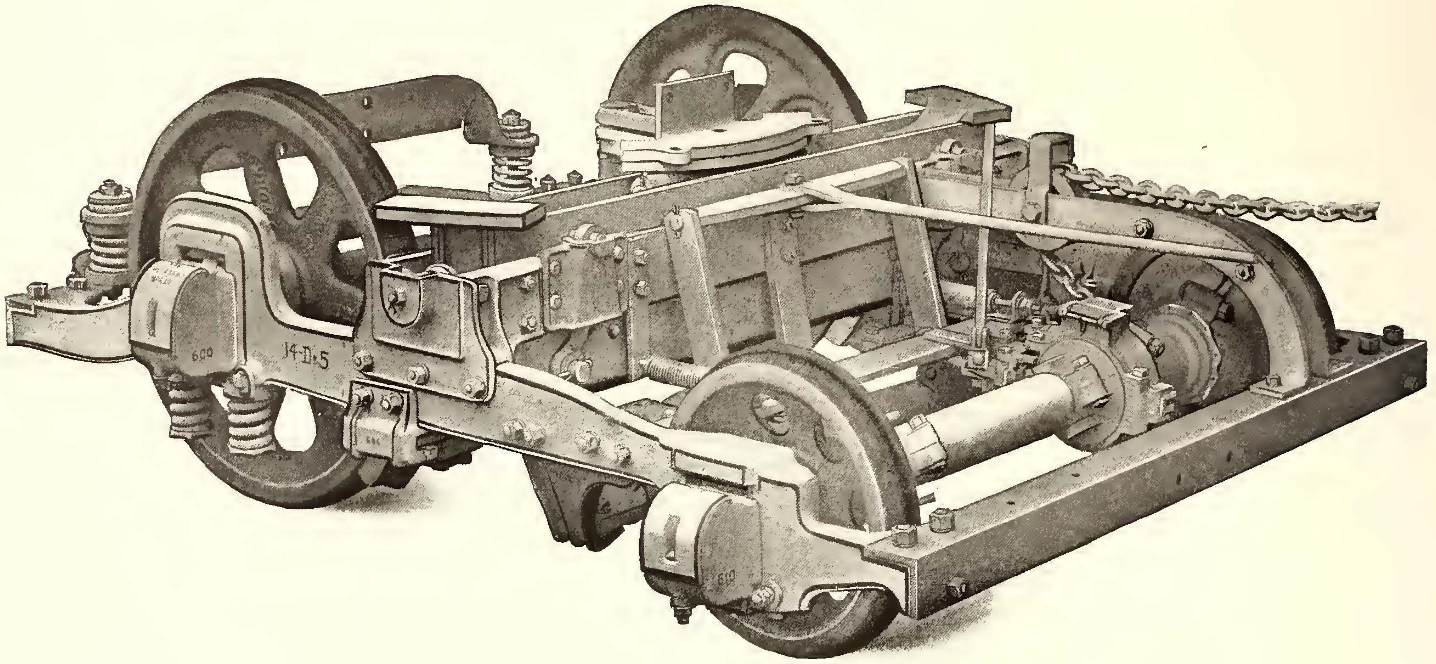
ing troubles from scale and corrosion or pitting, as the case may be, is outlined. A great number of the large stationary plants of the United States are to-day users of Dearborn feed-water treatment. Dearborn lubricating oils, made by this company, have demonstrated great economies in the operation of high-pressure stationary plants, as in most plants special care is given to the quantity used. The Dearborn motto has always been "quality first" in all the products manufactured. The Chicago works and laboratories represent an investment of $300,000. They have branch offices in the following cities: New York, Pittsburgh, St. Louis, St. Paul, San Francisco and Honolulu. The officers of the company are: W. H. Edgar, president; Robert F. Carr, vice-president and general manager, and C. M. Eddy, secretary and treasurer.

Electric Car Heating by Forced Draft

The Bay State electric car heaters are based upon the principles of the indirect steam-heating systems which have proved themselves so eminently superior to the direct radiation system when used for heating public halls and theaters. Fresh air is taken from the outside of the car and forced through the electric heater by an electrically-driven fan. From the fan the air passes into a duct, and by the pressure derived from the fan is circulated through the entire car, and is kept constantly in motion. The circulation of hot air going at such a pressure is not obstructed by the people in the car, and there is less tendency to excess of heat on any portion of the body than with radiated heat, as the circulation of air keeps the heat evenly distributed. The amount of heat that can be derived from a given amount of electrical energy is, of course, nearly the same as with any well-designed form of electric heater, and the question of difference of efficiency between heaters is largely one of distributing the heat to the best advantage. The Bay State heater, it is claimed, does this, and it is further claimed that the circulation and fresh air from the outside of the car provide air which is far purer and more comfortable than if the air was taken from the interior of the car and allowed to rise simply to be used over again. The fan is placed in series with the heater. The air duct is an enclosed wooden box running the entire length of the car, the front of which occupies the same position as the usual riser or heel board. At the lower edge of this board a slot extends the entire length of the car, and is graduated from about ½ in. at the heater to 1½ ins. at the far end of the car. Through this slot or opening the heat issues, and except for this and the opening next to the heater where the heat enters the duct is entirely closed. The amount of room taken by the heating outfit proper is less than that taken by stationary heaters. The Bay State Electric Heat & Light Company, of Boston, Mass., submits the results of tests, which go to show that a car can be effectively heated to the same temperature with 35 per cent less energy by this means of distribution than by natural circulation.

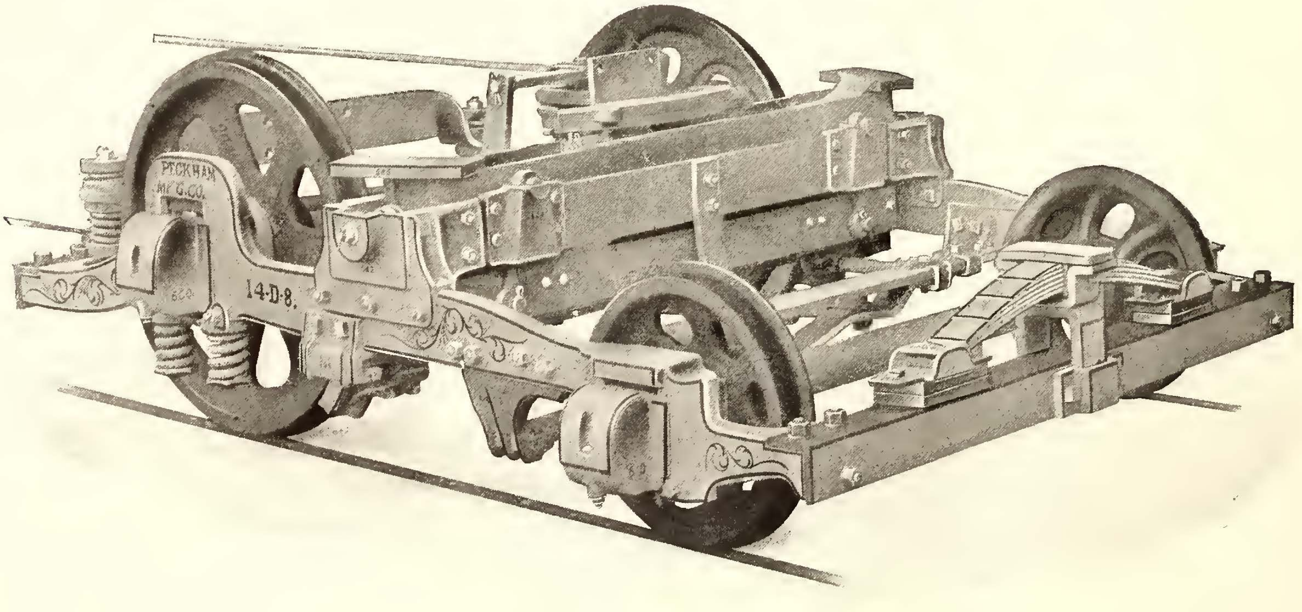
Some New Types of Trucks

The extensive line of trucks for all varieties of electric railway service, built by the Peckham Manufacturing Company, has recently been extended by the addition of three more double trucks, illustrated herewith. Of these the 14 D-5 and the 14 D-8 are maximum-traction trucks, and are intended for the class of service for which such trucks are particularly applicable, while the third, the M. C. B. 30 is designed for the heaviest high-speed interurban, elevated or trunk-line service.



14 D-5 MAXIMUM TRACTION TRUCK

The 14 D-5 and the 14 D-8 are similar in general construction, except that the former is intended for operation with the large wheels leading; that is, to have them nearest the ends of the car, while with the 14 D-8 the small wheels run forward, often under the platform timbers at each end of the car.



14 D-8 MAXIMUM TRACTION TRUCK

The side frames of this truck are made of the best soft steel castings and sufficiently strong to carry the heaviest car bodies. They are supported flexibly from the journal boxes, and are as "low down" as the motors will permit. Peckham's patent swing bolster is used in this truck. This bolster is constructed of steel channel-bars, supported upon a combination of half-elliptic and spiral springs, the elliptic spring being located in the center and the two spiral springs at each end of the bolster. Their strength is so adjusted that the spiral springs prevent the rocking of the bolster and reinforce the half-elliptic springs as the load of the car body is increased. The spring plant supporting the springs is suspended from the transom-bars by links, which are outwardly inclined so as smoothly to check the swing of the car. Buffer springs are inserted in the transom-bars and receive the end thrust of the bolster when it is inclined to swing too far.

The center-bearing swivel plates are constructed of segmental shape and provided with an oil chamber and wick for conveying oil to the center plates. The top and bottom swivel-plates are provided with projections so as to regulate the swing of the truck. The kingpin can be located at any desired distance from the axle.

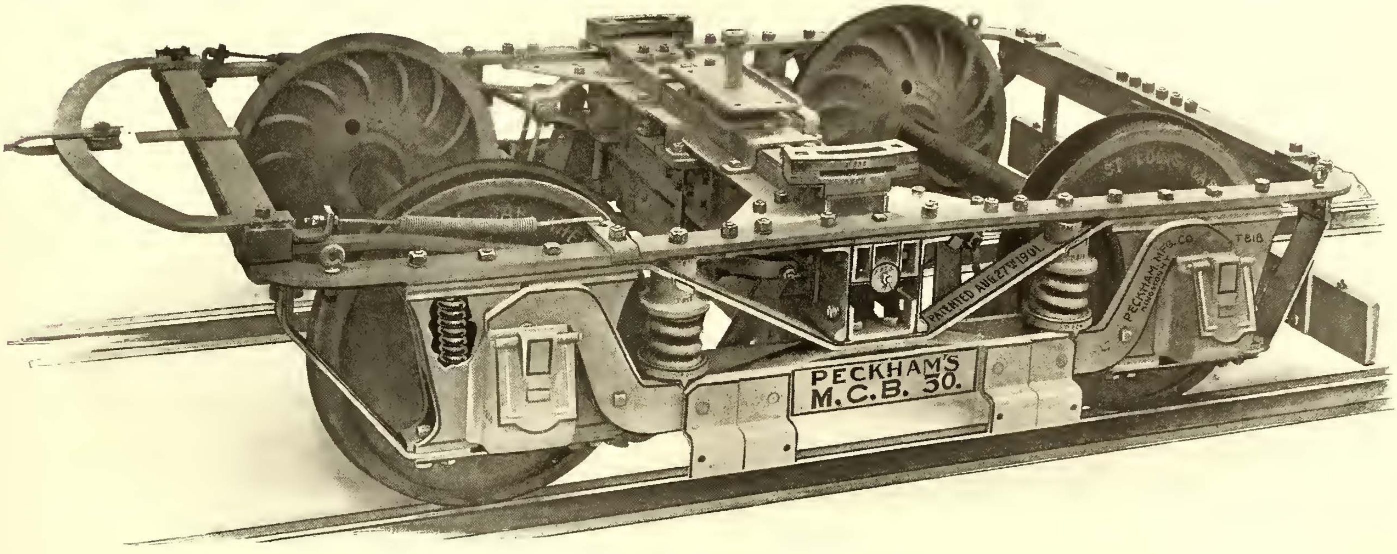
The end sections are of angle-bar shape, machine-fitted to the end extensions of the side frames and secured in place by machine-turned bolts. This construction, besides being very strong, keeps the truck square. Inside adjustable brakes are used, as shown.

The Peckham high-speed non-tilting M. C. B. motor truck No. 30 is illustrated in the next engraving. This truck is designed for two 150-hp motors per truck; that is, four per car. The side frames combine the equalizing-bars used in the standard M. C. B. steam passenger car trucks with that of the diamond frame used in the M. C. B. freight car trucks. This combination gives a double factor of safety, as the diamond frame alone is sufficiently strong to carry the weight of the car without the aid of the equalizing-bars, which are arranged in pairs, one each side of the pedestals. To prevent the tilting of the top frames, so objectionable in the standard master car builders' steam railway trucks, the spring base of the truck is increased by locating spiral springs each side of, and supported by saddles, from the journal boxes. The pedestal springs *F* carry a sufficient part of the load to prevent the tilting of the top frames, the greater part of the load being carried by the equalizing-bar springs *E*. The side and end portions of the top frame is all one piece of forging, which insures the trucks always remaining square. The transoms *K* are bulb angles 10 ins. deep, which extend full size with the side truss-frames to which they are very rigidly secured. Gussets *I* of sheet steel connect the transoms to the side frames and hold the frame rigid and square. Peckham's patent swing bolster is also used in this truck. It is constructed of plates in form of a channel 10 ins. deep, and is carried on four long coil springs and one elliptic spring, which support the bolster from the inside at its top, so as to hold it securely in a vertical position. Straps secured to the transom and extending over the bolsters prevent its being lifted out. The kingpin is 2 ins. in diameter, and is secured to the car body in such a manner that it cannot be lifted off the truck. The swivel-plates are large in diameter, machine-fitted, with a boss around the kingpin, which prevents the escape of the lubricating grease.

This arrangement of bolster springs, *i. e.*, an elliptic in the center and two long spiral springs at each end, is claimed to give a much easier riding car than the old form of bolster used in steam cars, and can be more easily regulated so as to prevent rolling motion of cars when running at high speed.

The journal boxes are M. C. B. standard pattern, with standard M. C. B. journals, as specified.

The brakes are constructed with shoes on the inside of the wheels, and can be easily adjusted to the wheels without placing truck over a spit.

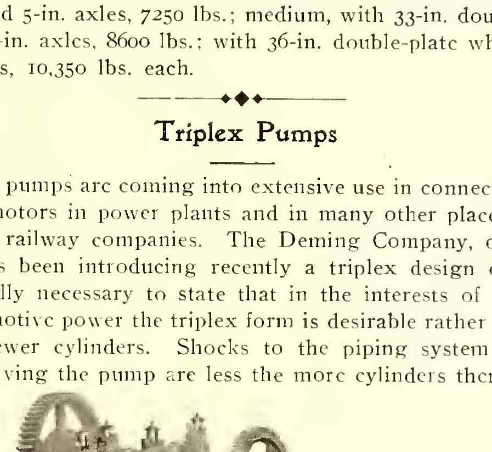


M. C. B. NO. 30 TRUCK, HIGH SPEED

This truck is constructed of three different weights to meet different conditions of service—light weight with 33-in. spoke wheels and 5-in. axles, 7250 lbs.; medium, with 33-in. double-plate wheels, 6-in. axles, 8600 lbs.; with 36-in. double-plate wheels and 7-in. axles, 10,350 lbs. each.

Triplex Pumps

Triplex pumps are coming into extensive use in connection with electric motors in power plants and in many other places owned by street railway companies. The Deming Company, of Salem, Ohio, has been introducing recently a triplex design of pump. It is hardly necessary to state that in the interests of economy and the motive power the triplex form is desirable rather than one having fewer cylinders. Shocks to the piping system and the motor driving the pump are less the more cylinders there are on the pump. Apart from the principles involved in moving the water the mechanism of the pump plays an important part in the economy of operation. Friction is the chief foe to contend with. By making all castings of ample weight the Deming Company secures the rigidity of parts necessary to small friction loss. A Deming electrically-driven triplex pump is illustrated herewith. These pumps are well adapted to power house and car house service as boiler feeders, tank supply pumps, and hydraulic pressure pumps, as well as to the uses of street railway pleasure resorts, situated at a distance from city water or requiring more water than can be economically purchased from a city supply.



ELECTRICALLY-DRIVEN TRIPLEX PUMP

Some British Tramway Motors

It is only about two years ago that the plans of the English Electric Manufacturing Company for the construction of large works at Preston for the manufacture of electric railway apparatus were announced in the STREET RAILWAY JOURNAL, and slightly more than a year ago the completed shops in all their departments were described in these columns. Since the opening of the works

FIG. 1.—MOTOR AND AXLE

at Preston the company has been very successful in securing orders and in supplying apparatus for tramways and lighting companies in England, and now makes generators and motors for all classes of electric work. Some particulars are given elsewhere in this issue of the generators manufactured by the company for railway purposes, and it is the purpose here to give a short summary of the standard electric tramway motor of the company.

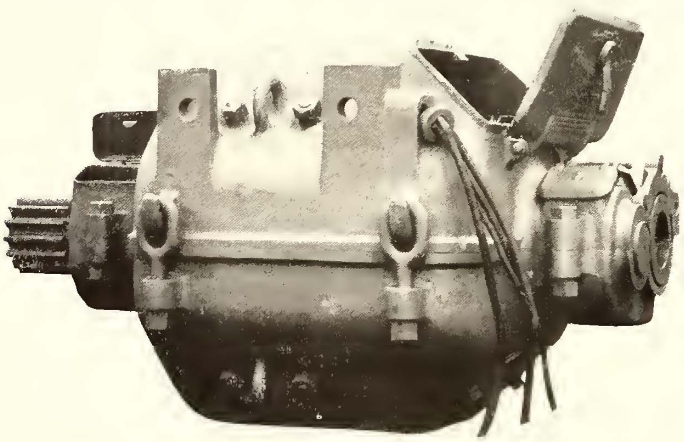


FIG. 2.—MOTOR SHOWING COVERS OPEN

For the purpose of description the company's No. 25-type-A motor will be taken up. This machine will deliver 25 shaft horsepower, based on the standard rating; that is a rise of temperature of not more than 75 degs. in its various parts when running for one hour at full load, the temperature of the surrounding air not exceeding 25 degs. C. It will be understood, however, that the company makes other sizes of motors, including those of 100-hp

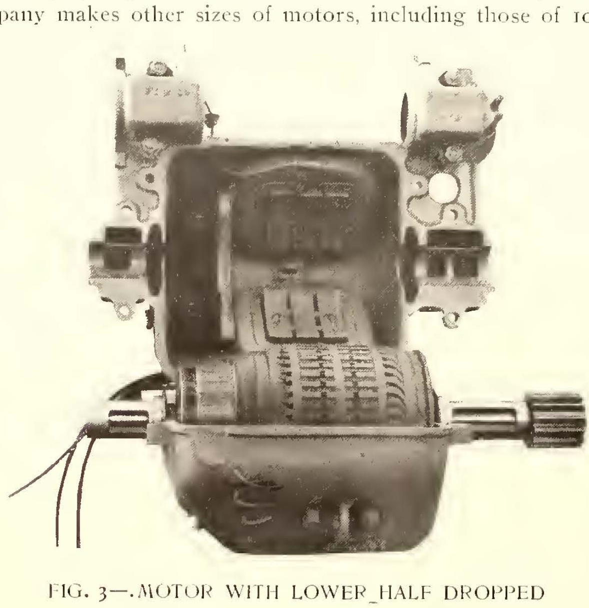


FIG. 3—.MOTOR WITH LOWER HALF DROPPED

FIG. 4.—DETAILS OF POLE PIECES AND FIELDS

capacity, of which a number have been manufactured for the Liverpool Elevated Railway, as well as larger machines.

A front view of the 25-type-A motor which is destined for a track gage of 41 ins. is shown in Fig. 1, and dismounted from the wheels is illustrated in Fig. 2. The lower half of the motor frame is hinged to the upper half and can be let down, as shown in Fig. 3, thus exposing the armature and lower fields for in-

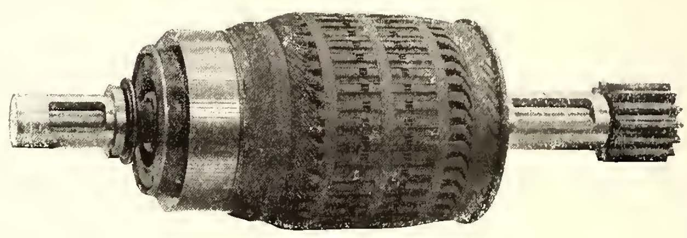


FIG. 5.—ARMATURE REMOVED

spection, cleaning and repair. The armature may be removed from the motor by loosening four bolts, or it may be retained in the upper half of the field and the lower half of the frame may be unhinged from the upper half.

The motor frame is two pieces of soft cast steel, fitted together with a carefully made machined joint to obtain low resistance

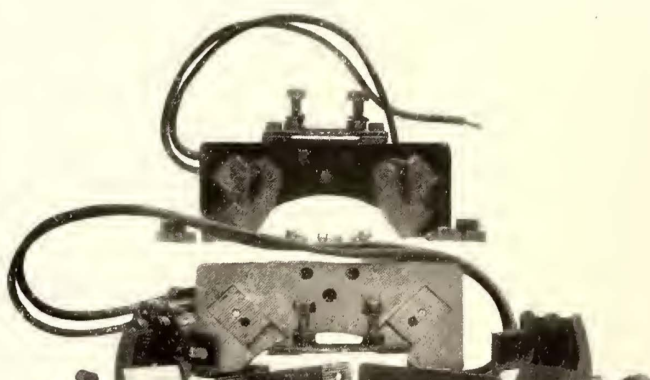


FIG. 6.—DETAILS OF BRUSH HOLDERS

for the magnetic lines, as well as to secure a water-tight joint. The pole pieces (Fig. 4) are made up of low-carbon sheet steel punchings riveted together. Each pole piece, as illustrated, is fitted with two ventilating places which correspond, in position, with the air spaces in the armature core, to be described later, so that the air, when forced out of the armature, passes through the center of the field-magnet core and is made to spread over the cold surface of the motor casing. In this way, it is claimed, a much cooler running machine is obtained than in the old method, where the circulation of air was stopped by solid pole pieces. The field coils themselves are of copper wire insulated with asbestos paper and cotton covering. The completed coil is waterproofed.

Fig. 5 shows the finished armature, which weighs, complete, 484 lbs. The armature core discs are stamped with forty-one slots in their edges and five ventilating holes around the shaft. Half-inch ventilating spaces are left at intervals between the core discs by inserting special spacing discs. The commutator, which is 11 ins. in diameter, contains 123 hard-drawn copper bars 4 ins. long. It has a wearing face of 3 ins. and a maximum wearing depth of 1 in. Silver amber mica is used for insulation. The insulation of the finished commutator is tested with 2000 volts alternating current between the segments and the hub, and with 500 volts between adjacent bars. As shown in the illustration, ventilating spaces are left in the commutator hub for the admis-

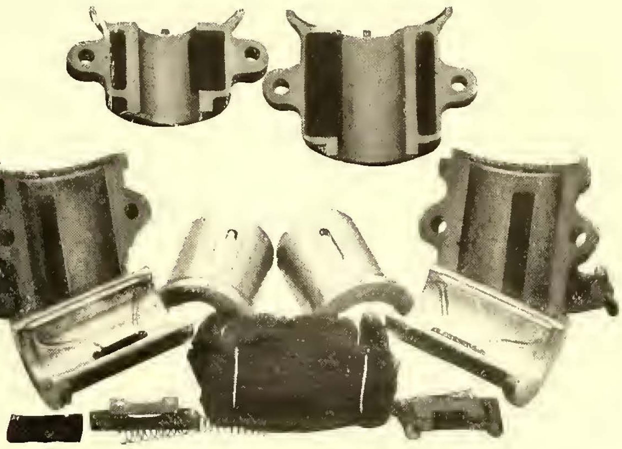


FIG. 7.—DETAILS OF BEARINGS

sion of cool air which subsequently passes out through the body of the armature.

Each armature slot contains three coils, making $41 \times 3 = 123$ commutator bars.

The brush holders are illustrated in Fig. 6. These holders are supported on a hardwood frame, and are adjusted radially (that is, in respect to the commutator), or lengthwise of the shaft for the

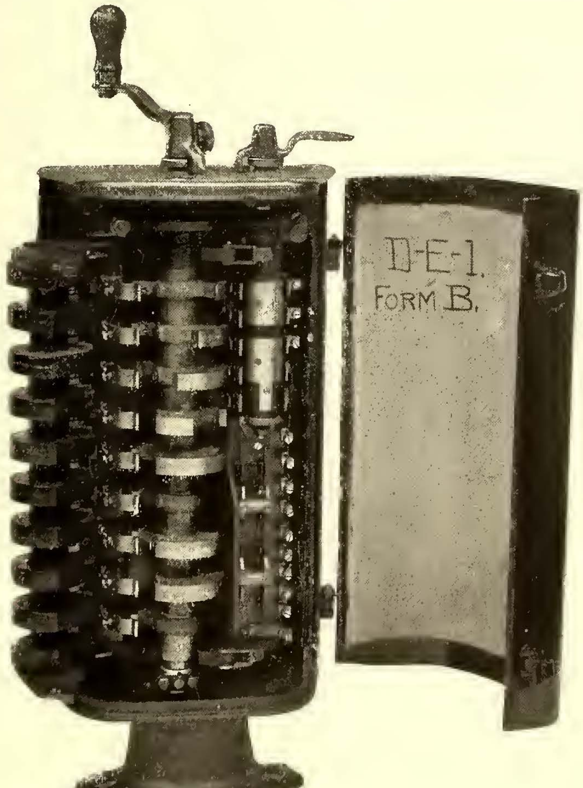


FIG 8.—TWO-MOTOR CONTROLER

purpose of centering the brush holders on the face of the commutator. The brush holder is immediately under the opening in the motor frame, and can therefore be easily reached.

Fig. 7 illustrates the armature and axle bearings. Each armature bearing has a large oil well containing from one to two pints of oil, which is fed to the shaft by means of wool yarn. In addition to the oil well a grease box is provided above the bearing, so that, if the oil should fail and at any time the box become hot, grease will run down through small holes into the bearing. The grease used for this purpose is very thick, so that it will not flow unless the bearing is hot. The company is using bronze bearings for the armature shaft instead of Babbitt metal, and reports excellent results from the use. A bronze bearing can also be seen in Fig. 5 mounted on the end of the armature shaft.

Another interesting feature in the motor of the English Electric Manufacturing Company is the improved gear housing. This is in two parts planed accurately together at the joints and bored to fit over both the armature and axle bearings. A felt washer also fits the gear hub accurately, so that all leakage of oil and grease from the gear housing and all noise is stopped. The motor, complete, weighs 1934 lbs.

Fig. 8 shows the company's D. E. 1 controller for double equip-

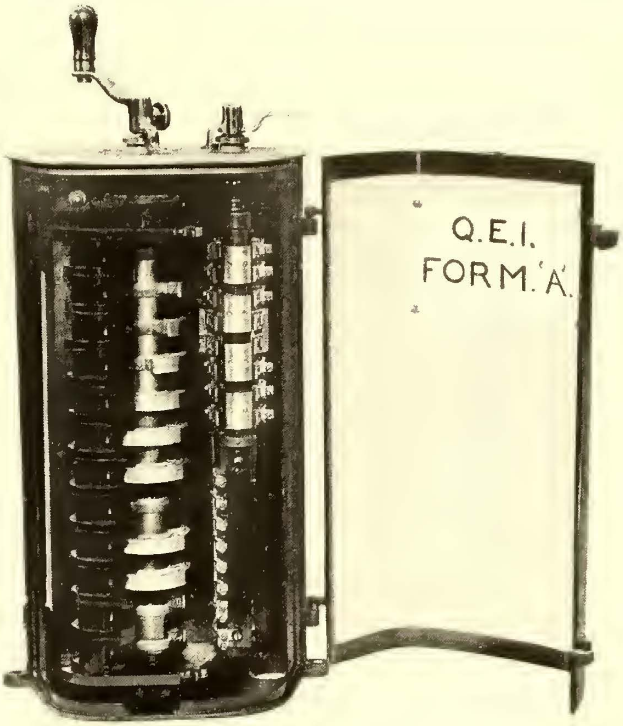


FIG. 9.—FOUR-MOTOR CONTROLLER

ment and made with an emergency-brake attachment. As will be seen, a solenoid blowout is used, and the controller cylinder segments are so mounted that they can be removed and adjusted at pleasure. The company also makes the same controller with an electric brake adjustment.

Fig. 9 shows Q. E. 1 controller made for four motors, or a quadruple equipment, and also provided with an emergency-brake attachment.

Automatic Couplers

The Van Dorn couplers, which have become the standard on so many of the street and elevated railways of the country, have recently been ordered for sixty cars of the Northwestern Elevated Railway, of Chicago. The Manhattan elevated, of New York, has ordered a special type of this coupler for its entire equipment, as noted in these columns last month. The New York, New Haven & Hartford Railroad has ordered some of these couplers for its electric lines and 200 car equipments for Washington and Baltimore are under way. The number of years Mr. Van Dorn has been making a specialty of automatic couplers for electric railway service and the requirements he has met from time to time, make him able to furnish couplers and draft riggings of thoroughly tried design for all conditions found in electric railway service.

The *Power Quarterly* for September is a handsome Pan-American edition. The exposition is treated in a most thorough manner from an engineering standpoint, and a large number of views are shown of the various mechanical and electrical exhibits, while the power plant in Machinery Building is described in great detail, a large number of line and half-tone engravings accompanying the text. Altogether, the number places before the reader the most comprehensive account of the engineering features of the exhibition yet made in a single edition.

Third-Rail Insulators and Track Cleaners

The rapid development during the last few years of elevated and interurban electric railway systems has led to corresponding improvements in the design and construction of such devices as are required by them. In this work third-rail insulators play a very important part, and in the accompanying cuts (Figs. 1 and 2) we show two improved types of third-rail insulators manufactured by the Ohio Brass Company, of Mansfield, Ohio. In each of these insulators the means of attachment between the third rail and the insulator is such that, while the former is held in proper horizontal alignment, a means is provided for a certain amount of vertical play or motion. Experience has shown the desirability of providing for a slight movement of the rail, and in practice this has been found necessary. This arrangement obviates the trouble which has been experienced in the past of the insulators breaking on account of the rails being clamped too rigidly to them, and in the two types here shown this difficulty is entirely obviated.

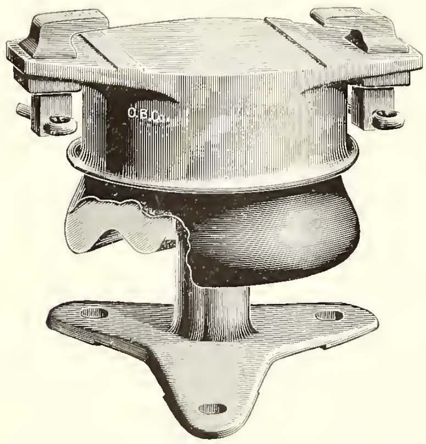


FIG. 1.—RECONSTRUCTED GRANITE INSULATOR

In the "Type A" insulator shown in Fig. 1, the insulating body is made of reconstructed granite or some similar material, and is of such size and design as to proprely support the third rail with safety, and to also present sufficient surface to prevent leakage of the current over its exterior. In the "Type D" insulator, shown in Fig. 2, the insulating medium consists of a thoroughly seasoned hardwood block, which has been specially prepared by thoroughly impregnating with oil so as to exclude all moisture and increase its insulating properties. In addition to the two types here shown, the Ohio Brass Company furnishes several other styles which, while similar to these in the method of attachment between the rail and the insulating body, differ in general construction, and are adapted to varying requirements and conditions.

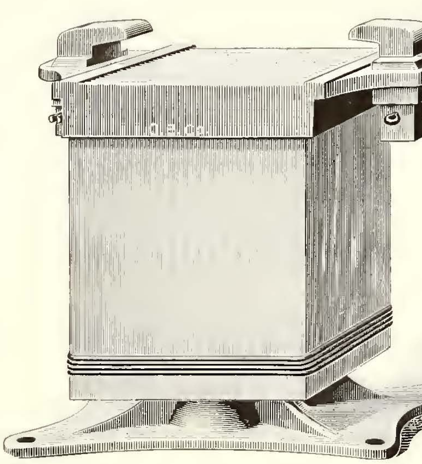


FIG. 2.—HARDWOOD INSULATOR

The Monarch track cleaner, which is shown in Fig. 3, will be exhibited at the convention by the Ohio Brass Company. The principal features claimed for this device are simplicity of design, substantial construction and lightness in weight. The castings throughout are of malleable iron, the blades of steel, and the supporting cross-bar of thoroughly seasoned oak. When in use the blades are held to the track under tension by means of two flat steel springs, which, while adding to the efficiency of the device, also permits either one of the blades to rise independently of the other in case unusually heavy obstructions are met with, and so prevent breakage and serious damage to the device.

At the scraping or wearing point of each blade a removable metal shoe is attached, which can be easily and quickly replaced at slight expense when worn out. This avoids the necessity of entirely new scraping blades, thus reducing to a minimum the expense for repairs or renewals. The scraping blades are pivoted near their center, and means are provided for securing them at any desired angle in respect to the track, so that they may be adjusted in this manner to varying track and pavement conditions in various localities.

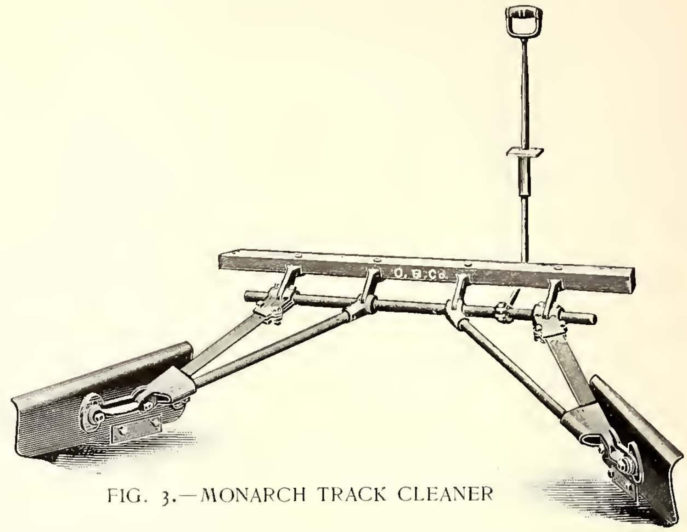
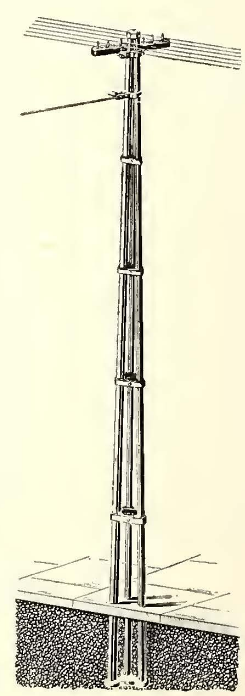


FIG. 3.—MONARCH TRACK CLEANER

The Tripartite Steel Pole

It is just a year ago that a view and description of the steel pole of the Electric Tripartite Steel Pole Company, of New York, was described in this publication. This pole had then just been placed on the market, and, as will be remembered, was made up of three high carbon-rolled steel U's formed in tripod shape and constructed to make a tapered pole. The poles differed entirely in design from any former built-up pole, in that there are no bolt or rivet holes in the poles. The three U's are held apart by patented spreaders and clamps, so constructed that they reinforce the legs and hold them absolutely in rigid position. The company has made one or two modifications in its pole during the last year, the principal one being that a spreader has been substituted at the base of the pole for a cast-iron base.



TRIPARTITE POLE

The present pole is illustrated in the accompanying engraving. The claims made for the pole over the ordinary tubular pole are strength, simplicity, elasticity and economy. The latter is shown by the fact that the first cost of the pole is less than of the tubular pole, and the cost of setting it only about one-half that of the latter, as, on account of the positive anchorage, it requires only a 3-ft. set. The weight of a 25-ft. pole is about 450 lbs., complete, and tests of it have shown that it does not take a set when an extra load is put upon it, either by heavy winds, snow or ice. Owing to its construction, it can be transported easily in parts and assembled on the ground along the line. Poles can be made all in one piece to any required length up to fifty feet.

The company has installed a number of these poles on the line of the Union Railway Company, in New York, where they have given entire satisfaction, and where they can easily be inspected by visitors to the convention this week.

Recent Developments in Magann Air Brakes

The Magann Air Brake Company, of Detroit, Mich., announces its acquirement of a new system for use in connection with the multiple-unit system of train propulsion. When air brakes are used on a train in connection with the multiple-unit motor-control system the air brakes must also be controlled on the multiple-unit plan. That is, it must be possible to control the air brakes from any car on the train, and each car must be a unit in itself, so that it can be coupled up indiscriminately with other similar cars. The Magann Air Brake Company's new multiple-unit air-brake system, which is being perfected, can be made to work with one train pipe, but if used on long trains many hours a day two pipes will probably be used. This new multiple-unit brake scheme uses the Magann storage system. The storage system binds itself nicely to a multiple-unit service because of the absence of compressors on the cars. The system just referred to employs pneumatic control of the brakes throughout the train. Another plan is also under way for electric control of the brakes throughout the train, which does away with train pipes entirely. The principles employed in the construction of these new brakes admit of a very rapid successive application and release of the brakes; much more rapid, in fact, than is possible with brakes now in use.

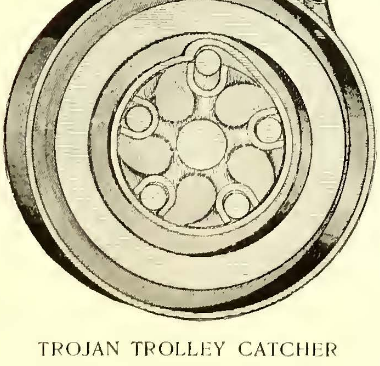
The Magann Air Brake Company has recently entered into a contract to furnish whatever power brakes are used to all the lines controlled by the Everett-Moore syndicate, of Cleveland, in which the Magann brake is to be used to the exclusion of all other power brakes on the 1400 miles of line controlled by that syndicate.

Cold-Water Paint

Lythite cold-water paint is now in general use by street railway companies and others the world over. While this material is especially valuable to owners of street railways, its uses are not by any means confined to that sphere. It is used wherever paint is needed. It is a dry powder, which, by the single addition of cold water, is made into a perfectly pure liquid paint. Water being cheaper than oil, there is a great saving in cost to begin with. This paint is most valuable for interior walls and ceilings of car houses, power houses and engine rooms, or any place where the greatest possible amount of light is desired. There is nothing that will give a whiter surface than white lythite. Its value in increasing in the illumination of a room is considerable. It also has valuable fireproof qualities. The coating it gives is very hard and firm, and the manufacturers guarantee it not to rub or peel off. Although used for much the same purposes, it can not be compared to whitewash or kalsomine, as lythite is much more durable than either of these, while being less than one-third the cost of oil paint. It is claimed that lythite will last ten times longer than any kalsomine or lime product. The Frank S. De Ronde Company, 46 Cliff Street, New York, furnishes practical working samples of this paint to interested parties. It also makes a specialty of high-grade insulating paint and varnish for street railway purposes.

Trojan Trolley Tender

In the Trojan trolley tender or catcher no spring or springs control the action of the locking device. This fact alone should be a strong point in its favor. The reel in the catcher is large enough and the spring strong enough to take care of the slack rope under any and all circumstances. The locking device is governed by ⅝-in. steel rolls, 1 in. long. While the trolley is on the wire the rolls remain in their pockets. The instant the trolley jumps the wire one of the rolls is instantly thrown out of its pocket in the circular ring, thereby locking the reel and preventing the trolley from going any higher. This simple trolley catcher is made by the Trojan Trolley Tender Company, of Troy, N. Y.


TROJAN TROLLEY CATCHER

Belt Ash Conveyors at the Ninty-Sixth Street Station

The Ninety-Sixth Street power house of the Metropolitan Street Railway, New York, about which considerable has been said elsewhere in this issue, is equipped with the Robins Conveying Belt Company's ash-handling apparatus. The maximum capacity of the plant being 50,000-hp the ash-handling problem is an important


ASH CONVEYORS AT NINETY-SIXTH STREET STATION

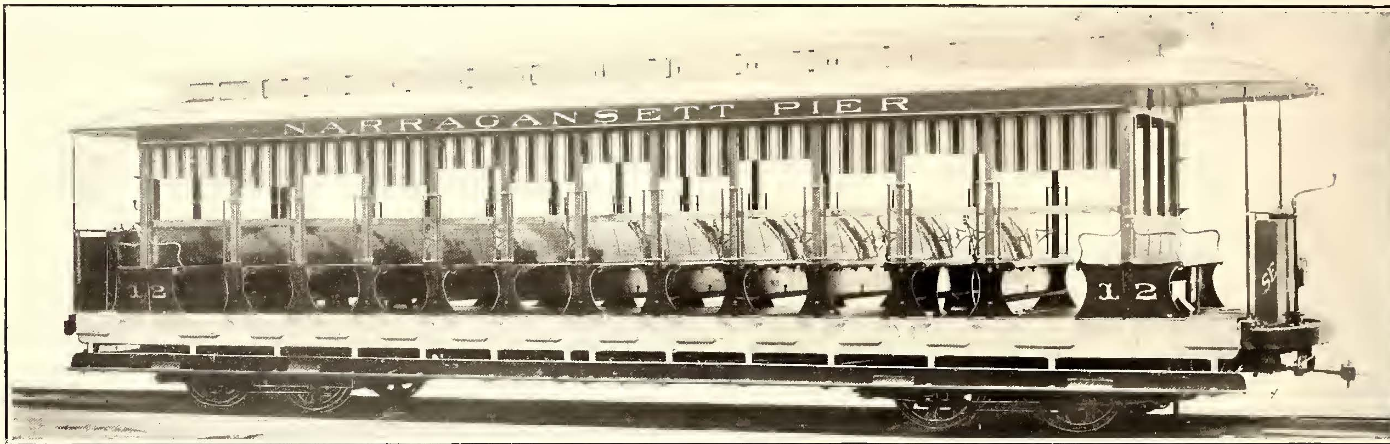
one. This conveyor has for two years handled all the ashes produced, and is said to be still in excellent condition. A photograph of the ash conveyors in the plant just mentioned is reproduced herewith. In the Robins conveyor pure rubber is the only material which comes in contact with the substance conveyed. For this reason the conveyor is entirely unaffected by the sulphurous acids which are present in all coal ashes, and which have a strongly corrosive effect on iron and steel. A revolving brush effectively removes anything which may stick to the belt, and thus prevents dripping of ashes and water on the return run.

A Self-Adjusting Car Fender

This fender, which is made by the Edward L. Dunning Company, of Boston, is one of the class which acts automatically without being tripped by the motorman. It is hung on a balance, and the impact of any weight makes it drop to any desired height from the rail. The fender is made very strong and is entirely of wrought iron. Therefore it will not break but will only bend if concerned in a collision, and can be straightened so as to be as good as new. To facilitate the storage of a maximum number of cars in car houses, the housing of the fender under the platform is the method adopted. The simple unhooking of the front or back loop hanger on the fender causes it to swing, front or back, to the desired position. The hooking of the loop hanger on the fender keeps it at the desired place. It is very easily handled and placed in any position. The weight of the fenders is about 100 lbs. for the two that go on a car. The fender is neat in appearance. It is being used on several leading roads of the country.

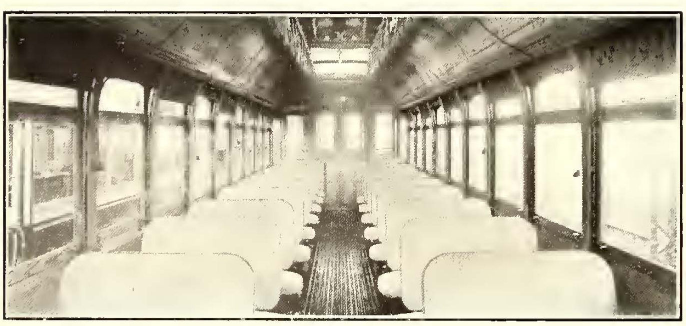
Some Recent Apparatus of the J. G. Brill Company

The extensive works of this company at Philadelphia exhibit at present a good example of the general prosperity which is prevalent in the street railway manufacturing field. The company was never so busy as at present, its orders keeping its plant occupied



A NOVEL TYPE OF OPEN CAR EQUIPPED WITH NO. 27-G TRUCKS

to its fullest capacity, even with the large additions which have recently been made. In the following pages a description is given of some of the more important of its recent developments in the scientific design and manufacture of street railway rolling stock. The company has found it necessary, in order to meet the demands



INTERIOR OF CONVERTIBLE CAR

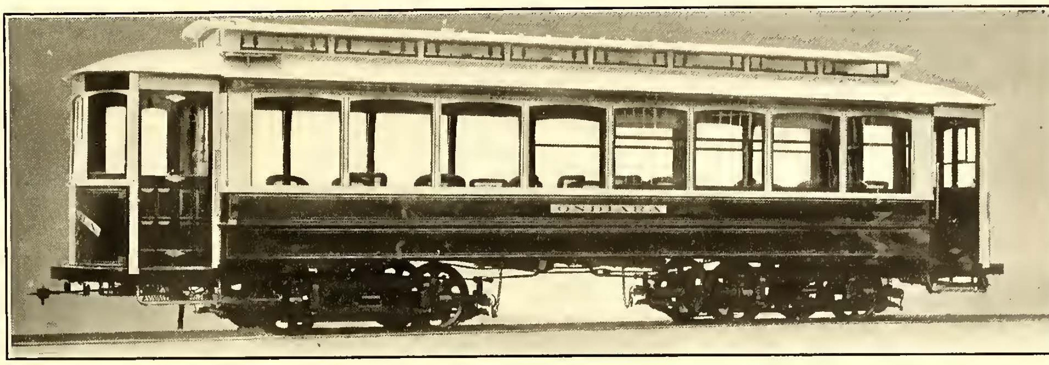
made upon its manufacturing facilities, to rearrange and enlarge certain portions of its already very extensive plant in Philadelphia. The office room has been increased by the addition of a large wing, and several new buildings are nearing completion. One of these, a handsome structure near the offices, will be used as a finishing and storage shop on both stories, the upper floor being

CONVERTIBLE CAR EXHIBITED AT THE PAN-AMERICAN EXHIBITION

reached by a two-story transfer table. This building is 195 ft. x 165 ft. Another building, known as the new stock building, and measuring about 200 ft. x 100 ft., is built over a part of the yard tracks, forming a much-needed space for the storing of the immense stock of castings that the Brill Company continually has in readiness.

Within a few months a new type of car has been supplied to the Sea View Railway Company, Narragansett Pier, R. I. This railway has already purchased a number of these cars, and they have given most excellent satisfaction. The type is a decided novelty in open cars, and it accomplishes desirable results which hitherto have seemed impracticable; that is, it admits the use of a No. 27-G Brill truck beneath an open car, without increasing the width beyond that of the ordinary design. These cars, which are the invention of John A. Brill, provide what is, in effect, a double step without the usual disadvantages of that form of construction. As seen by the illustration, they contain fifteen benches apiece, four of the benches being against the bulkheads. The general dimensions are as follows: 40 ft. 4⅜ ins. over the dashers, a fraction over 7 ft. 1 in. wide on the floor, and 8 ft. 2½ ins. wide over all. The folding step is brought within 17 ins. of the top of the rail. The main sill consists of a single angle iron running from one end of the car to the other, to which is bolted another angle iron projecting downward, and forming a support for the step iron. This has the effect of making the sill of a Z-bar pattern, having the corresponding strength and stiffness of this construction. There are two short center sills running from the end of the car to a point some distance inside the bolster, which is of the trussed form, with the upper edges coming just above the floor. As the bolsters are beneath the seat, this projection forms no obstruction. A great amount of vertical strength is produced by the manner of fastening the side posts. A peculiarly formed pocket is bolted to the side of the sill, and holds the end of the post, while on top of this is placed the ordinary round-cornered seat-end panel. A ½-in. bolt holds the post into the pocket, which is equivalent to a 7-in. tenon, while the fastening of the post into the round end seat panel box still further increases the stiffness and strength of the connection. This makes the Narragansett car the strongest and most rigid form of open car yet constructed. The eleven seats in the center part of the car have reversible backs, the four bulkhead seats, of course, having their backs stationary. The side openings are fitted with spring roller curtains, and the ends have the usual drop sash. Double ash grab handles are attached to the posts. The seats and backs are of ash strips, and the ceiling is of three-ply birch veneer, giving a handsome finish to the car. The platform openings are closed by chains with Brill entrance guards inside of posts. A portion of the cars which were included in the order sent to Narragansett Pier were fitted with G. E.-67 motors, and the remainder with Westinghouse No. 49 motors. The trucks are the No. 27-G, and weigh with motors, 9060 lbs apiece. The total weight of the car and four motors is 36,410 lbs.

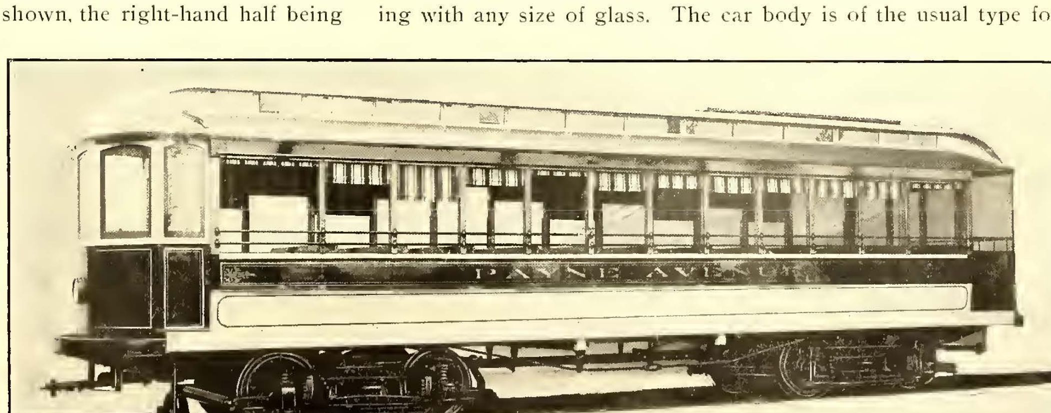
The Brill convertible car, which many admired this summer at the Pan-American Exhibition, is one of the very interesting recent developments in car building. It has accomplished what has long been considered exceedingly desirable; that is, it gives a car which, when closed, has all the characteristics desired in a standard closed body, and when open provides a car which has every advantage of the standard open construction. The great point of advantage to the railroad manager is that by the use of a car of this character a single equipment only is necessary, although all the advantages to be obtained from the use of open and closed cars are maintained. There is also another advantage which is not easily estimated; that is, the manager always has, at a moment's notice, possession of the type of car which is most serviceable for the season. Raw, cold days in the summer demand the closed car, quite as much as the weather of winter; warm spring days, far in advance of the season, make open cars desirable at such times.



PRIVATE CAR, BUFFALO RAILWAY—AN EXAMPLE OF THE SEMI-CONVERTIBLE CAR

With the ordinary forms of construction, and the exigencies of the service, the closed car must be kept in service until a complete change in the rolling stock is made, and when the open car goes into service it cannot be replaced by a closed car, except at a considerable cost of time and labor. The new convertible car possesses the advantage of being changeable from one to the other type within a few moments, and without any expense to the railway company. Sash, glass and panels can be pushed up into the roof, out of the way and out of sight, an operation which takes no more time than the opening of the similar number of windows would require; and when open the car can be closed and converted into a standard closed car, as far as the passenger is concerned, within an equally short period of time. These rapid changes not only adapt it to the daily variations of climate at our changeable seasons, but make it possible if desired to meet even the hourly variations occasioned by rain or storms.

The car illustrated is 28 ft. 4 ins. over the end panels, 7 ft. 2 ins. wide at the sills, and 7 ft. 10 ins. over the posts. It is mounted on a pair of Eureka maximum traction trucks, which bring its steps down to the same height as that of the ordinary closed car. It will be seen by a glance at the engraving that the car is provided with steps like the ordinary closed cars. There is also a runningboard, or step, which folds up when the car is closed, and is let down like the step of an open car, giving access to each one of the openings when open. The seats are transverse, and there is an aisle in the center. The appearance of the car, when open, as well as when closed, is very well shown, the right-hand half being open and the other closed. The inside finish is in selected white ash, with a decorated three-ply maple head lining. The seats are of spring cane, upholstered. Each end of the car is provided with a vestibule, having both gates and doors on each side. The details of the construction are practically the same as those of a standard open car.



LONG DOUBLE TRUCK CAR FOR CLEVELAND

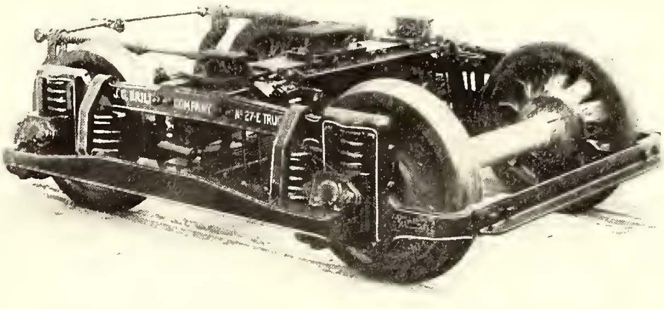
The roof structure, however, deserves a special mention, from the fact that owing to its depth at the plate, and the method in which the letterboard is put on the heads of the posts, the feet of the carlines and the lining are secured in a manner which is stronger than anything that has hitherto been used in car construction. The amount of timber found in the roof at the head of the posts is very nearly equal in section to that found in the sill, and the method by which posts are halved upon the letterboard and bolted to both letterboard and plate makes the construction, as we have said, unusually strong. Cars of this type have been in use for some time, and have had their share of collisions, where they have demonstrated their superiority by coming out of the wrecks with little or no damage to themselves.

President Ely, of the Buffalo Railway Company, has for his private car a Brill semi-convertible parlor car. This car is 31 ft. 8 ins. over the end panels, and 7 ft. 8½ ins. wide at the sill. Over the posts it measures 8 ft. Private cars and other forms of special parlor cars are becoming very popular with the larger railway lines, and the car illustrated is one of the latest examples from the Brill shops, and it is peculiarly interesting, because, in spite of the very large window sash, they can be raised, not only to any desired height, but, as shown in the engraving at the left-hand

INTERIOR OF SEMI-CONVERTIBLE CAR

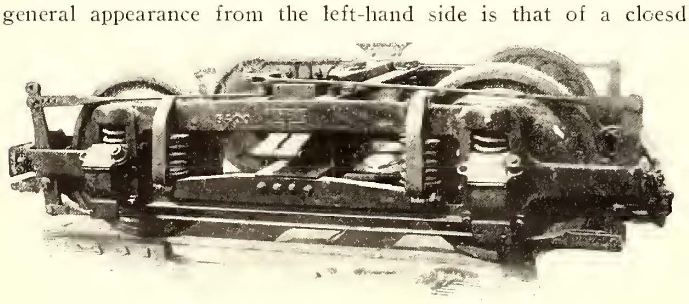
end of the car, they can, when necessary, be raised so as to leave the whole window free and clear. This is something which has not heretofore been accomplished, either in parlor cars or those having large sash. The advantages of the semi-convertible construction are at once apparent, securing, as it does, ample opening with any size of glass. The car body is of the usual type for cars of the length. It is mounted upon a pair of No. 27 trucks, and is propelled by four powerful motors. The platforms are fitted with vestibules, having folding doors on both sides, and are protected by Brill angle-iron bumpers. Among the smaller fittings are Brill sand boxes, and two 14-in. Dedenda gongs. The trim throughout is of bronze, with wooden grab handles. The interior finish is very neat. There are twenty wicker chairs, having cushions covered with pantasote. In place of the usual draperies, pantasote curtains are used. There are four tables, to be placed between the widows when desired. The inside finish is of mahogany, with decorated three-ply head linings. The car, as a whole, is neat and elegant, and the semi-convertible feature of construction gives it an adaptation to all seasons of the year, which has not hitherto been possible in cars of this kind.

The two types of cars last described, the convertible and semi-convertible, have reached a high state of perfection, and each is developing a field for itself. In city and very short suburban service it is desirable in warm weather to operate open cars with runningboards, but for high-speed long suburban and interurban work, the ordinary type of open car greatly increases the danger of accidents to passengers. The semi-convertible car exactly fits into the conditions found on this latter class of road, providing cool, airy accommodation for patrons with absolute safety. Both cars place at the disposal of railway managers a single equipment that is as serviceable at one time of the year as another, and that can adapt itself to unseasonable weather of any description, whether wet or dry, hot or cold, at a moment's notice. The well-known Brill principles of construction, which have been modified somewhat to give additional strength to certain parts, especially the roof, of these types of car, guarantees their stability, and as the economy of having one set of rolling stock for both seasons appeals strongly to the financial end of street railway managements, the well-merited growing popularity of the Brill convertible and semi-convertible cars is not to be wondered at.



MOTOR TRUCK, BROOKLYN ELEVATED LINE

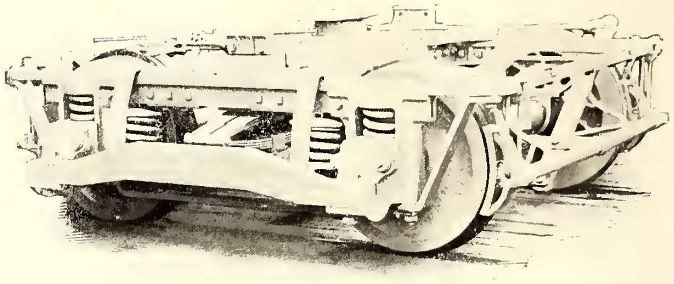
One of the illustrations shows a handsome open car of decidedly unusual construction built by the Brill Company for the Payne Avenue line of the Cleveland City Railway Company. Its length over the end panels is 41 ft. 3⅜ ins. The width at the posts is 7 ft. 10 ins. The car is mounted on No. 27-F trucks, and its general appearance from the left-hand side is that of a cloesd car with the windows out, or the semi-convertible car having removable sash. The car always runs in one direction. Each end is provided with a platform, that at the forward end being enclosed by a vestibule, while the rear platform is entirely open. The opposite side of the car from that shown is like that of any open car, there being an entrance between each pair of posts and at the platforms. There are two steps on this side with 12-in. risers, the lower one being but 14½ ins. from the head of the rail. This unusual and very peculiar construction is made possible by the fact that the cars run upon a loop, and only one side is used for the entrance and exit of passengers.



HIGH-SPEED TRUCK, ALBANY & HUDSON LINE

The seats are transverse, and the details of construction on one side are similar to those of the standard closed bodies, while on the other side they are the same as open cars. The one exception, of course, is the arrangement of the vestibule for the motorman, which is completely enclosed on the left-hand side. The use of the steam-car hood is, in this case, justified by the fact that the cars are intended when outside the city to maintain a high rate of speed. Eleven of the seats have reversible backs and three stationary ones. The trolleyboard is arranged at the rear of the roof. The grab handles are of hickory, 30 ins. long, and set in bronze sockets. The cars are provided with a sand box and a Dedenda gong at the front end. The sills are reinforced by a sill plate 8 ins. wide by ⅝ in. thick, extending the whole length of the car.

The trucks for the Brooklyn elevated naturally excite a great deal of interest because they were selected after a comparative test and examination, which included most of the leading styles of trucks used on both steam and electric roads at the present time. In these tests it was found that the so-called Master Car Builders' standard truck, in any of its forms, was unstable under the action of the brakes. The truck frame when brakes were applied in some instances was moved from the normal position as much as 5 ins. Two forms of Brill No. 27 trucks, which were adopted, are illustrated. One is the motor truck, which will be seen from a glance to be extremely heavy in its framework, axles, etc. The wheels are 33 ins. in diameter, mounted on axles which are 7 ft. long x 5½ ins. to 6 ins. in diameter. The wheels are steel-tired, and are also very massive, the keynote to the whole construction. The frame is of forged steel with angle iron end pieces bolted upon a heavy extension from the jaws. The general features of construction are those of the well-known No. 27 truck. The equalizer is carried by links suspended from the wheel pieces near the jaws; the springs on the spring plank are elliptics, and there are two on each side of the truck. The wheel base is 6 ft., which is sufficient to give room for the elliptics and the necessary brake hangers, as well as for the heavy motors employed. The whole truck is heavy, compact and strong, weighing about 10,000 lbs. The brake rods are placed on each side so that they are not in the way of the motors, and the brakes are hung between the wheels. The whole construction is specialized for the purpose. To the bottom of the boxes in front is bolted the beam on which the shoe or contact for the third rail is carried.

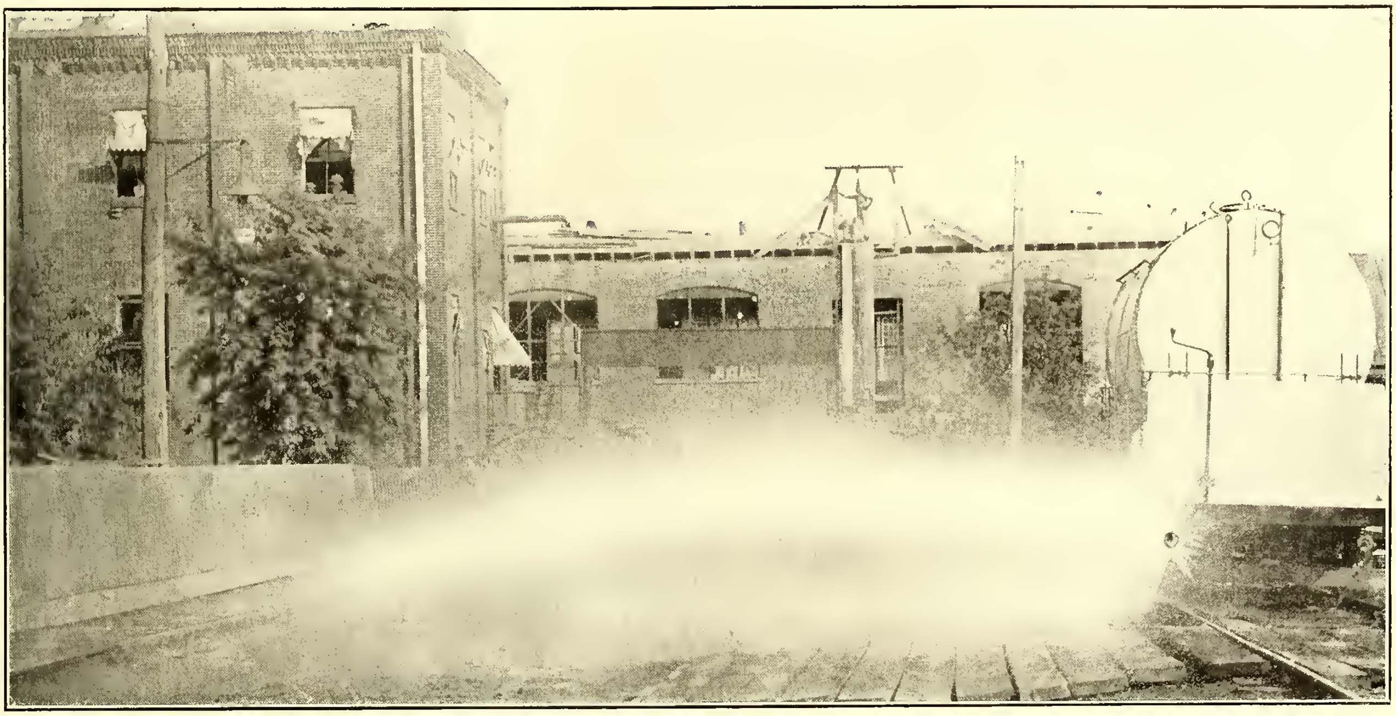


TRAILER TRUCK, BROOKLYN ELEVATED LINE

The features of the trail truck are similar to those of the motor trucks, but the details of construction are quite different. The top plate of frame is a continuous bar of iron, to which are bolted jaws for carrying the boxes. The equalizers, as in the previous case, are hung from this frame by spring links. The jaws are supported from the frame by diagonal bars, and are connected at the bottom in the usual way. There are, however, as in the other truck, three sets of springs, which act in the same way as in all Brill No. 27 trucks. The boxes, as in the previous case, are standard, and, in most respects, the same as those of the Master Car Builders, but carry a projection, to which a bar is bolted similar to that for the contact device in the motor truck. The brakes, however, differ from those in the motor trucks in being hung outside and connected up in the usual manner, the brake rods passing over the center of the truck. As both trucks have journal springs, the frame is carried with remarkable steadiness, and is not perceptibly affected by the severest action of the brakes. Both these modifications of the Brill No. 27 truck ride with great ease and steadiness at any rate of speed which has hitherto been possible to attain on electric roads. They have been tested in this respect up to 70 miles an hour, and have proved satisfactory.

The truck used under the cars of the high-speed Albany & Hudson railway is especially interesting. This is a Brill No. 27

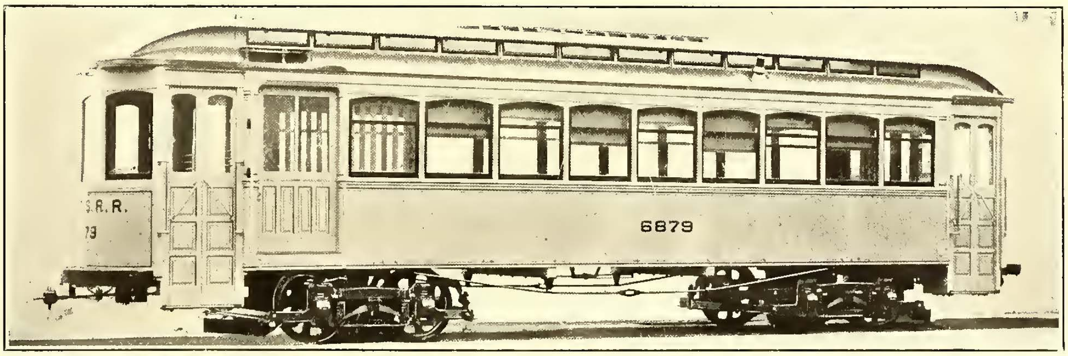
truck, with a steel frame having the usual three sets of springs, with the "swing motion" and equalizing bar combined into one and supported by swinging spring links. This truck, although very massive, is not quite equal, in the size of its details, to those trucks just mentioned. It has, however, a 6-ft. wheel base, Master Car Builders' standard journals, 4¼ ins. in diameter; axle, 7 ft. 1¾ ins. long, carrying 33-in. wheels. In this case the brakes are hung outside and are connected by double-brake rods outside of the wheels to avoid interfering with the large motors. On the spring plank there are double elliptics with the usual double-coil spirals in the spring links and over the journal boxes. Beneath the boxes will be seen the extensions to which the beam carrying the third-rail shoe is fastened. This truck appears somewhat more simple in many of its details than the elevated railway truck, but this is largely a matter of brake details, which, in this case, are placed away from the center of the truck outside the wheels.



A NEW FORM OF SPRINKLER OPERATED BY PNEUMATIC PRESSURE

One of the most recently designed specialties of the Brill Company is the new sprinkler, illustrated herewith. The demand has been very great for an efficient means of sprinkling evenly the whole width of a street from the car track, but to do this effectively it is necessary that the water should be forced out by some greater pressure than that furnished by its own gravity. In the Brill sprinkler an air pump is geared to one of the axles in such a manner that it keeps a constant pressure upon the surface of the water in the tank, and in this way provides sufficient force to send the stream to the most distant part of the roadway. The cylinder of this pump is made very large, so that the air is supplied to the tank at practically the same volume and pressure that the water is forced out, and an even flow is thus guaranteed. In the design of the pump and gearing every precaution is made to have it of the greatest mechanical strength, and it embodies the simplest mechanical principles. The cylinder is of the oscillating type, and delivers the air through a flexible connection directly to the water tank. Gages are provided, so that the pressure in the tank and the height of water can be at once determined by the operator.

In the combination car which the company has recently built for the West Jersey & Seashore Railroad Company they have united most of the conveniences of the steam railroad train. The car is completely vestibuled, and has both baggage and passenger compartment. It is mounted on No. 27-G trucks. The latter gives it an ease of riding not found in steam coaches, and, with the very powerful motor equipment employed, it will be able to attain a speed as great as that of the average steam train. The car is 31 ft. long over the end panels and 7 ft. 6 ins. wide. Over the vestibule it is 40 ft. in length, the platforms being 4 ft. 6 ins. each. The vestibule doors come down to the step, and for convenience, as they open in both directions, are provided with grab handles. As the car is practically in steam service, not having to enter city streets, the sides are made straight and covered with narrow sheathing boards. The passenger compartment has three-ply maple veneer ceilings, handsomely decorated. They are furnished with advertising moldings. The finish over the windows is of cherry with cherry hand poles having straps padded and stitched. The trim inside is of bronze throughout, and the curtains of pantasote. The car is fitted with Christensen air brakes and Brill gates, in addition to the folding doors. There are Brill rubber treads on the steps, bell cord carriers and a pair of Dedenda gongs. Two sand boxes are used, one upon each platform.



COMBINED PASSENGER AND BAGGAGE CAR, WEST JERSEY & SEA SHORE R. R.

A Royal Trolley Car

In a recent issue of this paper editorial comment was made of the fact that although private steam railroad coaches had been constructed for a number of the crowned heads of Europe, no instance was on record, so far as was known, of a royal trolley car. The suggestion was then made that this condition would probably not long continue, and that it would not be long before some member of one of the reigning families would be riding in an electric car built especially for himself, and fitted up as elaborately and with as many comforts as custom has decreed should characterize conveyances of this description. This prediction has already come true, as the accompanying engravings prove. They were kindly furnished the STREET RAILWAY JOURNAL by T. Ahern, president of the Ottawa Electric Railway Company, and show the new car,

TROLLEY CAR FOR ROYALTY

the "Duchess of Cornwall and York," built for that company to convey their royal highnesses over the tracks of that company during their coming visit to Ottawa.

The car is 50 ft. in length, with straight sides and vestibuled at both ends, and has a full monitor roof of the Pullman pattern. The color is also Pullman standard, with the British coat-of-arms in gold conspicuously painted on both front and rear ends. The interior of the car is finished in antique polished oak, the ceiling being covered with three-ply bird's-eye maple veneer, and decor-

INTERIOR OF ROYAL CAR

ated. There are four large British plate mirrors set in frames, two at either end of the car. All trimmings, such as hat racks, hooks, etc., are of solid bronze. The window curtains are of the latest design, and are very ornamental. The car is brilliantly illuminated by five clusters of incandescent electric lamps, twenty-one in all. The floor is covered with a rich, royal blue velvet carpet.

The car contains fourteen large, easy chairs, beautifully upholstered in olive green plush. The trucks are double, and of the swing motion pattern, with graduated springs. The electric equipment is very complete, and consists of four Westinghouse 50-hp motors. The car is also fitted with the Westinghouse automatic air brake, and is capable of attaining a speed of 50 miles per hour.

The car was manufactured by the Ottawa Car Manufacturing Company for the Ottawa Street Railway Company.

Improvement in an Electric Heater

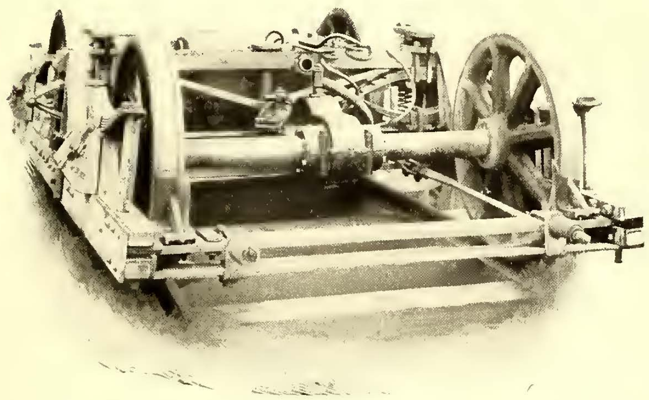
The Gold Car Heating Company has its plant located at the corner of Frankfort and Cliff Streets, New York City. It employs in the neighborhood of 150 men in the department which is devoted to the manufacture of electric heaters for street railways and other purposes. This industry, which has had its origin within the last six or seven years, has grown to enormous proportions. At the present time the Gold Company states that over 75,000 of its electric heaters are in use in different parts of the world. The principle of construction which has been followed has been to locate the resistance coils of the heaters in such a manner that the air in passing through the casing is given free access to and around the heated coils. By means of a very free circulation thus established, the largest amount of heat is delivered into the space to be heated. The coils are supported on a very ingenious contrivance in the shape of a crimped or zig-zag rod. It is a steel rod, thoroughly covered with enamel, which insulation is applied to the rod at over 2500 degs. F. The result is a very perfect insulation, and prevents the current passing into the rod proper. Owing to the high temperature at which this insulation is applied, it will never be affected by the heat of the resistance coils. The method of distribution of the heat is very simple, and is controlled from a central point. A three-point regulating switch is used. When this switch is turned to point 1, one-third of every heater in the car is in service; at point 2, two-thirds of every heater in the car is in service, and at point 3, which is the maximum, the full capacity of every heater in the car is utilized. By this means a very even graduation of the heat and a most uniform distribution around the car is insured at all times.

The Gold Company has not only improved the design and mechanical construction of its heater to a very great extent, but within the last few months has placed on the market a controlling switch, capable of satisfactorily breaking and carrying 60 amps. at 600 volts. This switch may be operated in either direction. Owing to its very large carrying capacity, it will readily be seen that this switch is of sufficient strength to control the heating apparatus of the largest cars in use on any street or elevated railway in the United States to-day.

The Gold Car Heating Company has furnished about 3000 equipments for cars in Greater New York. The Manhattan Railway, of New York City, has used the Gold Company's heaters for many years, and the satisfactory manner in which these cars have always been heated is the best evidence that can be offered as to the merit of its devices. The Metropolitan Street Railway Company has had about 600 cars equipped with the Gold system, and these have given satisfactory service for many years. Within the past few months the Metropolitan Company has placed orders for several hundred equipments of improved Gold electric heaters. The Brooklyn Rapid Transit Company, the Staten Island Electric Companies, the New York, New Haven & Hartford Railroad and the New Jersey Traction Companies are large users of the improved Gold electric heaters. In addition, the Gold Car Heating Company has placed its various heating devices on over three hundred other railroads in the United States and foreign countries. Over thirty thousand cars, some of which are operated in as remote territory as China and Japan, are equipped with the Gold systems of heating.

New Air Brakes for Birmingham, Ala.

The Birmingham Railway & Electric Company has recently been purchasing some air-brake equipments from the Knell Air Brake Company, of Battle Creek, Mich. A compressor, which is one of the new designs of the Knell Air Brake Company, mounted on a Dupont truck at Birmingham is illustrated herewith. The new type of Knell compressor is in general the same as the one that has been on the market for some time. The gear case of this compressor gives ample clearance above the roadbed when attached to maximum-traction trucks with wheels as small as 17 or 18 ins. Its extremely light weight is also a feature which will be appre-

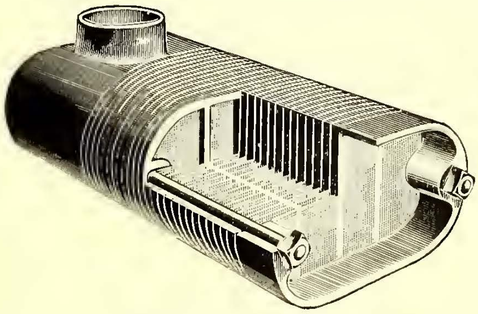


KNELL AIR BRAKE COMPRESSOR ON DUPONT TRUCK

ciated. The entire weight of the compressor complete, with valves, is given as 285 lbs. The Knell Air Brake Company is constantly receiving testimonials of a kind that the manufacturer appreciates above all others, namely, additional orders from companies that have adopted the brake, among whom may be mentioned the Birmingham Railway & Light Company, the Charleston Consolidated Railway, Light & Gas Company, and the Omaha & Council Bluffs Railway & Bridge Company. The company with its increased facilities is now in position to manufacture electrically-driven air compressors as well as axle-driven compressors. For the past year the company has made exhaustive tests of its new electrically-driven air compressors to meet the demands of four-motor cars. A strong feature of the axle-driven apparatus that has already been put out is the automatic suction and pressure regulating valve, which is quick in its action and insures at all times an ample air supply.

The Potter Mesh Separator and Superheater

Some particulars were published in the last issue of this paper of this new type of separator, but through a typographical error, omission was made of the fact that this separator is controlled and



THE POTTER SEPARATOR

is being placed on the market by James Beggs & Company, the well-known dealers in steam specialties in New York.

It is somewhat unusual at this late day to be able to record the application of an entirely new principle in steam engineering. This, however, is what is accomplished by the Potter separator, a view of which, reproduced from our last issue, is published herewith for a better understanding of the principles of its construction. Heretofore, as is well known, the separator is usually inserted in the line of steam pipe as near as possible to the delivery end of the pipe. In the Potter separator, however, the apparatus combines the functions of a superheater with that of a separator, and is placed at the boiler end of the steam delivery pipe and *within the boiler itself*. In the case of sectional boilers the separator is placed inside of the steam drum and in all cases it delivers directly to the boiler nozzle. In this way the moisture is returned directly to the boiler, so that no return traps or drain pipes are necessary.

The separator consists of a number of metal bands having an oval outline and being clamped together side by side with partitions of wire gauze between, as shown clearly in the accompanying engraving. The structure composed of these sections is flanked at each end by a tubular extension of oval cross section, one of these extensions being closed in by a head at its outer end and provided with a delivery outlet on one of the flat sides. The other extension is shorter and serves merely as a sort of clamping ring to give rigidity to the structure. The steam enters the structure at the open end, of course, and, after filtering through the consecutive partitions of wire cloth, is delivered at the outlet end to the boiler nozzle.

It is claimed that the steam is superheated in its passage through the apparatus, and it follows, of course, that when the stream is delivered to the boiler nozzle it is entirely free from suspended or entrained moisture. It is explained that the layers of wire cloth absorb to a large extent the pulsations due to the motion of the engine piston and thereby reduce the tendency to lift water. The small globules of moisture which are always contained in steam taken directly from the steam space of a boiler are broken up by the first gauze partition, still further disintegrated by the second partition, and so on, until the moisture is completely atomized and requires only a small degree of superheating to be flashed into dry steam. This superheat is obtained by the slight wire drawing consequent upon passing through the gauze, the reduction in pressure on this account, it is stated, being about 1 per cent. It is unnecessary to explain the effect of delivering superheated steam to the mains.

The builders state that a test of the apparatus made with the calorimeter located 2½ ins. from the bottom of the steam delivery pipe showed 0.3 per cent of moisture, as compared with 0.75 per cent found in a test under the same conditions without the separator. Wm. M. Brock, superintendent of the electrical department of the Paterson & Passaic Gas & Electric Company, who is using it on 3000 hp of boilers, states that calorimeter tests at that plant show a range of from 0.6 to 0.9 per cent, as against from 1.5 per cent to 4 per cent formerly.

The separator has been adopted very extensively by steam users, although it has been on the market only a short length of time.

Some Specialties in Insulating Materials

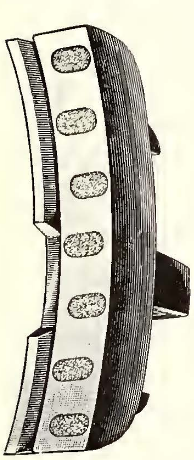
The insulation used in the manufacture of electrical machinery has, perhaps, gone through more radical changes in the last two years than any other line of supplies. Solid mica segments over five inches long are now a rarity, having been driven out by manufactured plate, which can be had in the sheet, or cut to pattern, milled to exact thickness at much less cost and of equal insulating value. One of the most popular brands is known as Micabeston, and is made by the Sills-Eddy Mica Company of New York. This company also manufactures the Imperial varnish muslins and linens, which are being used in large quantities by manufacturers and street railways. In addition to the manufacture of Micabeston and Imperial varnish insulation, the Sills-Eddy Company is the largest importer of amber mica and one of the largest of India mica in the United States.

Ventilators for Power Houses and Large Buildings

The Metropolitan Street Railway Company, of New York, makes use of a ventilator made by the Pan Coast International Ventilator Company, of Philadelphia. The construction of these improved ventilators is such that a wind velocity of 3.2 miles per hour is sufficient to start the apparatus. The capacity of the ventilator increases rapidly as the wind gains in velocity. The accompanying engraving shows a number of these ventilators about to be shipped to the American Bridge Company. The catalogue recently published by this company shows a number of interesting tests on this type of ventilators as well as a very complete illustration of its details and construction. The ventilators are used not only for power houses but for factories, office buildings and other large structures requiring ventilation. The ventilators are made in round, oval and square forms suited for use on skylights, chimney tops and ventilating flues. The popularity of the ventilators is attested by a large number of users upon whom, in addition to the Metropolitan Street Railway, mentioned above, are the St. Charles Street Railroad, of New Orleans, and the Galveston (Tex.) City Railway. Among the large factories supplied are those of the Westinghouse Electric & Manufacturing Company, Cramps Shipyards, of Philadelphia, and the American Bridge Company, some of those of the latter company being illustrated herewith.

A New Brake Shoe

The Crescent Brake-Shoe Company, of Philadelphia, recently organized, controls patents lately granted covering brake-shoes containing sand pockets. These brake-shoes are of iron, in the face of which are a number of pockets varying in size and number, and containing a composition consisting principally of sand. It is claimed that this form of construction is especially efficient in preventing chattering and gives excellent braking effect in the stopping of a car. Tests of this shoe have shown gratifying results as to its life and effect on the car wheels. A report of William F. Weiss, master mechanic of the Camden & Suburban Railway Company, shows that a set of these shoes with sand pockets was placed on a car of that road last spring, and that this car was run every day for eight weeks, making a total mileage of about 8000. There were during this time twenty-one rainy days. On the same road Mr. Weiss reports that the average life of brake-shoes is about 3500 miles for the same kind of shoes without sand pockets, and the braking effect is apparently better with the sand pockets than without. Further test of the shoe was made on an eight-wheel car and the shoes here showed a record of 9500 miles. On this test all the good points first noted as to the life of a shoe, fine braking qualities and good condition of wheel were again demonstrated.

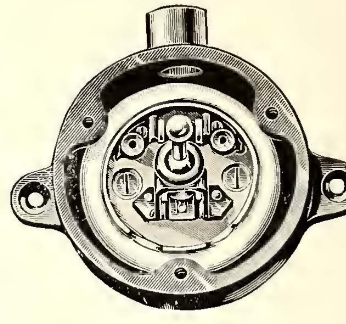


BRAKE SHOE WITH SAND POCKETS

An Improved Steel Conduit System of Electric Wiring

The Simplex steel conduit system for the interior wiring of electric light and power installations consists of a combination of enamelled or galvanized steel tubes and fittings and accessories, made of malleable castings. The conduits are made from selected steel strip, the gage of which varies according to the diameter, from No. 20 B. W. G. in the smallest size to No. 14 in the largest. This strip, after being cut to the exact size required, is passed through a tube machine, from which it emerges as a perfectly smooth and regular tube, with a close joint, and possessing an absolutely uniform interior and exterior diameter, which, with the Simplex method of patent socket joints, is of the utmost importance. The conduits, or tubes, are made in six grades, including enamelled steel conduits, enamelled brazed steel conduits, galvanized steel conduits, and screwed conduits, both brazed and unbrazed. In each of these grades the conduits are made in eight different sizes, so that all classes of work are provided for.

The Simplex enamelled steel conduits were the grade which was originally introduced, and is still the most largely used. They are similar to the screwed conduits shown in the illustration, but not made from such heavy tubing. The advantages claimed for this conduit are high economy in first cost, erection cost, and maintenance, mechanical strength, combined with lightness and durability, electrical efficiency, neatness, compactness and accessibility. It is suitable for all conditions of wiring work, except in exceptionally damp situations. These conduits are made in lengths of about 13 ft. 4 ins., and after leaving the tube machines, they are placed on end finishing machines, the object of which is to dress out the interior and exterior of their extremities. The lengths are next dried in a heated chamber, to extract any inherent or condensed moisture, previous to being placed in the enamelling vats. After being thoroughly coated with enamel, both internally and externally, they are placed on racks to drip in such a manner as to secure uniform distribution of the enamel. The enamelled tubes are then suspended from iron frames in specially constructed stoves, in which they are subjected to a high and constant temperature for some hours.

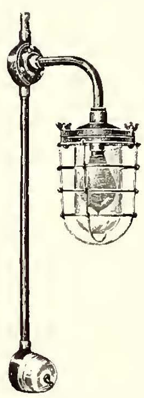


SIMPLEX SWITCH

Enamelled brazed steel screwed conduits, being screwed, are made from considerably heavier gage strip than the foregoing, which renders them much stronger. They are suitable for special work, where there is a likelihood of their being roughly handled or damaged, and on account of their smooth interior will be found a great improvement on gas and steam pipes for electrical purposes.

The enamelled unbrazed steel screwed conduits are similar to the ones just described, only that they have the longitudinal seam unbrazed. This grade has just been brought out in response to frequent inquiries for a heavy conduit for screwing, and a large demand is anticipated, on account of its cheapness. It, of course, presents the same advantages of perfectly smooth interior, complete continuity, and satisfactory mechanical protection as the brazed screwed type.

It is most essential that a complete set of fittings and accessories should be standardized to meet the many and varying conditions of installation work. In the Simplex system there are upward of 400 such fittings, which are kept in stock in large quantities by the company. They are applicable to each class of conduit, and have been designed with the primary object of efficiency, combined with economy. Nearly all these devices are registered or patented. Two of the Simplex fittings which have recently been brought out are herewith illustrated. The Simplex emigrant, corridor and subway fittings are for use chiefly with the Simplex screwed conduit, and are found to be very serviceable. The water-tight switch has been specially introduced for use in conjunction with these fittings. The box of the switch has been designed to take, and can be fitted with, any of the ordinary tumbler or turn switches in general use. The cover, as well as the nipple, are fitted with rubber rings, and the portion of the porcelain is kept about ⅜ in. off the base of the box, to allow for the wiring connections, which can be made before the switch is screwed down.



SIMPLEX LAMP FITTING

It was early recognized by the makers, the Simplex Steel Conduit Company, Birmingham, England, that to be adopted for installation work, the conduits and fittings must of necessity be sold at such a figure as would enable the contractor to erect an average installation on this system at no more than it would cost him to do the same work with wood casing—that, in fact, all the advantages of a conduit installation must be thrown in. There is abundant testimony from wiring contractors all over Great Britain to show that this can be done, and that in a great many cases installations erected on the Simplex system work out at a lower cost per point than by any other method. The reason for this is not hard to understand, for in installation work with wood casing the labor item forms a very heavy part of the total cost of the installations erected, both as regards the jointing and mitering of casing, and the cutting away of plaster, cornices, joists, etc., to receive it; and although socketed steel conduit and fittings can not be purchased per foot run at the same price as wood casing, yet they can be purchased and erected at the same, if not less, cost, on account of the enormous saving in this labor item.

A Universal Car-Step Lifter

This device is called a universal car-step lifter because of the ease of its application to cars having one, two or three folding steps. The use of only one runningboard is quite sufficient on the lower types of cars, but swivel trucks and heavy motors are being adopted on many lines, and this has resulted in the raising of the car floor until the step necessary with one runningboard is from 16 ins. to 24 ins., and this is a serious inconvenience for women, children and old people. As an important part of the travel on open cars is by women, it is a matter of dollars and cents to cater to their comfort. In many cases it is desirable, if not absolutely necessary, to fold the lower step, if two steps are used, and in these cases it would often be advantageous to fold the top step also, as by so doing longer or wider cars might be used. The accompanying illustrations are of a step lifter patented by L. G. Montony, of Troy, N. Y. Fig. 1 shows the step lifter adapted for two folding steps alone. This arrangement is suitable for an elevation of a car floor of from 30 ins. to 36 ins. The steps fold up to within 6 ins. of the floor sill. Fig. 2 shows two folding steps with a third fixed step. This is applicable to heights of floor over 36 ins. from the ground, in which case the two lower steps fold up entirely to the outer limits of the top step. In both figures the operating car is shown pivoted to the outer end of each step and provided with a lug for each additional folding step and calculated to engage a pin on its corresponding step and fold up each step. The light chains shown on the steps are for the purpose of positively opening them when the bar pivoted to the lower step is let down. Counter weights will probably be needed for the lower step, and if the step is longer than 25 ft. it would be better to have an operating bar at each end. It can be readily seen that the lower step will be partially turned up when the first lug engages the corresponding pin on the second step, and so on for the next step if another is used. Thus, the slightly increasing pull necessary to start to raise a step is met and overcome before the next step above is started. The operating bar must have a guideway to regulate its lateral movement, but the elevation of this can be within rather wide limits. These guideways and supports are shown occupying such a position on the dash as not to interfere at all with the usual equipment of controller and brakes.

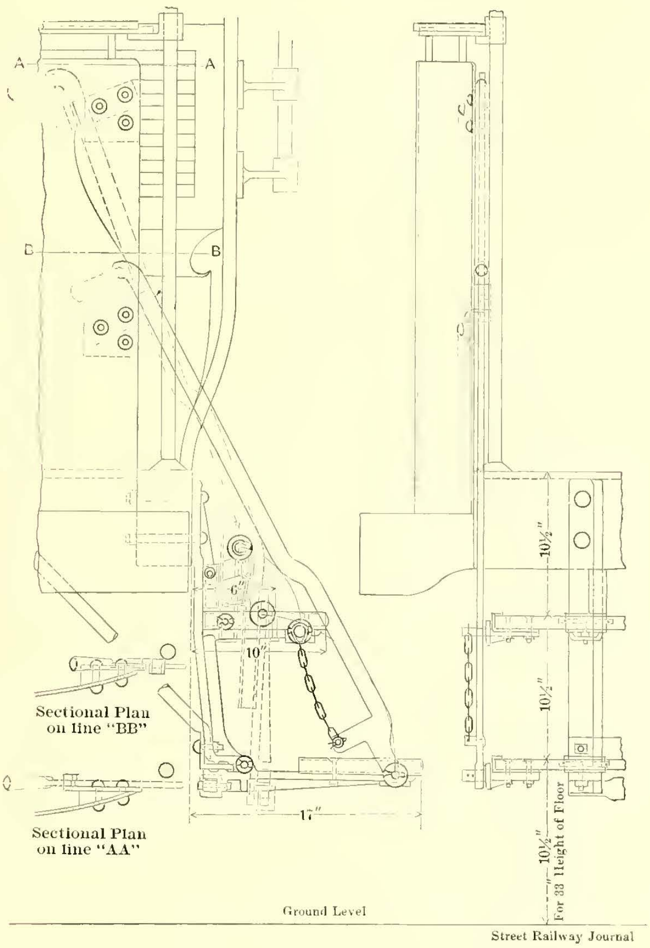


FIG. 1.—STEP LIFTER FOR TWO STEPS

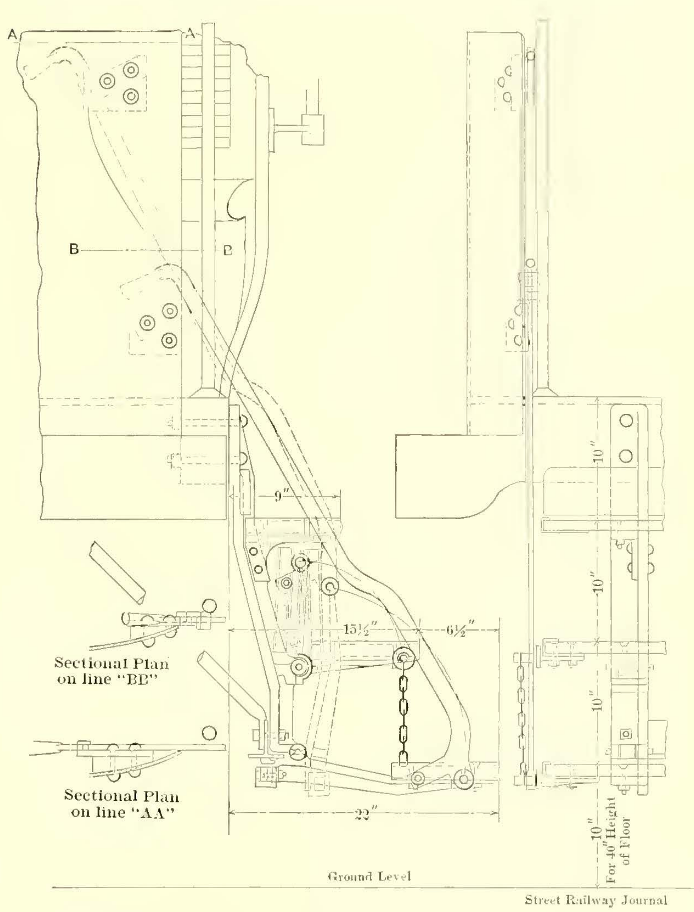


FIG. 2.—STEP LIFTER FOR THREE STEPS—ONE FIXED

A Growing Manufacturing House

The factory of the Morris Electric Company, of New York, which was recently started up near Ampere, N. J., has now reached an output of 3000 rail-bonds per day. The factory proper is 200 ft. long, but the capacities of the brass foundry, core room, machine and blacksmith shops, etc., are severely taxed, and additions to the equipment are being considered. The most pressing need is for a stranding machine for preparing cable for the bonds, and one will shortly be installed. The popularity of the Morris bonds is being rivaled by that of the new register, which has been perfected, and which contains among its carefully-designed mechanical details marked features of durability and reliability. Elmer P. Morris has given much personal attention to the operation of the factory, where it is intended ultimately to remove the shipping department, leaving the New York office as a selling office alone. Starting solely as a manufacturer's agent and general supply house, this company now occupies a conspicuous position in the field, and promises to be one of the most important manufacturers of railway specialties.

Convention Headquarters

Murray Hill Hotel has been selected as headquarters for the American Street Railway Association at its coming convention, Oct. 9, 10 and 11. The selection is an excellent one, considering all the conditions. This hotel is at Park Avenue, between Fortieth Street and Forty-First Street, one block south of Grand Central Station, and about ten minutes' ride on the Fourth Avenue line north of Madison Square Garden, where the exhibits are to be. The Murray Hill Hotel is on the highest ground in New York City, on famous Murray Hill, in the midst of a noted residence section. It is easily accessible from all railroad terminals. Guests may stop on either European or American plan.

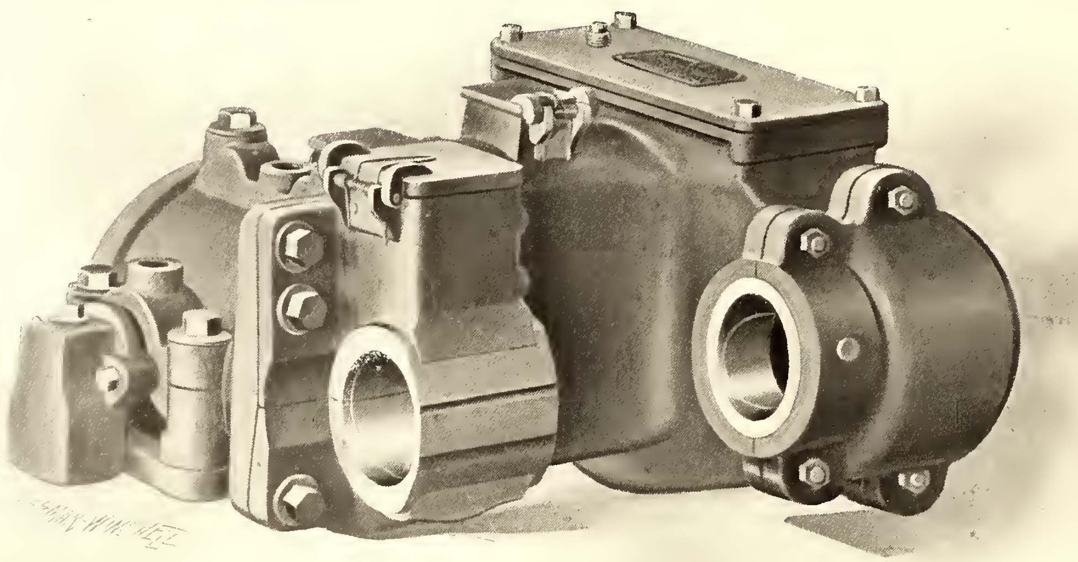
An Improved System of Air Brakes for Traction Service

It is a well-recognized fact that steam railroading in its present state of perfection would be impossible without the air brake, and a successful adaptation of the compressed air principle to the requirements of street railways has long been desired. The cars now very generally used in this service in respect to weight and speed approach, and in many cases exceed, the conditions that obtained in steam railway service thirty years ago, so that an air brake is peculiarly adapted to the requirements. The perfect brake for traction service must be reliable and quick to apply and release. The Standard Traction Brake Company is putting on the market an improved air-brake system, including an axle-driven air compressor, which is claimed to contain all the necessary essentials for the efficient operation of either single cars or trailers. The motorman has before him at all times a gage, which indicates the exact conditions under which he is working, so that he is always informed of the air pressure in his reservoir and knows what his brakes can do. Quickness in emergency and smoothness and precision in service stops have been given particular attention in the design of the apparatus. Air being an elastic medium, it fulfils the requirements in this direction admirably. The system also provides for a quick release to the brakes. It operates on the so-called "straight air" system, in which the pressure in the reservoir is admitted directly to the brake cylinder by means of the operating valve placed under the hand of the motorman, the stand being taken that the automatic air brake which is used on the steam roads introduces complications that are entirely unwarranted in electric traction service, with its single or two-car trains.

The compressor is the central point about which the system has been built up, and will be described first. The cylinder is horizontal, double-acting, with its axis at right angles to the car axle. The axis of the crankshaft, parallel to the car axle, intersects the axis of the cylinder at its middle point; the crankshaft also passes through the center of the piston, which latter, exclusive of its two packing rings, is a single casting provided in its interior with two parallel surfaces, between which slides the crank brass, as in a slotted cross-head. All of these parts run in a bath of oil. One side of the cylinder is provided with a flange, by which it is bolted to the oil-tight housing that encloses the gear on the pumpshaft, as well as the driving gear secured to the car axle. This housing is provided with bearings on the axle, which serve to keep the two gears in mesh; these bearings also support this end of the compressor. The other end of the compressor is supported by suitable brackets mounted upon it and the truck frame respectively, with a rubber cushion between them to deaden the vibration.

This type of compressor is especially adapted for mounting on the same axle with the car motor, as the axle gear and its bearings take up but little room, and the balance of the housing and the pump cylinder occupy the vacant space back of the motor. When the motor bearing is so constructed that it would interfere with placing the pump cylinder close to the gears, the pump shaft is prolonged sufficiently to admit of locating the cylinder in the space between the motor bearings, in which case the compressor is provided with an additional or auxiliary axle bearing mounted on the cylinder head.

The suction and discharge valves, together with their renewable seats, are interchangeable, of the most approved design, and have no springs to wear out or gum up. There are no stuffing boxes whatsoever in the entire equipment, and all parts requiring lubrication are provided with oil wells and grease pockets. To meet the various conditions imposed by the different kinds of service, the company manufactures this type of compressor in several forms, the diameter of axle and pump gears in each case being so proportioned that the piston speed never exceeds the safe limit. Each of these compressors, furthermore, has a capacity double that required for a motor car with one trailer running under the most severe conditions of the service for which it is designed, so that during a large portion of the time they are running with the pump automatically cut out of operation.

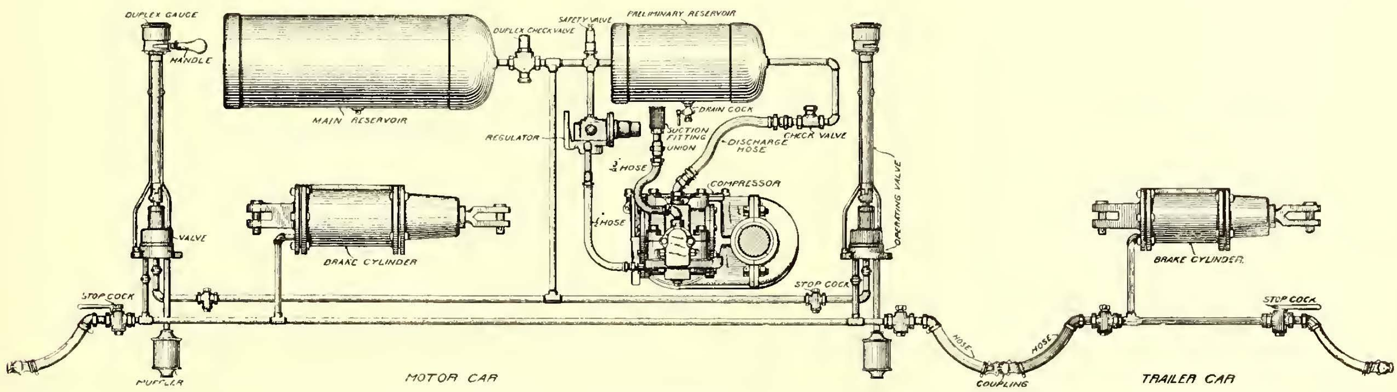


AXLE COMPRESSOR FOR HIGH-SPEED CARS

The regulator consists of a chamber, in free communication with the reservoir, one wall of which is formed by a diaphragm or piston subjected on one side to the reservoir pressure and on the other to the pressure of the atmosphere and a graduated spring. As the pressure in the reservoir increases, the piston or diaphragm moves outwardly, which motion is imparted to a D slide valve in the regulator chamber, and so constructed that in its outward position a port is uncovered, admitting compressed air to closed chambers, and in its inward position connecting this port to one leading to the atmosphere. The chambers are located in the body of the pump cylinder directly beneath the suction valves, and connected by hose to the regulator. Each of the two chambers is provided with an air-tight piston, such that when the reservoir pressure reaches the predetermined maximum and the compressed air acts upon them, the suction valves are lifted and the pump thrown out of action.

When the reservoir pressure has fallen slightly the D valve passes to its inward position, the air escapes from the trip-piston chambers and the pistons are forced down by springs provided for the purpose, the suction valves seat themselves and the pump is in operation until again cut out by the regulator. This type of regulator gives perfect satisfaction, it being absolutely tight at all times.

Reservoirs are supplied in such sizes and numbers as the type of car and nature of the service may demand. On cars running in city and also interurban service a system comprising two reservoirs has been introduced, a preliminary of moderate capacity connected directly to the discharge pipe of the compressor and the operating valves, and a larger main reservoir that is connected to the preliminary through a duplex check valve so constructed that air may flow freely from the main to the preliminary, but about 35 lbs. pressure must be attained in the latter before any air can pass into the main. Thus a car starting out of the depot with empty reservoirs will not have to run 100 yards before sufficient pressure is attained in the preliminary reservoir to enable the motorman to operate the air brakes. It also insures sufficient braking pressure on interurban cars when running at slow speed through the cities, and effectually removes all objection that has been raised against the axle-driven compressor on this score.



ARRANGEMENT OF APPARATUS FOR AXLE-DRIVEN COMPRESSOR

The brake cylinder is of the standard steam-railroad pattern with hollow rod that has been found to be best adapted for operation in conjunction with hand brakes. To avoid unnecessary wear and useless expenditure of force when the brakes are applied by hand, the piston of the brake cylinder is so connected to the foundation rigging that it moves only when the power brake is in use. To provide for cars of all weights, from the light trailer to the heavy interurban, these cylinders are made in sizes ranging from 6 ins. to 12 ins. in diameter.

The operating valves, of which there are ordinarily two on each car, are made in two forms. One has the valve proper placed upon the platform, with the operating head directly above it, at the level of the motorman's hand. On the top of this head is a double gage, of which the red hand shows the reservoir pressure and the black one the pressure in the cylinder. Owing to this most convenient location, directly in the range of the motorman's vision as he looks ahead, he can not fail to know at all times the pressure in his reservoir, and just how much braking power he is using. The gage is protected by heavy plate glass and is in practically no danger of being broken. In the head directly below the gage is a revolvable casting provided with a horizontal cylindrical socket and a latch, such that when the handle is inserted in the socket the latch is lifted and the handle may be rotated, but when it is withdrawn the casting is locked in its place. The shell of the head is so made that the handle can be inserted or removed when it is in but one position, usually that of "lap," when all parts of the valve are closed. Thus mischievous tampering with the valve at the rear end of the car is rendered impossible. By means of a vertical shaft, enclosed in a pipe shield and provided with a flexible coupling, the revolvable casting in the head is connected to the stem of the valve proper. This stem is provided with a pinion which engages with a rack mounted on the slide valve, so that when the handle is moved the valve slides from side to side between suitable guides. The slide valve is particularly well adapted to traction service, with its frequent stops, as it remains perfectly tight for years. When it is inconvenient to place the valve on the floor a form is used in which the valve is placed in the operating head, just below the handle.

Ordinarily the various organs are connected by half-inch wrought-iron pipe. The accompanying diagram shows the way the brake is applied to a car and trailer.

The compressor illustrated is especially designed for the fastest interurban service. It has a gear ratio of 1 to 2, and has satisfactorily solved the problem presented by this difficult service. With all these brakes the regulator works so perfectly that the pump "cuts in" automatically every time the brake is applied, and thus a portion of the momentum of the car is utilized in restoring the pressure expended in the brake cylinders. As the capacity of the pump is great enough to do this while an interurban car is running over the distance required in making a service stop, the power-house energy for braking is reduced to almost nothing. Another very desirable feature is the minimizing of the fluctuations in pressure, as it materially aids the motorman in making uniform stops and avoiding the flattening of the wheels.

This equipment is all made in the Wilmerding shops of the Westinghouse Air Brake Company, which guarantees the highest grade of material and workmanship. The parts are made interchangeable and renewal parts kept in stock for prompt delivery.

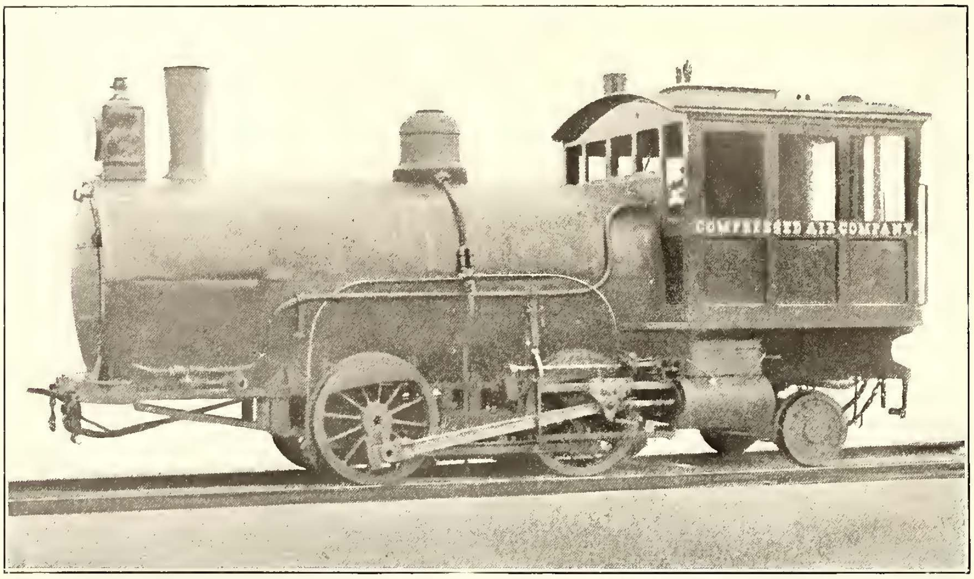
The Design of Power Plants

One of the most important features of a successful electric railway installation is the design of its generating stations and sub-stations. The firm of Sheaff & Jaastad, of Boston, Mass., has made a specialty of up-to-date power stations, and its name has been connected with some of the largest and most complete ones to be found in New England. Understanding to the minutest detail the requirements of street railway companies in this direction, it is enabled to give the most excellent work in the erection of the buildings and foundations, and the laying out of the steam-piping system. At present the company has under construction a large number of street railway stations, among which are some of great interest. The Worcester & Black Stone Valley Street Railway Company is erecting a power station at Millbury, Mass., and the Milford, Holliston & Framingham Street Railway Company is erecting one at Framingham, Mass., both of which have been designed by Sheaff & Jaastad. The system of the Exeter, Hampton & Amesbury Street Railway Company is building a large power station, eight sub-stations and five car houses, and the Newton (Mass.) Street Railway Company and Portland (Maine) Railroad Company are each building a power station under the firm's direction. The business is, however, in no way confined to New England, much work being done at present at Columbus, Ohio. This includes a central station and two sub-stations for the Columbus, London & Springfield Railway Company and a central station and sub-station for the new Columbus, Buckeye Lake & Newark Traction Company.

That the liberal offer of the St. Louis Transit Company, of St. Louis, Mo., to provide free transportation to the sick children of that city during the torrid weather was taken advantage of is shown by the number of guardians who availed themselves of the free transportation provided by the company. From July 27 to Sept 5, 33,805 free tickets were recorded, an average of 824 per day. The largest number recorded in one day was 1827, and the smallest 96. During the month of August 26,646 free rides were recorded. This would have amounted to $1,690.25 in 5-cent fares, and at 3 cents it would have amounted to $1,014.15.

Compressed Air Locomotive in Brooklyn

The accompanying illustration shows a compressed air locomotive which has been placed in operation on the Brooklyn elevated lines. The Brooklyn Rapid Transit Company was compelled some months ago, on account of its lack of current supply, to withdraw the electrically-operated trains from the elevated service, and since that time the old steam locomotives have been in use. The company has recently, however, made arrangements with the Compressed Air Company of New York City to use one of this company's locomotives, and if the experiment proves successful more will be put in operation.

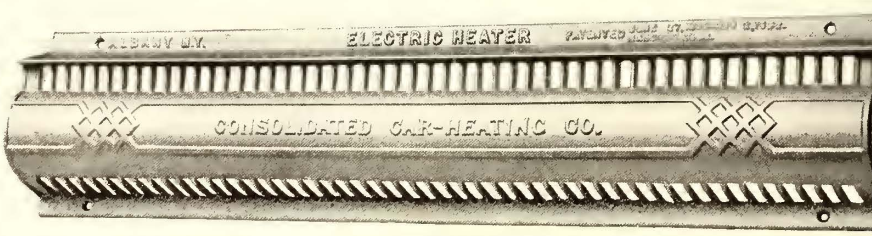


COMPRESSED AIR LOCOMOTIVE FOR ELEVATED SERVICE

The locomotive shown in the engraving is the same one upon which such successful tests were made some months ago in Rome, N. Y., but it has been remodeled to conform to the conditions required in elevated service. As at first made, the weight upon the drivers was heavier than the specifications insisted upon by the Brooklyn company allowed, and certain modifications in the construction have therefore been adopted in order to fit it more perfectly for its new work. It has also been supplied with a headlight and dummy stack, which gives it the general appearance of the conventional steam locomotive. A compressed air plant has been installed at the end of the line near Fulton Ferry, and the compressed air locomotive has been used for drawing four-car trains on the Fulton Street line. It was found, however, that the capacity of the plant was too small to properly charge the locomotive's air tank, so that the compressor has been removed, and a larger one will be substituted as soon as the Compressed Air Company can get it installed.

New Type of Car Heater

The accompanying illustration shows a single section of an electric heater recently perfected by the Consolidated Car-Heating Company, of Albany, N. Y. This heater is for use in cars in which are installed individual revolving seats, such as described in another part of this issue as in use in Brooklyn. The heaters are made in two 30-in. sections, each section containing one coil. When the coils in both sections are in service the heat is distributed over a space 5 ft. in length, which is twice the length of the panel heaters. This heater has a capacity of from 750 to 900 watts, about the same as the panel heaters. The heaters are arranged in two separate circuits, the coils in the first circuit being of greater resistance than those in the second circuit, and three gradations of heat are therefore obtainable. The company's latest type of three-point regulating switch is used with the equipment. The new design is screwed to the side of the car, and its peculiar shape renders it the most compact heater so far placed upon the market. The heaters are finished in gold bronze, and a line of these heaters gives a very handsome appearance to the interior of the car. The Consolidated Car-Heating Company has recently received an order from the Boston Elevated Railway for equipment of fifty new elevated cars with electric heaters. Eighteen heaters are to be used to a car.



A NOVEL FORM OF ELECTRIC HEATER

Reorganization of the Kuhlman Company

The C. G. Kuhlman Company, of Cleveland, has been reorganized under the name of The G. C. Kuhlman Car Company, with the following officers: Fayette Brown, president; T. P. Howell, vice-president; C. A. Ricks, secretary and treasurer; G. C. Kuhlman, general manager. The directors are: Fayette Brown, Frank Rockefeller, J. H. Morley, R. A. Harmon, C. C. Bolton, T. P. Howell, G. C. Kuhlman.

The company has let contracts for new shops at Collingwood, work on which is progressing rapidly, and they expect to move in Dec. 1. J. Milton Dyer was the architect who prepared the plans and specifications for the new shops, and it is expected that they will be as fine as any shops in this country. The company was most fortunate in the purchase of 31 acres of an admirably situated manufacturing site on the line of the Lake Shore & Michigan Southern Railroad. The Adams Avenue line of the Cleveland Electric Railway Company and the "Shore" line of the Cleveland, Painesville & Eastern Railroad run on two sides of the site, so that cars can be delivered either by steam or electric power.

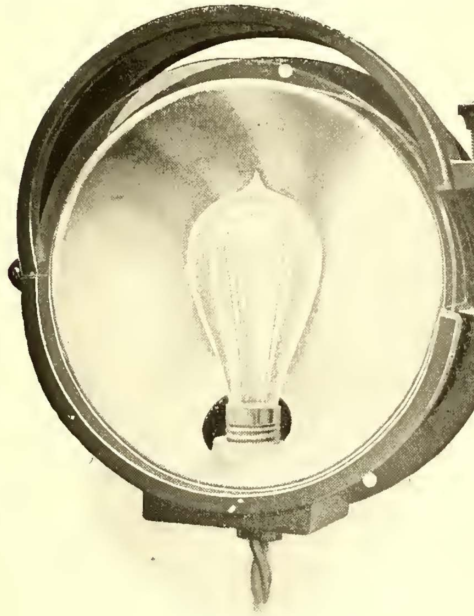
The new plant will consist of the following buildings running along the railroad tracks from east to west: The office building will be on Adams Avenue, and immediately back of it come the dry kilns and the boiler and engine building, and on either side of this building will be the woodworking machine mill and iron mill, both two-story buildings. Between these will be the storage house. The erecting room follows, and last the finishing room. Transfer tables between and tracks through all the buildings facilitate the handling of the material and finished product. A foundry is to be built immediately alongside the iron mill, so that for perfection in arrangement and economy in handling the new shops will be unsurpassed.

The buildings are large and roomy. The erecting and finishing rooms are to be 170 ft. x 250 ft.; the wood mill 80 ft. x 150 ft.; the iron mill 60 ft. x 200 ft., and the storeroom 40 ft. x 120 ft. The capacity of the plant will be 500 cars a year to start with, and the buildings are so arranged that the capacity can be doubled by adding on to the wood mill and erecting and finishing buildings. The new company is undoubtedly one of the strongest manufacturing companies ever gotten together in Ohio, comprising, as it does, among its stockholders some of the best known and oldest business men in this part of the country. That it will be a success is assured, for Kuhlman cars have always been in demand, and now that the company can meet the demand much better than formerly there will be no question as to the outcome.

which can not be completed until the new plant is in operation. Among other contracts are the following: Detroit & Toledo Shore Line, fifteen cars; Aurora, Wheaton & Chicago, thirty cars; Northern Texas Traction Company, fifteen cars; Saginaw Traction Company, seven cars; Grand Rapids, Holland & Western Railway, six cars. When the company was reorganized, some months ago, it was planned that steam-road cars, as well as interurban cars, should be built, but the demand for the latter is now so heavy that they may be built exclusively.

New Type of Headlight

The accompanying engraving shows a new type of headlight for electric cars recently put on the market by the Dressel Railway Lamp Works, of New York. The frame is of malleable iron, although the company also builds a frame of sheet steel, in case



DASH HEADLIGHT

this is preferred by the user. The application of the headlight does not require any cutting of the dash. The lamps can be easily cleaned and adjusted and the frame is water-tight. They are fitted with 7, 8 or 10-in. reflectors.

The New Castle Bridge Company, of New Castle, Ind., is now constructing large new shops at Indianapolis, Ind., and will remove its general offices to the Indianapolis site about Jan. 1. The new shops of the company are of steel and brick, and will be equipped with the most improved facilities for handling heavy bridge and structural-iron work.

The Ohmer Car Register Company, of Rochester, N. Y., has just issued an artistic and intensely interesting catalogue, in which the various claims made for its registers are impressively set forth. Attention is for the first time called to several new features of the registers and the various types of registers manufactured by the company are illustrated. Instructions for taking measurements for the Ohmer car-register system are given, and a few of the many testimonial letters from users of the Ohmer registers are reprinted. Special attention is called to the simplicity of the system, especially where different rates of fare are charged, and sample conductors' reports are given to substantiate the various claims made. The Ohmer system indicates and records separately each fare received, whether it is in the shape of a transfer or whether it is a 3-cent fare or a 5-cent fare, or, if on an interurban car, whatever the amount is, be it 10 cents or 50 cents. The conductor is enabled to give a visible receipt for each and every fare collected, thus dispelling any doubt or suspicion as to his honesty, and tends to so lessen his labors that he can bestow proper attention to passengers.

Some of the Apparatus in Use in Greater New York

The electric railways of the city of Greater New York furnish an operative street railway appliance exhibit on a large scale such as can be found in few other places. As many of the convention visitors will wish to see certain kinds of apparatus in service, the following list has been prepared, giving in a most complete manner nearly all of the principal street railway material in use and where it can be found.

The Harrison Foundry & Machine Works have installed at the Ninety-Sixth Street power house of the Metropolitan Street Railway one 9 in. and 15 in. x 22 in. tandem compound, non-condensing engine, direct conected to a 75-kw generator running 270 r. p. m. In the same station are also two 12-in. and 22-in. x 16-in. engines of the same type, direct connected to 150-kw generators running at 225 r. p. m. These machines are used as exciters. In the Manhattan elevated power house this company is installing four 14-in. and 25-in. x 18-in. right and left-hand tandem compound, condensing engines direct connected to exciting generators.

W. T. Van Dorn has his automatic coupler on the Brooklyn Elevated roads, and has also secured a large order from the Manhattan Elevated road for the equipment of all its cars, which comprises 1000 equipments for old cars and 100 for new ones.

The Samson Cordage Works furnish the trolley roads of Greater New York with Samson "spot" trolley rope, waterproofed.

The Sprague multiple-unit system as furnished by the Sprague Electric Company is in use in Brooklyn. The Brooklyn Rapid Transit Company has equipped many of its elevated cars with this system.

The Green fuel economizer is to be found in Brooklyn Rapid Transit power houses, and will be used in the new Manhattan Elevated central station and the Kingsbridge power house of the Metropolitan system. At the Fifty-Second Street power house of the Brooklyn Rapid Transit Company are four groups of economizers of 1800 hp each. At the Kent Avenue power house of the same company there are six economizers of 1800 hp each. In the Manhattan Elevated Railway power house now under construction there are sixteen units of 2000 hp going in at the present time and eight more to be added later.

Machado & Roller are equipping the seven sub-stations of the Manhattan Elevated with Whitney column type recording volt and ammeters on the total panels.

The Taunton Locomotive Manufacturing Company has supplied five Wainwright expansion joints, 30 ins. diameter, to the Metropolitan Street Railway power house, and is furnishing a large order of Wainwright expansion joints of various sizes from 16 ins. to 48 ins. to the Manhattan Railway power house. Its snow plows are in use on the Metropolitan system.

The McRoy Clay Works have sold 7,000,000 duct feet of the McRoy conduit to the Metropolitan and leased lines and 500,000 duct feet to the Brooklyn Rapid Transit Company.

The American Vitrified Conduit Company is supplying some 20,000 ft. of multiple duct to the Rapid Transit Subway, and the Manhattan Elevated and Metropolitan Companies are also heavy purchasers. The company has a large plant for the manufacture of conduit duct at Perth Amboy, N. J., near New York, and B. S. Bernard, manager of sales at the New York office, will accompany any convention visitors who may desire to go there.

The Curtain Supply Company has its curtain devices on all the surface and elevated systems in New York. On the Brooklyn surface cars are its No. 83 fixtures, with pantasote curtains, and for the elevated cars there the Acme closed car fixtures with pantasote curtains are used. In the open cars on the Brooklyn surface lines the Burrowes and Forsyth fixtures are in use. The Metropolitan cars of New York have the Acme open-car fixtures, and this company's curtains have been specified for the new work on the Manhattan Elevated.

The Standard Underground Cable Company is furnishing the Manhattan Railway Company all the cables to be used for transmitting power from its generating station on the East River and Seventy-Fourth Street to the sub-stations along its lines of the elevated railway. These are three-conductor, paper-insulated, lead-covered cables, to be operated at a pressure of 11,000 volts alternating current. More than half of the 350,000 ft. of cable involved in this order has been shipped, and much of it is installed in the

The company is at work on a number of contracts, some of company's subways. These cables are manufactured at the company's Perth Amboy factory.

The Jackson & Sharp Company, operated by the American Car & Foundry Company, has under construction a number of cars for the elevated railways, including an open type which has not hitherto been tried, but of which a large number are proposed for next summer.

The DeWitt Sand Box Company has equipped fifty cars for the Metropolitan Street Railway Company with its sand boxes, and some of these boxes are in use on that company's sand cars. It has also equipped seventy-eight cars for the Brooklyn Rapid Transit Company.

The Watson-Stillman Company has furnished the surface and elevated roads of Greater New York with hydraulic jacks, punches and motor lifts, and they can be found in operation in the various shops.

The Falk Company has done a large amount of cast welding both in Manhattan and in Brooklyn in the past two years. In New York it has cast welded all the joints on the following lines: Lenox Avenue, Columbus Avenue, Lexington Avenue, Amsterdam Avenue, Third Avenue, Twenty-Third Street, Forty-Second Street, 116th Street and 125th Street. In Brooklyn the joints on the following lines have been cast welded: Sand Street, Hudson Street, Navy Street, Flushing Avenue, Kent Avenue, Atlantic Avenue, Flatbush Avenue, Hamburg Avenue, Marcy Avenue and South Fifth Street. In the Bronx on the Union Railway lines, now controlled by the Metropolitan, the track on Boston Road, Franklin Avenue, Webster Avenue, Fulton Avenue and Main Street has been cast welded. There are about 50,000 Falk cast-welded joints in Greater New York, and the satisfaction they are giving can best be seen by a ride over the lines and actual inspection of the track. Particular attention is called to the welding of the Third Avenue line. The rail welding there is what is known as 7-in. Johnson Trilby, laid on stringers except at the joints, where the rail supports itself. All these joints were welded without interruption of car service for any considerable length of time during the twenty-four hours of the day, and the company was compelled to devise a method of welding while cars were passing over the rail. This was accomplished by means of a bridge about 6 ft. in length, which was carefully fitted to the rail and allowed cars to pass over the joint without deflecting it. It was in New York, also, where this company inaugurated the square joints, which are easier to pave to than the older forms.

The B. F. Sturtevant Company has furnished equipments for heating the New York & Queens County car house and the Nassau car house, and has four 5½-ft. fans direct conected to motor for forced draft in the Brooklyn Rapid Transit power houses. The Manhattan (elevated) Railway will have sixteen special 8-ft. fans with motors for forced draft in its power station, and fourteen special 5-ft. fans with motors for cooling transformers.

The Allis-Chalmers Company furnished the eleven engines for the mammoth plant of the Metropolitan Street Railway Company at Ninety-Sixth Street. Eight of these engines are now running, driving 3500-kw generators. These engines are compound condensing, 46 ins. and 86 ins. x 60 ins. stroke. The Manhattan (elevated) Railway in its power house at Seventy-Fourth Street is putting in eight engines of the combined vertical and horizontal type, each driving a 5000-kw generator. These engines have two horizontal high-pressure cylinders, 44 ins. x 60 ins., and two vertical low-pressure cylinders, 88 ins. x 60 ins. The eight engines recently ordered by the Rapid Transit Subway Construction Company are similar to the Manhattan engines. The Brooklyn Rapid Transit Company has two stations with this company's engines. The Kings County Electric Light & Power Company's station in Brooklyn contains four of these engines, and the New York & Staten Island Electric Company has three Allis engines. As will be seen from the foregoing, this company's engines occupy a very prominent place in power generation in Greater New York.

The Sterling Varnish Company furnishes the Brooklyn Rapid Transit Company with all the insulating varnish used for preparing armature and field coils. It also furnishes the Metropolitan Street Railway and allied lines with its Sterling extra insulating varnish used on its armature and field coils and Sterling extra black varnish for the finishing coat on armatures after they have been built up.

The Buda Foundry & Manufacturing Company has supplied the Paulus track drills which are in extensive use in Greater New York.

The Crouse-Hinds Electric Company has put a number of changeable headlights on the cars of the Brooklyn Rapid Transit Company. It built the switchboard in the New Rochelle plant of the Union Railway, and is constantly supplying the Metropolitan Street Railway with small knife switches. The drawbridge switchboard at 129th Street and Third Avenue is this company's work.

The Leonhardt emergency tower wagons are in use on the Union Railway in the Bronx, and also on the Brooklyn & Coney Island road.

The Partridge Carbon Works supply all the roads in Greater New York with carbon brushes.

The Universal Safety Tread Company has supplied its safety tread to the Manhattan elevated road, which is using it on the station stairways. The Brooklyn Rapid Transit Company also has a large number of car steps of this type, and is steadily increasing the number.

The Neal headlights are to be found in extensive use in both Manhattan and Brooklyn.

The New York Switch & Crossing Company has special work on all surface and elevated lines in Greater New York, save where the conduit system is used.

The Monarch Manufacturing Company has placed the Monarch engine-stop system on the engines in the West Farms power station of the Union Railway, in the plant of the Kings County Electric Light & Power Company at the foot of Gold Street, Brooklyn, and in the North River Electric Light Company's plant. It is also used in a number of important plants other than electric.

The Dearborn Drug & Chemical Works furnish the street railway and other steam plants of New York with feed-water treatments designed to suit the analysis of the different waters.

International registers are the regular equipment of the cars of the Brooklyn Heights Railroad Company, about 1000 cars being so equipped.

The McGuire Manufacturing Company made all the trucks for the Brooklyn Bridge cars, and has a considerable number of trucks on the Brooklyn Rapid Transit Company lines, besides some sweepers on the Metropolitan Street Railway and the New York & Queens County Railway, of Long Island City.

The J. T. Schaffer Manufacturing Company has installed a wheel press in the Rochester Car Wheel Works' New York City shop.

The Dayton Manufacturing Company has furnished the surface and elevated roads of Greater New York with many of the brass goods that pertain to the trimming of their cars, as well as many electric and oil headlights.

The Steel Cable Engineering Company has its coal and ash conveying machinery in the Kings County Gas & Illuminating Company's plant in Brooklyn, and also has a coal and ash conveyor at the Brooklyn Navy Yard.

Albert & J. M. Anderson Manufacturing Company has furnished a large amount of line material for the Brooklyn Rapid Transit Company, and also for the Union Railway in the Bronx.

The Best Manufacturing Company furnished and installed the large steam piping in the Ninety-Sixth Street power house of the Metropolitan Street Railway. It furnished the complete piping for the Thirty-Ninth Street power house of the Brooklyn Rapid Transit Company and the expansion binds for the Fifty-Second Street and Kent Avenue stations of that company. At present it is filling an order for Best gate valves for high and low pressure for the Manhattan Railway power station.

The G. P. Magann Air Brake Company has equipped the Brighton Beach division of the Brooklyn Rapid Transit Company with the Magann storage air system for air brakes, and for the past two summers these cars have operated from New York to Brighton Beach, through the Borough of Brooklyn, where they are now in operation and can be inspected by convention visitors.

The Mayer & Englund Company secured the adoption of its "Protected" rail-bond by the Manhattan (elevated) Railway, and has filled contracts for nearly 100,000 rail-bonds used in the electrical equipment of the Second and Third Avenue lines. The Manhattan also uses the Keystone cable hanger for suspending underground cables in manholes and vaults. The Brooklyn Rapid Transit Company adopted the Protected rail bond as standard several years ago, and about 150,000 of these bonds have been put on its track. This company has also purchased from time to time about 1000 International registers.

The John A. Mead Manufacturing Company furnished the coal-handling apparatus for the Ninety-Sixth Street power house of the Metropolitan Street Railway. This equipment takes coal from vessels, and conveys it to the coal bunkers above the boilers. The tower on the wharf is of the two-man type, with steam hoisting engines and the Rawson automatic bucket. The bucket discharges into the tower hopper, from which the coal passes through a crusher into hopper scales, and then to the two lines of the McCaslin overlapping gravity bucket conveyors, which deliver the coal to the bunkers over the boilers. The cost of taking coal from the vessels, crushing, weighing and depositing in the bunkers is given by the installing company as 3½ cents per ton. The machinery is handling coal every day at the rate of 125 tons per hour, although the guarantee was but 75 tons for this installation. A new, heavier engine, direct connected to the hoisting drum is being put in, on account of the increased tonnage. This company's apparatus also handles all the coal at the Kent Avenue power station of the Brooklyn Rapid Transit Company and the Edison Illuminating Sixty-Fifth Street station in Brooklyn. It has the coal and ash handling equipment for the Manhattan Railway power house at Seventy-Fourth Street and East River under contract, and has equipped the New York Steam Company's plant at Sixtieth Street and East River. These various plants include several different types of apparatus for unloading vessels and afford a good opportunity to study conveying machinery.

The Ohio Brass Company has supplied the Union Railway with a large number of Richmond flexible pole brackets, both single and double suspension, as well as hangers, ears, section insulators, feeder insulators, etc. The Brooklyn Rapid Transit Company, the New York & Queens County Railway of Long Island City, the Staten Island Electric Railroad, the Coney Island & Brooklyn Railway and the Staten Island & Southfield Beach Railway use quantities of Ohio Brass overhead material. This company's emergency hose bridge, which permits cars to run over tracks across which hose is laid, is used by the Brooklyn Rapid Transit Company, the Coney Island & Brooklyn Railway and the New York & Queens County Railway.

The General Electric Company has running or under construction for Greater New York a total of 8380 double-motor equipments. It built the generators and switchboard for the Metropolitan power house at Ninety-Sixth Street and the apparatus for most of the sub-stations. It has made many generators for the Brooklyn Rapid Transit Company power houses. In fact, its street railway apparatus is to be found at every turn, and an extended account of its apparatus in use in Greater New York would take a good-sized volume.

The Westinghouse Electric & Manufacturing Company has under contract the eight 5000-kw, three-phase generators of the revolving field type which are going into the Manhattan Railway power house at Seventy-Fourth Street and the East River. For the same company twenty-six rotary converters are being built. These generators and converters are the largest yet built. One of the 5000-kw generators is now being erected. The Manhattan Railway will also use seventy-six transformers of 400 kw each. In the way of motors the Westinghouse Company has furnished to the Brooklyn Rapid Transit Company 1700 No. 68 and eighty No. 56. All of the cars of the Brooklyn elevated are provided, or will be provided, with Westinghouse automatic air brakes and Westinghouse pneumatic multiple-unit control. On the Third Avenue division of the Metropolitan system there are 1500 Westinghouse motors. In the 129th and Sixty-Fifth Street sub-stations on the Metropolitan system are six Westinghouse converters of 1000 kw each. A large contract has also been made by the Brooklyn Rapid Transit Company for four 2700-kw, three-phase generators, three 2700-kw direct-current generators, eleven 1000-kw converters, five 500-kw converters, thirty-nine 400-kw transformers and three 200-kw transformers, together with all the switching apparatus for power house and sub-stations.

William Wharton, Jr., & Co. furnished the Metropolitan Street Railway with all the rails, slot rails and conductor bars for the first electric lines, consisting of about 30 miles of track. For the last four years a large part of the special work, comprising over 100 layouts, has been supplied to this company, among the more prominent of which may be mentioned the special work at Eighty-Sixth Street and Second Avenue, Twenty-Third Street and Sixth Avenue, Fifty-Ninth Street and Columbus Avenue, Lenox Avenue and 135th Street, Sixth Avenue and Fourth Street, State and Whitehall Streets, 125th Street and Amsterdam Avenue, Fifty-First Street and Seventh Avenue, Ninety-Sixth Street and Second Avenue. Practically all this work was of manganese steel, hard center construction. For the Brooklyn Rapid Transit Company 200 pieces of special work have been furnished by this company in the last few years, to say nothing of the crossovers, of which there are in Brooklyn over 100 of the unbroken main line style. Probably the most notable locations of this special work are along Fulton Street and at the foot of the Brooklyn Bridge. The immense traffic on Fulton Street has shown the merits of manganese steel points, as some frogs have had 4,000,000 cars pass over them before they were discarded. There are also a number of important steam and street railway crossings in Long Island City, among which may be mentioned the crossing at Broadway and the Long Island Railroad at Flushing.

The St. Louis Car Company's most interesting product in New York is the lot of 100 convertible cars built for the Third Avenue Railroad two years ago and still running. The Brooklyn Rapid Transit Company has hundreds of St. Louis cars, both open and closed. The Long Island City roads have St. Louis cars and trucks.

The Electric Storage Battery Company, of Philadelphia, has a large number of its chloride accumulators in both Manhattan and Brooklyn. These batteries are, with but one exception, installed in the power stations of the Metropolitan and Brooklyn Rapid Transit Companies, and serve to carry the peak of the load on the various lines. The single exception mentioned is in the case of the Thirty-Fourth Street Crosstown line, where fifty storage-battery cars have been equipped with the chloride accumulators. Each car contains seventy-two cells, and the batteries are of 300-amp.-hour capacity. The general type of cell used by the Metropolitan Street Railway in its various power stations are known as G-53, and have a capacity of 2080 amps. for one hour. They are distributed as follows: In the Front and Stone Streets sub-station there are 278 cells; in the Twenty-Third Street and North River sub-station there are 540 cells; in the Ninety-Sixth Street and East River station there are 278 cells; at Fiftieth Street and Sixth Avenue there are 556 cells; at 129th Street and Amsterdam Avenue there are 276 cells, and at 146th Street and Lenox Avenue there are 276 cells. In Brooklyn there is a battery of 248 cells of type G-51. These cells are of a capacity of 2000 amps. for one hour; at East New York there are at present two batteries, one a stationary battery and the other of a portable type, placed on old elevated railroad cars. Each of these batteries consists of 248 type G-27 cells, having a capacity of 1040 amps. for one hour. These two batteries are connected together, and therefore correspond approximately to a single battery of 248 cells of type G-53, the figures in the rating of the cells being indicative of the number of plates therein contained.

The Weber Railway Joint Manufacturing Company states that its joints are practically the standard on the Brooklyn Rapid Transit Company's lines, both surface and elevated. A piece of track near New York in which the company takes special pride is the 80-lb. T-rail on the New Jersey & Hudson River Railway & Ferry Company, Edgewater, N. J., on which 3000 Weber joints have been placed. The other New Jersey roads near New York use large quantities of the Weber joint. It is the joint adopted for the Fordham extension of the Manhattan elevated.

The Columbia Machine Works, Brooklyn, manufacture the illuminated car route signs of the type used on all the electric cars of the Metropolitan Street Railway. There are about 1600 of these cars so equipped on the street every evening during rush hours. The sign is illustrated in the article by Mr. Millen, general master mechanic of the Metropolitan Street Railway, elsewhere in this issue.

The American Steel & Wire Company has estimated that the number of Crown bonds sold and now in use in New York City and its immediate suburbs would furnish a perfect electrical equipment for both rails of a road long enough to reach from Canada to the Gulf of Mexico, while the total annual sales of the Crown bond would similarly equip a road extending from the Atlantic to the Pacific Ocean. They are in use on the Brooklyn Rapid Transit lines and for bonding the conductor rails on the Metropolitan Street Railway.

The St. Louis Register Company expects to have its self-recording registers in operation on the Brooklyn Heights line of the Brooklyn Rapid Transit Company by the time the convention opens, so that the working of this very interesting register, for which Giles S. Allison is New York agent, can be seen.

Babcock & Wilcox Company boilers have been used very extensively in Greater New York, but the newest, largest and most typical installations will be found in the power stations in Manhattan Borough which are fully described in the article in this issue by Mr. Kent.

The Corning Brake-Shoe Company, of Corning, N. Y., is doing a large business in the metropolitan district by supplying brake-shoes to the cars of the various systems therein. Francis Granger, Eastern sales agent, states that the Corning brake-shoe is used as standard on the surface, elevated and bridge lines of the Brooklyn Rapid Transit Company, and the continual repetition of large orders speaks very highly for the efficiency of the product. The Coney Island & Brooklyn Railroad Company is also using the Corning brake-shoe as standard on its entire equipment, this road using on the maximum-traction truck an inside-hung brake for which the Corning company supplies a special type of shoe, made interchangeable. The Corning brake-shoes are also used extensively on the cars of the New York & Queens County Railroad Company, of Long Island City, and the Union Railway, and the Metropolitan Street Railway, of Manhattan, while the Manhattan elevated has for some years used the Corning shoe well nigh exclusively.

The Laconia Car Company has built for the Brooklyn Rapid Transit Company 100 thirteen-bench open cars and seventy-five 25-ft. closed cars for the surface lines.

The Peckham Manufacturing Company reports an immense number of trucks in use in Greater New York. In the Borough of Manhattan about 1200 Peckham single trucks are in use on the Metropolitan and Union systems. In Brooklyn on the lines of the Brooklyn Rapid Transit Company and the Coney Island & Brooklyn Railroad there are about 1500 single trucks. In Long Island City there are about 200 single trucks on the New York & Queens County Railway. On Staten Island the Staten Island Electric Railroad has fifty single trucks. In addition to the foregoing single trucks there are in use on the lines mentioned some 800 of Peckham's short-wheel-base and maximum-traction trucks.

The Ramapo Foundry Company, which manufactures the "Diamond S" street-car brake-shoe in the Eastern territory, supplies shoes to the Brooklyn Rapid Transit and Metropolitan Street Railway systems. The shoe is popular because of its wearing qualities, coupled with the high coefficient of friction.

The Exeter Machine Works are supplying the complete coal and ash handling outfit for the New York Gas, Electric Light, Heat & Power Company's station at Thirty-Ninth Street and East River. This system unloads coal from barges and deposits it in the storage bins. The installation is now well enough along so that a good idea can be had of the construction.

The Silver Lake Company, through its New York agents, supplies waterproof trolley and bell cords to the Union Railway and the Manhattan elevated.

The Christensen Engineering Company has placed over 100 air-brake equipments on the elevated cars of the Brooklyn Rapid Transit Company, and also a few surface car equipments.

The R. Bliss Manufacturing Company, of Pawtucket, R. I., owner and manufacturer of the Wood patent safety car gate, has secured the adoption of this gate as standard by the Brooklyn Rapid Transit Company and the Coney Island & Brooklyn Railroad Company. The Brooklyn Rapid Transit Company has the platform gate, with a single fold on the right-hand side of the car, two gates to a car; while the Coney Island & Brooklyn is using and installing as rapidly as possible the double folding gate, which is rendered necessary by the extremely wide platforms. The exigencies of the Brooklyn service when encountering the congestion on the bridge requires a platform gate that is of the most perfect mechanical construction. The strength of the Wood gate renders it peculiarly adapted to service on lines operating under conditions which necessitate crowded platforms, and the two railways of Brooklyn have thoroughly appreciated this fact in adopting the Wood gate as their standard. The platform gate is also used extensively on the Third Avenue and the Union Railway divisions of the Metropolitan Street Railway system operating in Manhattan. Francis Granger, New York representative, announces that the R. Bliss Manufacturing Company is now getting out a folding gate to be operated by hand leverage, which will be peculiarly adaptable to elevated service of both New York and Brooklyn, and which, with other gates, will be on exhibition at the convention.

The Consolidated Car Heating Company, Albany, N. Y., has its well-known heaters on 3500 cars in Greater New York and vicinity, and has orders on its books from the same territory for equipping 1300 additional cars in the near future, making a total of 4800 cars. Among the orders is one for 21,600 electric heaters, by far the largest contract for this class of apparatus ever awarded, from the Manhattan (elevated) Railway Company, to be used on its elevated line after the installation for electric operation has been completed. These heaters were described and illustrated in the STREET RAILWAY JOURNAL a few weeks ago, and will contain 13,500 miles of wire in the heating coils. The order was obtained through the company's New York agent, Cornell S. Hawley. In addition to the above, the company is now filling an order for 360 metal cases to replace the wooden ones on the heaters furnished by it to the Union Railway, of New York City, in April and May, 1893. This is the first type of heater case put out by the company, and after eight years of service the heaters are in such good condition that it has been decided to replace the wooden cases, making no other change in the heaters. A similar change was last year made in 500 heaters furnished the Albany Railway in 1892 and 1893.

The Ham Sand Box Company, of Troy, N. Y., has approximately 1000 of its well-known track-sanding devices in operation on the surface cars of the Brooklyn Rapid Transit Company, and has equipped as an entirety the cars of the Coney Island & Brooklyn Railroad Company, both of these roads having adopted the Ham sand box as standard. The No. 4 type sand boxes are used on the closed cars of the Coney Island & Brooklyn Railway, while the No. 5 type, or under-the-platform box, is used on the open cars of the same line. There are a number of different railways also operating in Greater New York on which tests of the Ham sand boxes are now being made with very gratifying results, while there are other and smaller roads that have adopted the sand box after a very rigid test, and are now using it as standard. Francis Granger represents the company in New York.

J. R. M'Cardell & Co. have furnished their Trenton trolley wagons to the Brooklyn Rapid Transit Company, the Union Railway in the Bronx and the New York & Queens County Railway, in Long Island City.

The New York Car Wheel Works have supplied the Metropolitan Street Railway with an average of 500 wheels a month for the past four years. The Brooklyn Rapid Transit lines have been supplied with 19,750 wheels in the past four years. From this it will be seen that the greater part of the car wheels running in Greater New York were supplied by these works. All the wheels furnished to each of the companies mentioned are machined on the tread by being rotated between emery wheels to remove irregularities.

The Crocker-Wheeler Company, of Ampere, N. J., is another company which has a considerable amount of its apparatus in use in the railway power stations of Manhattan Borough. The motors of this company are employed principally to operate auxiliary apparatus, such as pumps, air compressors, coal conveyors, etc., and can be seen in operation in the Ninety-Sixth Street station of the Metropolitan Street Railway Company. Crocker-Wheeler motors were also used to a considerable extent by many of the contractors in their work of construction.

The J. G. Brill Company, of Philadelphia, has a very large number of its cars and trucks in use in Greater New York. In this district there are over 4600 of the well-known maximum traction trucks made by this company in use on all of the surface lines. On the Brooklyn elevated railroads there are operated a large number of the company's special trucks for this service, and orders are constantly being received for more. The cars of the Metropolitan system of Manhattan have been built in a large measure by the Brill Company. This is especially true of the long box cars, long open cars and combination cars, a large percentage of the total number of these types, which aggregate nearly 1400 in all, having been supplied. Some of the finest examples of parlor cars in the world are in operation on the Brooklyn Rapid Transit Company's lines, these cars being also made by the J. G. Brill Company.

The Electric Tripartite Steel Pole Company, of New York, has installed a number of its poles on the lines of the Union Railway of the Bronx system.

The Compressed Air Company, of New York, has, as stated elsewhere in this issue, one of its compressed air locomotives in use on the elevated lines of the Brooklyn Rapid Transit Company. This locomotive has only recently been delivered, so that the actual results of its operation are as yet only a matter of conjecture; but it is believed that it will show considerable economy over steam.

The Consolidated Car Fender Company, of New York, has a large number of its fenders in use in New York City; in fact, every electric car of the Metropolitan Street Railway Company is equipped with this fender except the few cars operating on Broadway. The Broadway cars, which are in large part those which were used with cable, still employ only a wheel guard. There are very few other devices which have been given such an emphatic indorsement by the officials of the Metropolitan Street Railway as the Consolidated car fenders, and their record as a life saver has been most successful.

The Gold Street Car Heating Company, of New York, has not only equipped all of the cars of the Manhattan Elevated Railway Company with its steam heater, but also a large number of the surface cars of the Metropolitan Street Railway Company's cars with its electric heater.

A considerable part of the track work installed in New York City was furnished by the Lorain Steel Company. It was this company which originated the well-known Trilby rail, and it was the Metropolitan Street Railway Company which first adopted this rail. This rail in a somewhat modified form is now the standard construction in Manhattan Borough.

The Safety Car Heating & Lighting Company has equipped with its Pintsch gas system all the cars of the Manhattan Elevated Railway Company.

The John Stephenson Company has been identified peculiarly with the New York City street railways. The first street car operated in New York, and in fact in the world, was, as is well known, one of the Stephenson cars, and since that time Stephenson cars have upheld their reputation for service on the city railways of New York. A large part of the rolling stock of the Metropolitan Street Railway Company was made in the Stephenson shops, and practically the last order given in Greater New York—that is, an order for the new combination car of the Brooklyn Rapid Transit Company, awarded a week or two ago—was divided between the Stephenson and one other company.

Wendell & MacDuffie, as agents in New York for the Falk Manufacturing Company, the Taunton Locomotive Manufacturing Company and other prominent concerns, have secured a large number of orders for their specialties for all the roads in Greater New York.

The Sterling-Meeker Company, of New York, has supplied practically all the cars of the Metropolitan Street Railway Company with the well-known Sterling brake, and has also supplied the Broadway cars with the Sterling fender. The Sterling sand box and the company's register is also used to a very large extent on the roads in the greater city.

The New Haven Car Register Company some time ago made a special register for the Third Avenue Railway, of New York, according to specifications of the managers of that road. This register has proved very successful, and is in use not only on that line, but on other roads as well. The company also has machines on the Coney Island & Brooklyn Railway, the Staten Island Midland Railway, the New Jersey, Hoboken & Paterson Railway and others.

The Subject of Car Fenders

One of the most serious problems encountered by the street railway manager in the operation of his road is the prevention of accidents to pedestrians. The conditions of city traffic render it almost impossible for the motorman to have sufficient alertness to avoid serious collisions with the numerous trucks and other vehicles which continually cut across his path. The irresponsible parties who attempt to dart ahead of the car and those who appear suddenly from behind a car going in the opposite direction are, therefore, sure to be injured if mechanical means are not provided for their safety. No brake is possible that will stop a car in sufficient time to save such persons from being struck, and the only alternative which a railway company has is to employ some fender that will effectively protect them from accident.

The Metropolitan system of New York probably has as many serious obstacles to a high-speed service as any other road. After its lines leave the congested business districts below Twenty-Third Street, the cars are operated at a very high rate of speed through streets that are continually being crossed and recrossed by pedestrians, and the motorman would be entirely powerless should a person suddenly appear in front of his car to prevent a serious accident if the front of the car was not provided with an effective life-saving device. The Metropolitan Street Railway Company, fully realizing the position in which it was placed, adopted as a standard on all parts of the road where traffic conditions permitted a fender that has given most perfect satisfaction and has resulted in a considerable reduction in the company's accident account. The fender which fulfils these requirements is the well-known Providence fender, made by the Consolidated Car Fender Company, of New York. The number of persons that are continually being saved from death or serious injury on the streets of New York daily by being picked up by the fenders of the street railway is very large, but, of course, the only record of such cases is to be found in the archives of the company. Everyone, however, at all familiar with the city can probably recall several instances from his own personal knowledge where a grown person or child has been most miraculously saved by this device. Although the Metropolitan system is undoubtedly one of the best-managed roads of the country, and is able to keep its "accident to passengers account" down to a very small percentage of the gross earnings, the great difference in the total accident claims shown by the Metropolitan report and that of other roads operating under similar conditions, but without efficient protective devices, is undoubtedly due to the adoption of a first-class fender.

A further advantage of the Providence car fender is the ease and rapidity with which it can be placed out of the way against the end of the dasher, which is an important feature in the New York service. It is impossible for the cars of the Metropolitan Railway to remain more than a few seconds at their termini, and any device which required more than this interval of time to adjust would be impracticable. The effective manner in which the change is made at such busy localities as the Brooklyn Bridge in Park Row shows that the Providence fender is particularly applicable to this class of service.

The North Jersey Street Railway Company, which operates a number of its lines through more or less open country, and includes in its system a large amount of interurban work, has also adopted the Providence fender with marked advantage. Some fenders which may prove satisfactory in busy streets where high speeds can not be attained, and where the motorman has at all times complete control of his car, may prove entirely ineffectual in high-speed interurban work, but the results attained by the Providence fenders of the North Jersey Street Railway Company's system have shown that this type is peculiarly adapted to both classes of service. The accidents to pedestrians in the open country are, of course, less frequent than in the crowded streets of a city, but in general when they do occur, they are of a more fatal nature. The installation, therefore, on interurban cars of more practical safety devices of this nature is of great importance, and a fender which has also proved its merits in the most congested city districts combines in itself all the requirements asked for by the most exacting management.

The two roads above are taken as typical examples, but the Consolidated Car Fender Company's apparatus is now in general use throughout this country and abroad, so that its operation can be observed in every part of the world. Nearly every road, of all types and sizes, have either adopted the Providence fender as standard, or are negotiating with the company with such plans in view. Notwithstanding, however, the immense shipments which are continually being made, the capacity of the company's shops enables it to keep a large stock on hand ready for boxing, and orders can therefore be filled with the greatest despatch.

New Publications

Trips by Trolley Around Hartford. Published by White & Warner, Hartford, Conn. 1901. 88 pages. Illustrated. Price, 10 cents.

Notwithstanding its title, this little book is of considerable interest outside of the neighborhood of Hartford. Nearly half of its pages are devoted to trips from Hartford to New York, and from Hartford to Boston, with descriptions of the towns passed through, so that it is practically a trolley guide between New York and Boston. The pages are illustrated in a handsome manner, and the letter press is clearly and concisely written. Such pamphlets are of great benefit, both to the traveler and railway companies, and their appearance from time to time in new localities is sufficient indication that their usefulness is appreciated.

Twentieth Century Trolley Trips: Boston. By Katherine M. Abbott. 1901. 128 pages. Illustrated. Price, 10 cents. Published by Charles B. Webster & Co., Boston.

Any description of the country traversed by a trolley road from the pen of Miss Abbott is sure to be entertaining, and her last book is no exception. Her facility of expression, her familiarity with history, both legendary and authentic, and her ability in suffusing her work with apt quotations makes this little pamphlet most fascinating reading. The district dealt with is the vicinity of Boston, including the "blue hills of Milton and Plymouth," Lexington, Concord, Medford, Gloucester, Hampton Beach, etc.—all rich in natural beauties and romantic pasts. One should read the "Trolley Trips," however, before setting out on an excursion, as it is to be feared the interest of the pages will keep the attention away from the "sights" if an attempt be made to enjoy both simultaneously.

The Construction of a Gasoline Motor Vehicle. By C. C. Bramwell. 1901. 149 pages. Illustrated. Price, $2.00. Published by Emil Grossman & Brother, New York.

The subject of the automobile is a most interesting one, and many amateur mechanics have desired to construct a machine for themselves. This book not only gives complete instructions for building a practical gasoline motor vehicle, but thoroughly discusses the principles which underlie the operation of this type of apparatus, placing at the disposal of the reader a large amount of information gathered from many years' experience in this country and abroad. The volume is a collection of several articles by the author which appeared in the *Motor Vehicle Review*, and which have been carefully edited and brought together by E. W. Graef. It is illustrated by many diagrams and working drawings, and the general information included will undoubtedly prove of value to the manufacturer and buyer, as well as to the amateur builder.

PERSONAL MENTION

MR. GRANT S. WHITSLAR has been appointed general passenger and freight agent of the Youngstown-Sharon Electric Railroad, of Youngstown, Ohio.

MR. G. MARTIN BRILL, president of the J. G. Brill Company, of Philadelphia, sailed last week on the American liner "St. Louis." Mr. Brill goes abroad on business in connection with the projected establishment of a Brill plant in England, and according to present arrangements will be absent about two months.

MR. A. E. WORSWICK, the resident manager of the Mexican Tramways Company, City of Mexico, who has been taking a trip in Europe, has returned to America and is staying at the Holland House, New York. Mr. Worswick is making some important extensions to his road, and is placing contracts for the new equipment necessary.

MR. I. K. SIEBER, managing director of the Nürnberg-Fürther Strassenbahn Gesellschaft, and one of the most prominent members of the Verein Deutscher Kleinbahn und Strassenbahn Verwaltungen, has come to this country on a tour of inspection of the principal electric railway systems. Mr. Sieber arrived in New York Sept. 26, and is planning to visit Philadelphia, Washington, Pittsburgh, Chicago, Cleveland, Buffalo, Niagara Falls, Schenectady, Boston and other cities before his return home. He also expects to attend the convention in New York.

AMONG THE MANUFACTURERS

THE WHITNEY CAR WHEEL COMPANY, of Philadelphia, reports that it has decided upon plans for its factory, and that it is now in the hands of a contractor, and work will be commenced on its place in Camden by the 15th of October.

THE NILES CAR & MANUFACTURING COMPANY, of Niles, Ohio, will be represented at the National Street Railway Convention by W. C. Allison, general manager, and G. E. Pratt, assistant general manager and contracting agent.

ARTHUR KOPPEL, New York, manufacturer of narrow-gage railway material and apparatus, has issued a neat catalogue, in which he sets forth the advantages of contracting for complete outfits from one firm familiar with the entire equipment.

THE CROCKER-WHEELER COMPANY announces that after Oct. 1 its New York office was put under the management of Francis B. DeGress. Mail for this office should be addressed to the Crocker-Wheeler Company, New York branch, 39 Cortlandt Street.

PAN-AMERICAN WIRE ROPE AND PAN-AMERICAN INSULATED WIRE are the titles of two handsome booklets the Hazard Manufacturing Company, of Wilkesbarre, Pa., got up especially for Pan-American distribution, but those who do not visit Buffalo will receive copies by making their wants known.

THE LEHIGH CAR WHEEL & AXLE COMPANY, of Catasauqua, Pa., will exhibit at the convention some of its standard spoke and single-plate wheels for street railway service, and also some sections of broken wheels, showing the chill and chill blocks. Francis Granger, New York representative, will be in charge of this exhibit.

HANNA & GRAY, 1626 Marquette Building, Chicago, announce the withdrawal on Oct. 1 of W. H. Gray. His interest is assumed by Mr. Hanna, who will move his office to Cleveland, Ohio, and continue the business in the same manner and in the same territory as heretofore. Mr. Hanna's Cleveland office will be at 312 Electric Building.

THE HIPWOOD-BARRETT CAR & FENDER COMPANY, of New York and Laconia, N. H., will show a full-sized fender attached to a car. A novel feature of the exhibit which will be under the direction of Francis Granger, New York representative, will be mutoscope pictures of tests of fenders in actual operation, which will no doubt appeal to visitors.

THE AMERICAN CIRCULAR LOOM COMPANY, Chelsea, Mass., is calling attention to the adaptability of circular loom to uses of street railways, especially in the wiring of cars for the protection of controller cables, lead wires from the trolley and wires passing through the floors or near ironwork, and also in car-house and repair-shop wiring.

BRILL TRUCKS FOR ENGLAND.—The J. G. Brill Company, of Philadelphia, continues to receive a number of contracts calling for trucks to be utilized by various British electric traction systems. Fifteen No. 22 trucks are just going forward to Farnworth, while several Eureka maximum trucks will shortly be shipped to Hadley, in the North of England.

"DEMONSTRATED FACTS ABOUT RUBEROID ROOFING".—This is the title of a small folder just issued by the Standard Paint Company, of New York, in which the various claims made for Ruberoid Roofing are set forth impressively. A portion of the catalogue is devoted to the reproduction of a few of the letters from users of Ruberoid, testifying to its merits.

CORNELL S. HAWLEY, the New York agent of the Consolidated Car Heating Company, reports that never before has there been such a large demand for the well-known electric heaters made by his company. Since June 15 of the present year he has made the unprecedented record of closing orders for over 1800 car equipments in the Eastern territory which he covers.

GILES S. ALLISON, New York agent for St. Louis registers, Tripartite steel poles, Valentine varnishes, and the sales agent of the Brooklyn Heights Railroad, will receive visitors at his limited space at the Madison Square convention hall, but his main exhibit will be in Parlor G, Murray Hill Hotel, where he will be able to show some very interesting developments, especially in the register line.

THE SYRACUSE CHANGEABLE HEADLIGHTS are described in a unique booklet being sent out by the Crouse-Hinds Electric Company, of Syracuse, N. Y., which is well worth having, and will be sent to any street railway man desiring it. The Richmond (Va.) Carnival committee procured a number of changeable headlights from the Crouse-Hinds Electric Company, which were used during the Carnival.

GEORGE W. LORD, of Philadelphia, the well-known manufacturer of Lord's boiler compounds, has just opened an office and warerooms at Bradford, England, which will be in charge of Fred. Brown. Mr. Brown sails on Sept. 28 to assume his new duties. As Lord's compounds are so well known and highly thought of in America, there is no doubt but that Mr. Brown will meet with great success abroad.

THE LORAIN STEEL COMPANY, of Lorain, Ohio, is about to ship 550 tons of rails to Halifax, Yorkshire, and three lots aggregating 1500 tons will soon be sent to Manchester. The firm of J. G. White & Company has also ordered some 50 tons of special track work for the Perth Tramways, West Australia, and it will thus be seen that the Lorain Company is keeping up most successfully its already large British trade.

THE CENTRAL ELECTRIC COMPANY, of Chicago, has published a new discount sheet on its general catalogue, dated Sept. 1. Anyone having a Central Electric general catalogue who has not received a discount sheet should notify the company at once. This sheet not only covers everything listed in the general catalogue, but contains such new material as has been placed on the market since the publication of the general catalogue.

THE VALENTINE AUTOMATIC ELECTRO MECHANIAL BLOCK SIGNAL SYSTEM, made by the Reliance Manufacturing Company, 56 Wilder Street, Brockton, Mass., is a valuable adjunct to suburban and interurban trolley lines operating on single track. It is thoroughly described in a recent pamphlet by that company, and its application should be thoroughly investigated by anyone considering the adoption of the block signal system.

H. M. SHAW & COMPANY report their sales this week as being very heavy, including snow sweepers, car-house fittings, overhead insulation, span wire and rail-bonds. The majority of these orders were placed in Greater New York, and will be used in connection with roads in the immediate vicinity. C. J. Harrington, who is the new member of the firm, is looking after this department, and reports the outlook for winter trade exceedingly promising.

T. W. HORNE, of Yokohoma, has recently contracted, through W. J. Kingsland, of 35 South William Street, New York, for a large amount of American machinery. Mr. Horne is an American, and was formerly connected with the Central Railroad, of New Jersey. Among the orders is one for fifteen pumping equipments from the Stilwell-Bierce & Smith-Vaile Company, of Dayton, Ohio, to be used chiefly in connection with electrical work in the north of Japan.

WHIPP & SEELEY, of New York, are doing a large business as manufacturers' agents in all kinds of steam and electric railroad supplies. They are at present furnishing large quantities of material and general repair parts for all forms of traction work, the State of Connecticut alone taking $10,000 worth of special track work. The factory of the company at Norwalk, Conn., is very busy turning out trolley wheels, line material and all kinds of special brass work, and the outlook is a most attractive one.

THE S. A. WOODS MACHINE COMPANY, South Boston, Mass., has a very complete line of woodworking machinery, thoroughly suited to the requirements of car and repair shops for street railways. Its business in that line is constantly increasing, and it numbers among its users the most prominent steam and street railways in the United States. It has on its staff men of long experience, thoroughly conversant with car-shop requirements, and its tools form a standard of excellence in the woodworking line.

A LARGE SHIPMENT OF CARS FOR LISBON.—Barber & Company's steamship "Nordpol," which sailed last week for Spanish and Portuguese ports, carried nearly 9000 tons of material, valued at almost $300,000, the largest cargo ever forwarded from this port to that part of the world. Included in this amount was some 1400 tons of car material intended for the Lisbon Tramways. The shipment contained twenty-five cars built by the St. Louis Car Company, equipped with Brill trucks and General Electric motors.

THE ST. LOUIS CAR COMPANY will be pleased to welcome its friends at its New York office, 716 Broad Exchange Building. The merits of the product of this company are so well known as to need no further references. Street railway representatives will find the fullest line of information at hand and all necessary photographs, blue prints and general details will gladly be furnished. The general officers of the company will be found at the New York office and also the general Eastern agent, F. E. Huntress, who will be assisted by the New York office corps.

CRANE & COMPANY, of Chicago, in order to relieve the works at Canal Street and Judd Street of some of the heavy work, have this summer erected at their works at Jefferson Street, Van Buren Street and Desplaines Street a foundry, which is to be devoted exclusively to very heavy work, that is flanged fittings and large valves. It is a one-story brick building, with a slate roof, and is equipped with two cupolas, an electric traveling crane and every other modern convenience. This new foundry will increase Crane & Company's capacity for very heavy work 50 per cent.

THE STANDARD POLE & TIE COMPANY, of New York, successor to the business of the late A. D. French, reports a very successful year, having closed large contracts for construction material in New York, Pennsylvania and the Middle West. Its specialties, the Southern white cedar, as well as the long-leaf yellow pine poles, for trolley and electric light work, have proved all that has been claimed for them, and are much sought after. The prospects for the winter and spring of 1902 are excellent, the company having already closed large contracts for spring delivery.

EUGENE MUNSELL & COMPANY, New York and Ottawa, Canada, mica dealers, is first hand in this article. It obtains its supply direct from the miners in India and Canada, and carries at all times a large stock of all grades to fill any orders with which it may be favored. It enjoys the trade of the largest street railways in the United States, and has always been well known for intelligent and liberal dealing. All goods are exactly as represented, and nothing is handled but the very best material. It would be glad to meet any of the delegates to the convention at its New York office, 218 Water Street.

THE B. F. STURTEVANT COMPANY, of Boston, Mass., has upon the press a very complete catalogue of its motors, generators and generating sets. Previous publications have been in the form of bulletins, descriptive of special types—this catalogue will present them all—and will in some degree reveal the fact that although the Sturtevant Company has a world-wide reputation as blower manufacturers, its business is by no means limited to the production of these useful machines, but that it is also equipped with a more complete line of engine and motor designs in small and medium sizes than any other concern in the country.

"ELECTRIC LOCOMOTIVES" is the title of an artistic and extremely interesting catalogue issued by the Jeffrey Manufacturing Company, of Columbus, Ohio. The cover of the catalogue is especially artistic and the cuts and descriptive matter of the catalogue proper are tastefully displayed. A brief description of the various locomotives made by the Jeffrey Manufacturing Company is given a considerable portion of the catalogue, being devoted to storage-battery locomotives. The dimensions, weights and capacities of the various Jeffrey locomotives are given in a number of tables, and typical views of the locomotive at work are presented.

THE WESTERN ELECTRICAL SUPPLY COMPANY, of St. Louis, is introducing a new trolley wheel made especially for it under its own brand, called "Wesco." It states that this wheel is made of the best lake copper, which is especially treated before being made up into wheels. It guarantees this wheel to outlast two of any other make; that it will run smoother, is self-oiling and works with less injury to the overhead equipment. This wheel is made in all sizes to fit any standard harp. It is also prepared to furnish any special size. It is very desirous of sending this wheel out on trial to anyone interested in getting a good wheel at a reasonable price.

THE ALLSTON FOUNDRY COMPANY, 620 Atlantic Avenue, Boston, Mass., is making more "Compo" brake-shoes than at any time in its past history, and is constantly increasing its facilities for making them. The "Compo" shoe, which showed up so well in the tests made by the Master Car Builders' Association, is largely in use in New England, where it is in fine repute. This principle of a friction face with cork inserts is also employed in a number of other devices made by this company, such as pulleys, machine clutches and automobile band-brake wheels. The employment of this principle gives a very high coefficient of friction, and accounts for the popularity of the "Compo" shoe.

THE NEAL ELECTRIC HEADLIGHT COMPANY will be pleased to see its friends at its New York office, 716 Broad Exchange Building, where various types of headlights are on exhibition. This company has placed headlights in all the principal cities of the United States, and has also a very large foreign business. The Neal headlights are in extensive use in Greater New York, Boston, Baltimore and Pittsburgh, where they are giving good satisfaction. This company was one of the pioneers in the electric headlight business, and from a very humble beginning in 1894 has built up a very large and increasing trade. F. E. Huntress, general manager of the company, will be glad to meet his friends at the abovve adddress, and will also be present at the convention.

THE MACK EQUIPMENT COMPANY, of Chicago, is distributing a beautiful, but unique, catalogue. It is covered with a handsome dark-green leather cover, on which is imprinted the name of the recipient and the Mack Equipment Company, the latter being on the left-hand corner. Instead of using a coated paper, as is usually done in a catalogue of this description, linen paper is employed, and the prints are in blue. The various products of the Mack Equipment Company are displayed, the right-hand pages being used only. On the upper left-hand corner of each page is a description of the accompanying engraving, and in the right-hand corner is a landscape scene, which lends to the catalogue from an artistic point. The catalogue is one that is destined to remain permanently at the hand of all street railway men who receive a copy of it.

THE MICA INSULATOR COMPANY, New York, Schenectady and London, reports a very gratifying demand for "Micanite" and "Empire" material. It has long held the reputation of furnishing high-grade goods, which are universally accepted as standard. It received the gold medal at the Paris Exposition. This gold medal was honestly earned in competition with other manufacturers. This company originated and built up mica insulators under the name of "Micanite," and is the sole owner of patents on this article. It uses nothing but the very best of India or amber sheet mica in the construction of its material, which alone is fitted for commutator insulation. It carries in stock at all times mica rings, collars and segments for all the standard makes of street railway motors. These rings, etc., are guaranteed to fit the shells.

KILFYRE, a dry powder compound fire extinguisher, manufactured by the Monarch Fire Appliance Company, of New York, while being a good all-round extinguisher for all kinds of fires, is of especial value for use in stopping fires which have been started in the neighborhood of electrical circuits and apparatus. In such locations water is likely to cause more damage than the fire which it is intended to stop, and may give rise to a serious blaze where otherwise the fire would be easily put out. The advantage of Kilfyre for putting out electrical fires, as compared to water, is, therefore, considerable. There is the further advantage that around high-voltage circuits the use of water may give serious shocks to those applying it, if applied with a hose. Kilfyre being a dry powder, has a tendency to extinguish arcs, as well as put out fires.

CHARLES W. MACKEY, president of the Electric Tripartite Steel Pole Company, whose New York office is at 253 Broadway, and whose works are at Danville, Pa., in an interview states that the company's works are crowded to their full capacity, and, in order to meet the increasing demand for the company's new steel pole, it has been necessary to enlarge the company's plant. For this the company is now having plans made. The Tripartite steel pole is commanding favorable attention, and the fact that the company has booked several large contracts from prominent electric roads and lighting companies, after having these poles in actual service for over a year, is a positive indorsement of all the claims made for the pole. These poles can be seen at the convention, Madison Square Garden, New York City, Oct. 9-11. Giles S. Allison, of 57 Broadway, New York, is general sales agent for the pole.

THE GENERAL ELECTRIC COMPANY'S London office has been removed to the office building of the British Thomson-Houston Company, Ltd., 83 Cannon Street, E. C., and the commercial and engineering departments of the British Thomson-Houston Company have been removed to the new works at Rugby. On Nov. 1 the accounting department of the British Thomson-Houston Company will also be removed to Rugby. The proposed new internal organization of the British Thomson-Houston Company will conform closely to that of the General Electric Company in America, its London office occupying relatively the same position toward Rugby that the General Electric New York office does toward Schenectady. Official cable addresses are as follows: That of the London office of the General Electric Company, "Hypsometer, London;" the British Thomson-Houston Company, at London, "Asteroidal, London;" at Rugby, "Asteroidal, Rugby."

THE G. C. KUHLMAN COMPANY, of Cleveland, has broken ground for its new car manufacturing plant, which, when completed, will have a capacity of 500 cars per year. There will be eight buildings—two shops 170 ft. x 250 ft.; woodworking shop, 100 ft. x 200 ft.; iron mill, 80 ft. x 175 ft.; storage, 40 ft. x 160 ft.; dry kiln, 100 ft. x 150 ft.—besides power house and office building. The company is at work on a number of contracts, some of which can not be completed until the new plant is in operation. Among other contracts are the following: Detroit & Toledo Shore Line, fifteen cars; Aurora, Wheaton & Chicago, thirty cars; Northern Texas Traction Company, fifteen cars; Saginaw Traction Company, seven cars; Grand Rapids, Holland & Western Railway, six cars. When the company was reorganized some months ago it was planned that steam road cars, as well as interurban cars, should be built, but the demand for the latter is now so heavy that they mav be built exclusively.

THE AMERICAN STEEL & WIRE COMPANY has not spared time or expense in meeting the advanced ideas of New York's leading engineers in regard to the important detail of track bonding. The "Crown" bonds are made entirely of wrought copper, thus avoiding the many defects of copper castings, and providing conductivity of copper better than 98 per cent of Matthiessen's standard. Added to these all-important features is the method of application by drift-pins, which is well known as the peculiar feature of this most popular rail-bond. For cases which require application by compressor, these same manufacturers have now produced a wrought copper bond called the "United States bond." This, in quality and conductivity of copper, is the equal of the "Crown" bond. By a special welding process these experienced rail-bond makers have avoided all copper castings, producing perfect contacts between the terminals and the leaves of copper, which are used instead of wires in the United States bond.

GUSTAV AD. MEYER, of the firm of Allut Noodt & Meyer, of Hamburg and Berlin, left Europe Sept. 19 for the United States. Allut Noodt & Meyer act as representatives and sole selling agents of the Standard Paint Company, of New York, for the greater part of Europe, and Mr. Meyer has come to the United States to personally visit the firm's numerous personal and business friends, which include the Mayer & Englund Company, of Philadelphia; New York Belting & Packing Company, Ltd.; Frank S. De Ronde Company, Ltd.; the Standard Varnish Works, etc., and to study American business methods and make new business connections. Mr. Meyer solicits correspondence with American manufacturers who are willing to have the sale of their products pushed in Europe, especially in Germany, Austria-Hungary and the northern countries, and he can be addressed at the Standard Paint Company, 100 William Street, New York. Allut Noodt & Meyer are well connected in the electrical and building lines, and command the highest American and European references both as regards their financial and business position.

THE J. G. BRILL COMPANY, of Philadelphia, has recently completed a series of new catalogues which thoroughly cover the extensive line of street railway rolling stock made at its works. The catalogues are of practically uniform size, except as to thickness, and are remarkable for that artistic make-up and entertaining clearness of description that is always apparent in publications of this firm. The various lines of material which the Brill Company manufactures are separately treated in the books, among which are the following: Standard American electric cars, snow plows and track scrapers, electric crane locomotives and other industrial locomotives, the "Eureka" maximum-traction truck, the "Universal" high-speed truck, etc. One of the best educational pamphlets on the subject of car trucks that has ever been issued is entitled "A Solid Wrought Steel Passenger Truck," and is a most interesting treatise on the fundamental principles of successful truck design. The catalogue of American cars has been translated into both German and Spanish, these editions containing a few additional types which have found favor abroad.

EXHAUST HEADS.—A comparison of the various exhaust heads on the market vividly illustrate the difference between so-called practical designs and those which are based on scientific study. In the former category are to be classed those heads in which baffle-plates and tortuous passages predominate, introduced, it would appear, in the effort to wrest the water from exhaust steam by mere brute force. On the other hand, a typical example of well-applied scientific reasoning is presented in the centrifugal head manufactured by the B. F. Sturtevant Company, of Boston, Mass. Recognizing the fact that centrifugal force is proportional to the weights of the bodies in motion, and that water is nearly 1600 times heavier than steam, this head was so designed that the exhaust steam is given a vigorous whirling motion within the case, thus throwing the water outward with such excessive force as to absolutely prevent its escape through the large central exit opening provided for the steam. The water, and likewise the oil, trickles down the sides of the case, which is in the shape of an inverted cone, and finally escapes through a special drip pipe at the bottom.

THE DEARBORN DRUG AND CHEMICAL WORKS, of Chicago, have established an Eastern branch, with headquarters at 120 Liberty Street, New York. William B. McVicker, Eastern manager, who has been with the Dearborn Company five or six years, has charge of the New York office, which will be the directing office of all salesmen east of Chicago. Mr. McVicker will spend the greater part of his time East, making occasional trips throughout his old territory and to their several branch offices. The Dearborn Drug & Chemical Works have been quite successful in securing a large amount of business from the East, although up to the present time without a permanent Eastern location. They are supplying boiler compounds to all the street railway and lighting plants of Washington, D. C.; all the street railway plants of Philadelphia; the William Cramp & Sons' Ship & Engine Building Company, Philadelphia; the Brooklyn Edison Company, and many other large corporations. It is needless to say they have also done a very large business throughout the West. The Dearborn methods assure proper treatment, as they take the conditions in each plant and analyze the feed-water, and then prepare the proper compound.

THE BROWN-CORLISS ENGINE COMPANY, which was organized on May 15, 1901, with a capital stock of $1,000,000, is now constructing an extensive new plant at the new town site of Corliss, on the main line of the St. Paul Railroad, between Chicago and Milwaukee. This plant has been designed to meet the latest requirements in heavy-duty Corliss engines, being equipped with the most modern improvd machinery, with economy in view, and it is expected that it will be ready for operation by Nov. 30. The Brown-Corliss Engine Company will confine its efforts to the manufacture of the Corliss engine, intending to make a specialty of this line of work for some time to come. The officers and members of the company are all men of high commercial standing, the officers having had extended and varied experience. Julius Wechselberg, a prominent resident of Milwaukee, and who is very well known throughout the West, is president of the company; Walter S. Whiting, who has been connected with the Calumet & Hecla Mining Company, Philadelphia & Reading Coal & Iron Company, Boston City Engineers' Works and other equally prominent concerns, is vice-president and treasurer of the company; W. F. Brown, well known in the engine business, having been connected with the E. P. Allis Company, Filer & Stowell Company, Providence Steam Engine Company, is second vice-president and general manager of the company.

PAINT FOR RAILROADS.—It is often many years before iron or steel framework shows signs of deterioration from rust, but once that process sets in, unless it is promptly arrested it spreads so rapidly that it soon reduces the strength of the metal to a point where it can not be repaired, and must be renewed. A case in point is that of some steel cars which were bought by a prominent concern about eight years ago for gravel service in contract work. They passed into the hands of a railroad company, and later on were used for hauling coal, gravel and cinders. Two years ago the cars looked well, showing but few signs of the rapid deterioration which has subsequently developed. A recent examination of the cars shows that they have so decayed as almost to necessitate the entire rebuilding of them. For instance, the I-beams had rusted away on each side so that holes clear through the web resulted, while the tap of a hammer on the bottom or sides of the cars would puncture them. The Standard Paint Company, of New York, has for years been manufacturing the P. & B. preservative paints, the value of which is well known for the protection of metal, as well as wood and brick. It is not merely a surface coating, as it sinks deeply into the pores of the steel, and is both tenacious and elastic. It meets with an especially large use from railroad companies, where is is used not only on iron framework around cars, but in all places where it is desirable to make wood fireproof and waterproof and add to its insulating qualities.

THE ABENDROTH & ROOT MANUFACTURING COMPANY announces that since the destruction of its plant by fire in Brooklyn it has purchased the entire plant of the Wright Steam Engine Works, Newburgh, N. Y., together with 3½ acres additional, making a total of 12 acres and giving a water front of 825 ft. This new plant is already equipped with a modern machine shop 100 ft. x 400 ft., containing a thorough equipment of machinery and tools, a large foundry 100 ft. x 180 ft., a commodious forging shop, pattern shop, testing and erecting departments. In addition to these buildings is an office building, and two more buildings have been contracted for, each 100 ft. x 250 ft., in which the most modern tools and appliances are to be placed for heavy riveted sheet steel work, including spiral riveting machinery. In the future this company will turn out improved Root water-tube boilers, spiral riveted pipes, heavy straight riveted work, foundry work and general machine-shop work. The company is now prepared for machine-shop work, and can supply repair parts for the Wright-Corliss and Payne high-speed engines. Having employed a corps of the ablest machine designers and machinists, it especially desires to secure machine contracts. Newburgh is well situated as to railroad shipping facilities, and the company has its own docks, at which any deep-water vessel can land. The general offices will remain at 99 John Street, New York. While heavy losers by the fire, it will be seen from the foregoing that the company is prepared to go ahead with business on even a larger scale than before.

THE McGUIRE MANUFACTURING COMPANY'S street railway exhibit at the Pan-American will undoubtedly be visited by many delegates to the convention who stop over in Buffalo. The Street Railway Journal has from time to time called attention to the display of the different manufacturers of street railway apparatus exhibiting at the Exposition, and that of the McGuire Manufacturing Company, being one of the largest and most attractive, was fully described in these columns some time ago. The McGuire Manufacturing Company shows one of its snow sweepers, solid steel Columbian truck, a No. 39-A double truck, and a maximum traction truck, also fenders, life guards, car heaters and brake handles. The exhibit is very tastefully arranged, characteristic cleverness even marking the advertising line. The company suspends from pedestals erected for the purpose long lists of the users of its product, which goes to show that they are in use throughout the whole of America, with considerable numbers in Australia, England and France. The record shows no snow sweepers in use in South America, but Southern points, such as Washington, with ten, and St. Louis, with fourteen, indicate that the railway managers at these points have a wholesome fear of snow blockade. Considerate of the welfare of all, the McGuire Manufacturing Company has reserved the center of its space as a resting spot, and here visitors will find easy chairs and other conveniences of the home, and command a point from which the passing throng can be viewed to advantage, as well as other exhibits in the building.

Reduced Rates to New York and Return

from Chicago, via Michigan Central, "The Niagara Falls Route," in connection with the Twentieth Annual Convention of the American Street Railway Association, to be held at New York, Oct. 9, 10 and 11, 1901, good for return within twenty days, and for stop-over at Niagara Falls and Buffalo. City ticket office, 119 Adams Street, Chicago.***