STREET RAILWAY JOURNAL

VOLUME XIV. NUMBER 9

NEW YORK AND CHICAGO

SEPTEMBER 1898

STREET RAILWAY CONDITIONS AND FINANCIAL RESULTS IN METROPOLITAN BOSTON

IT is intended in this investigation to describe the principal investment, traffic and operating characteristics of thirty-nine street railways located in the city of Boston, and in about seventy-five suburban cities and towns in the immediate neighborhood. The territory covered is shown on the accompanying map. It is generally limited to the area more or less dependent for its prosperity upon Boston proper, excluding several interesting and prosperous systems which, though connected with the Boston suburban system by street railway lines, are, nevertheless, working independently in their own respective fields.

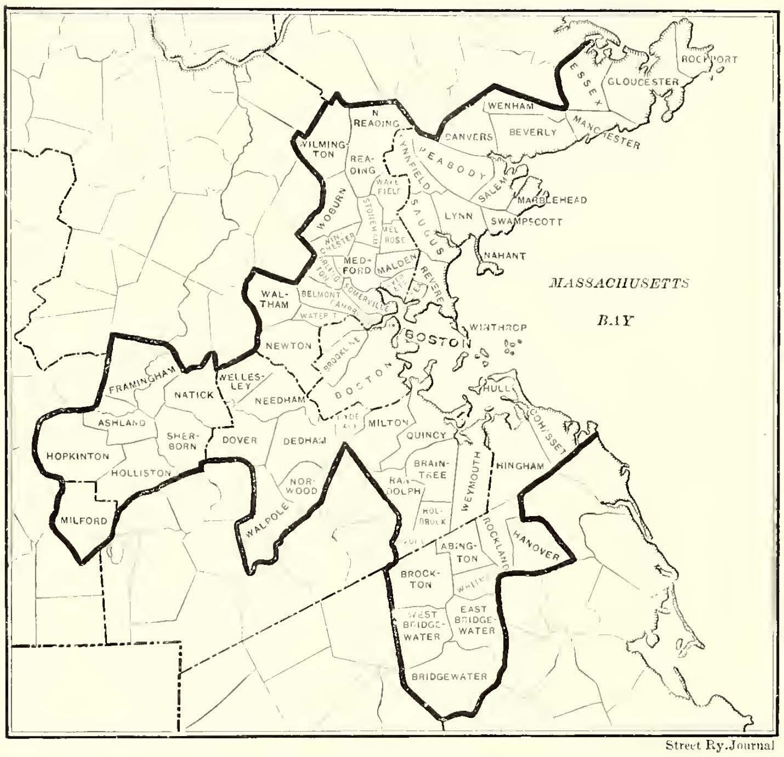
GENERAL CHARACTER OF THE TERRITORY

The living conditions of the people of metropolitan Boston are probably better than those of any other large American city—perhaps of any in the world. Boston is really a city exceeding 1,000,000 inhabitants, but more than half this number live, not in Boston proper, but in some thirty suburban cities and towns within a half-hour's ride from the business section. In the territory under investigation are no less than 1,250,000 permanent residents, to say nothing of a large summer population. These conditions make for health, homes, and a fair prosperity, as well as for transportation profits.

BEACON HILL ACROSS BOSTON PUBLIC GARDENS

The diagram, page 473, shows the relative growth for eighty-five years past of Boston proper, of Boston with its annexations, and of metropolitan Boston, including twenty-six towns within ten miles of its State House. It will be seen how little the old city has grown, and how stationary is its present population; and how rapidly the suburbs have grown, especially since the beginning of street railway building, about 1850. The curve of metropolitan Boston has taken a sharp upward turn, ever since 1885, and especially since 1890, when electric traction came to Boston in force, and the census of 1900 is quite sure to show a continuance of this upward movement.

The maximum population density of this area is 63,800 per sq. mile, and is found in the district within a half mile of the State House. From this figure it rapidly falls off, so that from three to four miles away it is but 6000 per sq. mile, and from nine to ten miles but 1300. In the whole area about 45 per cent of the entire population are living within a quarter mile from steam railroad suburban lines,



THE FIELD OF INVESTIGATION

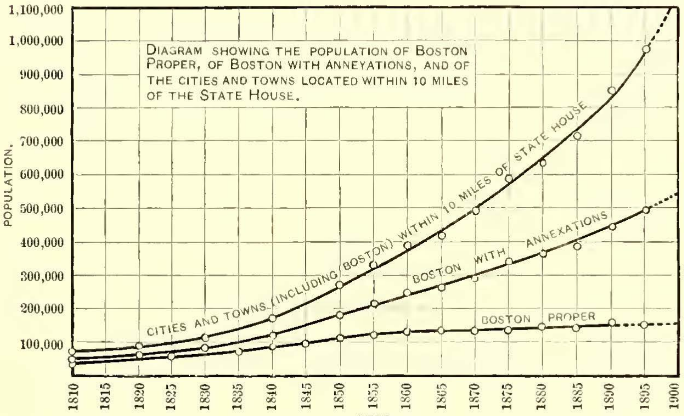
the service on which is wonderfully good, and the fares low, averaging, for commutation tickets, considerably less than one cent a mile.

These suburbs of Boston are not composed, as with the newer cities of America, of straggling lines or groups of houses, interspersed with large areas of geometrically arranged "city lots," weed overgrown and generally painfully "new." Rich and poor alike live in Boston suburban cities, the former in beautifully and carefully kept up country houses, with fine old trees and all the conveniences of city life, and the latter in tastefully built individual homes, each with its garden plot and lawn, and with strong neighborhood associations and local prides. All through this area are the modern comforts of gas, electric lights, water supply, sewerage and street railways. A magnificent metropolitan park system has been established, and reservations of woodlands and picnic grounds, the laying out of boulevards, arboreta and pleasuring places of many kinds on land, on river fronts, around lakes and ponds, and on the beautiful coast of Massachusetts Bay, have been among the most beneficent results of recent State and city legislation. Who has not heard of Boston Common, with its Frog Pond of ante-Revolutionary fame; of the Boston Public Gardens, with their beautifully laid out flower beds; of Beacon Street and Commonwealth Avenue, the seat of social happenings in Boston and the incarnation of blue blood and wealth; of the Boston Public Library, largest and best in all the United States, excepting the Congressional Library at Washington, and recently housed in a most beautiful and artistically decorated building in a fine location on the Back Bay; of the State House, with its gilded dome and "sacred codfish;" of Bunker Hill and Faneuil Hall; and of Trinity Church, whose rector was the world-famed Phillips Brooks? All through the suburban cities, too, are houses interesting from one cause or another, such as the homes of Lowell and Longfellow, in Cambridge; the old Fairbanks farmhouse in Dedham, dating from 1636; and "The Old Ship," of Hingham, said to be the earliest church edifice in America. A large amount of money has been spent by the Metropolitan Park Commission in improving Revere Beach, and this is now one of the finest coast resorts on Massachusetts Bay, while south of Boston, Nantasket Beach is a popular pleasuring ground.

Regularly twice a day a great majority of Boston's business men pass between home and office over electric or steam railroad tracks. Several times a week their wives and children "go in town" for shopping, visit friends in other suburbs, or, in the summer months, take a pleasure ride on the trolley cars, either with or without an object. The three or four thousand students and professors of Harvard and Tuft's Colleges in Cambridge and Medford near by have much to do with Boston proper, both day and night. The great manufacturing city of Lynn and the charming residential cities along the North Shore furnish an immense amount of business to the railroads and street railways serving them, and in all directions are found comfort and prosperity on large or small scale and comparatively little of grinding poverty or tenement house living.

BEACON STREET AND BOSTON COMMON

How valuable, from a transportation standpoint, is the area under investigation, may be judged from the fact that 231,000,000 passengers per annum, in round numbers, were carried on its street railways alone in their last financial year—an equivalent of 633,000 passengers, or one-half the entire population, per diem. In 1885 the number of street railway passengers in this same area was but 91,000,000! The difference is due partly to the great increase in mileage, partly to the electrical equipment of all lines, partly to consolidations, with their attendant advantages to the people, and partly to the natural increase of population and traffic.



Nearly 50,000,000 passengers per annum use the steam railroads in and out of Boston, but this number is decreasing quite rapidly with electric railway competition, the decrease in the last year alone being 7.1 per cent, and in the last four years, 12.2 per cent, as against an increase of street railway traffic in the same four years of 31.2 per cent.

The Massachusetts system of conferring street railway franchises is peculiar and merits special attention. It is not possible for Massachusetts street railways to obtain " vested rights," properly so-called. Theoretically, they hold their locations in the streets and on the highways at the pleasure of the municipal authorities, who can order a change in, or the complete removal of tracks, their orders being subject, however, to revision by the State Board of Railroad Commissioners. It must not be hastily inferred, however, that for this reason Massachusetts franchises are valueless or even less valuable than those conferred in most of the remaining States, for it is undoubtedly true that respect for true or even presumptive vested rights, and a desire to do justice in dealing with invested capital is, and always has been, unusually strong in Massachusetts, and it is almost certain that public opinion would never countenance arbitrary or unreasonable use of authority, while the check imposed by the Railroad Commission—composed of three men of fixed tenure in office responsible in effect directly to the people, though appointed by the Governor—is of no mean value to investors.

In practice, there has never been a case of extreme conflict between the municipal authorities and street railway companies, or of serious interference with the reasonable rights of the latter. As a matter of fact, the power reserved to the municipal authorities amounts to little more than a club held in reserve to compel the companies to give proper service and fulfil their just public duties. The Massachusetts Railroad Commission is known all over the country as exceptionally able, broad minded and intelligent, particularly in its dealings with the new problems brought up by the introduction of electromotive power on street railways, and its wise decisions have probably done more to establish electric railroading in Massachusetts on a sound and profitable basis than any other single influence.

The new law recently passed by the Massachusetts Legislature recognizes 8 per cent as a fair and just dividend to be paid by street railway companies upon their stock in any year, and 6 per cent per annum from the beginning of operation. If dividends exceeding 8 per cent are paid by any company, an amount equivalent to the excess must be paid by it in addition to other taxes, provided that the company shall have paid at least 6 per cent per annum since the date of commencing operation. An excise tax on gross receipts is also imposed on all Massachusetts railways, on the following basis:

Gross receipts of $4,000 or less per mile of track operated, 1 per cent.

Gross receipts of $4,000 to $7,000 per mile of track operated, 2 per cent.

Gross receipts of $7,000 to $14,000 per mile of track operated, 2¼ per cent.

Gross receipts of $14,000 to $21,000 per mile of track operated, 2½ per cent.

Gross receipts of $21,000 to $28,000 per mile of track operated, 2¾ per cent.

Gross receipts of $28,000 or more per mile of track operated, 3 per cent.

This tax is apportioned to the cities and towns in which a company's tracks are located in proportion to the total track mileage (including sidings and switches) operated by the company in the several cities.

COMMONWEALTH AVENUE

LOCATIONS, INVESTMENT AND REVENUE PRODUCING POWER

The street railways of the Boston metropolitan system may be conveniently grouped for discussion as follows:

The Boston system.
The Lynn & Boston system.
The Gloucester group.

ON BOSTON COMMON

The Wakefield-Stoneham group.
The Newton group.
The Framingham group.
The Dedham group.
The Brockton-Bridgewater group.
The Quincy-Hingham group.

THE BOSTON SYSTEM

A single corporation, the Boston Elevated Railway Company, controls the entire street railway system of Boston proper and many of its suburbs. This control is by lease from the owners of the property, the West End Street Railway Company, until recently in independent operation since 1888, when it was formed by consolidation of five previously existing street railway companies. There is at present no elevated railway in Boston, but franchises for the construction of elevated lines presently to be mentioned are possessed by the Boston Elevated Railway Company, which intends to build as soon as necessary consents can be obtained.

The lines of this company aggregate 154 miles in length of streets occupied, and 303 miles of single track. The entire resident population served by this company alone is about 788,000, equivalent to 5100 per mile of road. About 2650 passenger cars are owned, of which 2360 are equipped for electric operation. About half the equipment is in open cars.

An examination and analysis of this system will show the enormous strength of its position from an investment and traffic standpoint, and will also make clear some of the difficulties connected with its service of the public. It is distinctly a radiating system, whose center is the Boston business district, a little peninsula with an area less than one-fiftieth that of the territory tributary to it. From this center no less than fourteen main lines pass into the adjoining country, north, south and west, as follows:

The East Boston-Chelsea Division (connected with the peninsula by ferry) serves, approximately, 75,000 population, and requires about 44 cars per hour in East Boston and Chelsea.

The Charlestown-Somerville-Medford-Everett Division serves about 165,000 population and requires about 82 cars per hour. Over this line pass, also, about 30 cars per hour of the Lynn & Boston Railroad Company from Chelsea, Revere and Lynn.

The Cambridge-Arlington, Newton & West Somerville Division serves about 130,000 population, and requires about 156 cars per hour.

The company's Second and Ninth Divisions, serving the Back Bay, Brookline and Allston, together with parts of Jamaica Plain, Roxbury, Brighton, Newton and Cambridge, require over 200 cars.

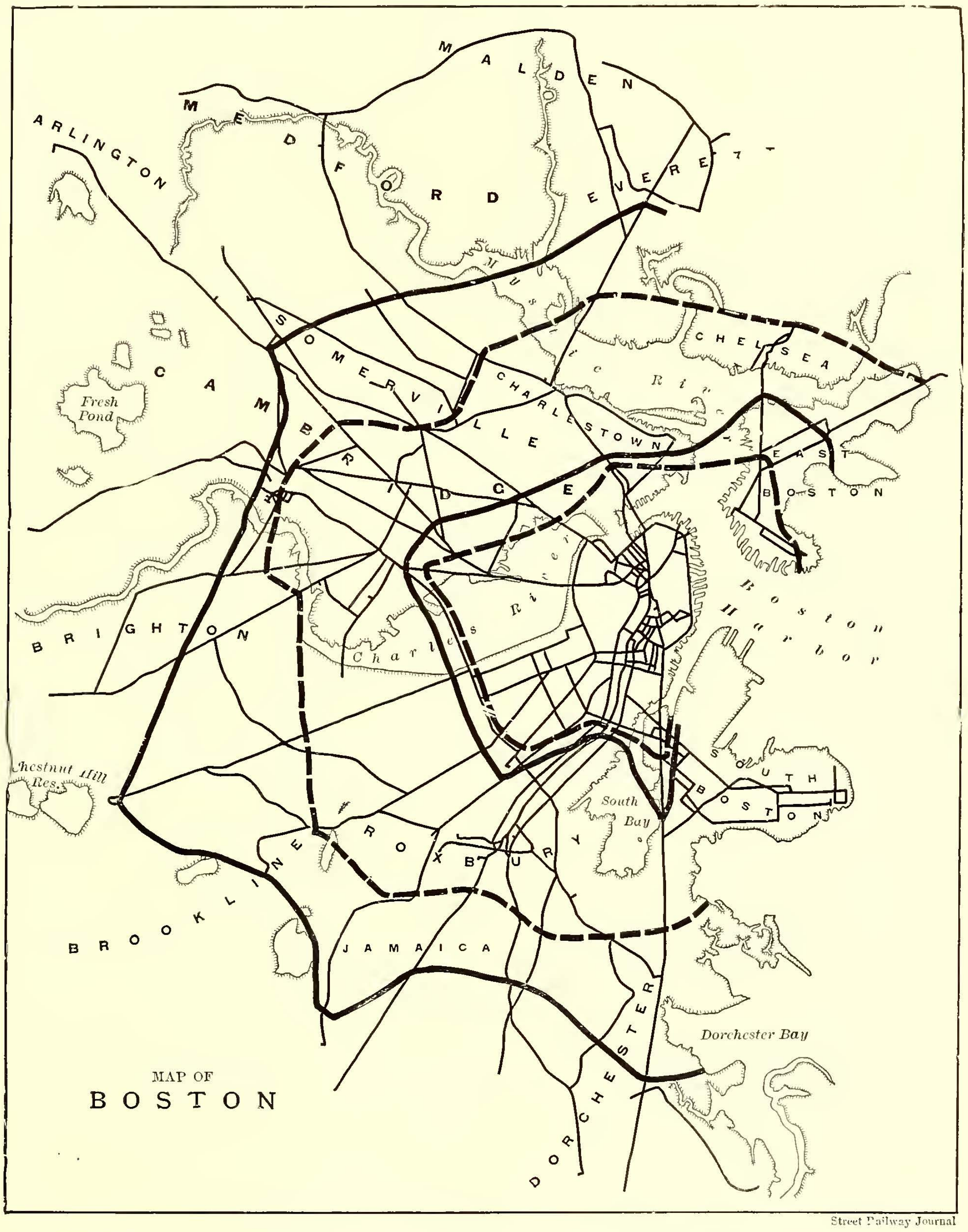
Five lines to Roxbury and West Roxbury, through Columbus Avenue, Tremont Street, Shawmut Avenue, Washington Street and Harrison Avenue, serve about 125,000 population and require about 140 cars.

Two lines to South Boston serve about 70,000 population and require about 64 cars, and the line to Dorchester and Milton serves about 50,000 and requires about 40 cars.

The above car requirements are based on the heaviest hours of the day in the summer season.

From the above analysis of the system it will be seen how serious must be the congestion of traffic in this small business area and how completely is the service of the entire system dependent upon some relief from congestion. As a matter of fact, until the recent opening of a portion of the new Subway, Washington and Tremont Streets, the two main thoroughfares north and west, were centers of congestion, which often caused stoppage of traffic or de-

TREMONT STREET AND BOSTON COMMON, SHOWING SUBWAY ENTRANCES lays equivalent to a heavy reduction of the total speed advantage to the system in electric traction over horses. No less than 216 cars per hour formerly passed certain points on Tremont Street. In an article by Louis Bell, published in the STREET RAILWAY JOURNAL in January, 1896, was given a very interesting analysis of the results, in the matter of saving in speed, brought about by electric traction in Boston, from which article is taken the accompanying map of a district swept by a five-mile radius around the Boston peninsula. The heavy lines on this map represent the fifteen and thirty-minute boundaries under horse and electric traction, respectively, the inner dashed lines representing the old boundaries with horse traction, and the outer solid lines the points possible to reach in fifteen and thirty minutes, respectively, from the peninsula. Dr. Bell finds that the area added by electric traction to the fifteen-minute district was 1.15 sq. miles, or 37 per cent, while that added to the thirty-minute district was 8.3 sq. miles, an increase of 57 per cent. It will be seen how narrow is the fifteen-minute district north and south through the business center, and how little has been added to it by electric traction.



FIFTEEN AND THIRTY MINUTE TRANSIT AREAS WITH HORSE AND ELECTRIC TRACTION

The best engineering and financial talent of the State has been for many years at work upon various plans to relieve this congestion in the heart of Boston, and to make it possible to greatly perfect the service to the public. A Board of Rapid Transit Commissioners was appointed in 1891 to examine the transportation conditions and report a plan of relief. The problem which this commission had to solve was not only to provide better means for passing street cars through the city, but to improve also the railroad termini and connections so as to overcome, as far as possible, the grave difficulties connected with river traffic, bridges, grade crossings, etc. Through the efforts of this commission, with modifying influences, five steam railroad lines entering four separate stations at the northern part of the city have been brought into a single Union Station, while four railroad systems entering the city at four stations in the southern part are now being diverted into a southern Union Station—the largest in the country, if not in the world. The plan recommended by the Rapid Transit Commission for the relief of street railway traffic was not, however, approved by the Legislature, but in July, 1894, a second body of men, the Boston Transit Commission, was appointed by the Governor, and by this commission the plans now being carried into effect were prepared. The work of this commission forms the subject of a special article in this issue, and will not be here described in detail. It is sufficient to say that a subway has been constructed from the Northern Union Station to and along Tremont Street and through a portion of Boston Common to a point on Shawmut Avenue, with a branch from the corner of Boylston and Tremont Streets to a point in the Public Garden near Boylston Street. The southern portion of this subway has now been in operation since September, 1897, and has already greatly relieved the congestion on Tremont and Washington Streets, and materially reduced the time from the center of Boston peninsula on all the company's southern routes. When the northern portion is opened this fall, it is expected that the relief will be much more apparent and the northern lines will be greatly benefited. The subway was built by the city and was leased to the West End Street Railway Company for twenty years at a rental equivalent to $4\frac{7}{8}$ per cent of the net cost to the city (about $5,000,000),

SCOLLAY SQUARE

and is now controlled by the Boston Elevated Railway Company through its lease to the West End.

In connection with the subway it is proposed to build an elevated line between the northern and southern stations around Atlantic Avenue and further south to Norfolk House in Roxbury, a connection being made at the Shawmut Avenue entrance to the subway, by which certain of the trains may pass back to the northern station through the subway. Another elevated line is to go north to Charlestown, and a third is to go west from Scollay Square through a subway to the river, and thence to Harvard Square. The Boston Transit Commission is also authorized and instructed to build a tunnel under the river to East Boston, but nothing has as yet been done to carry out these instructions beyond making the preliminary surveys.

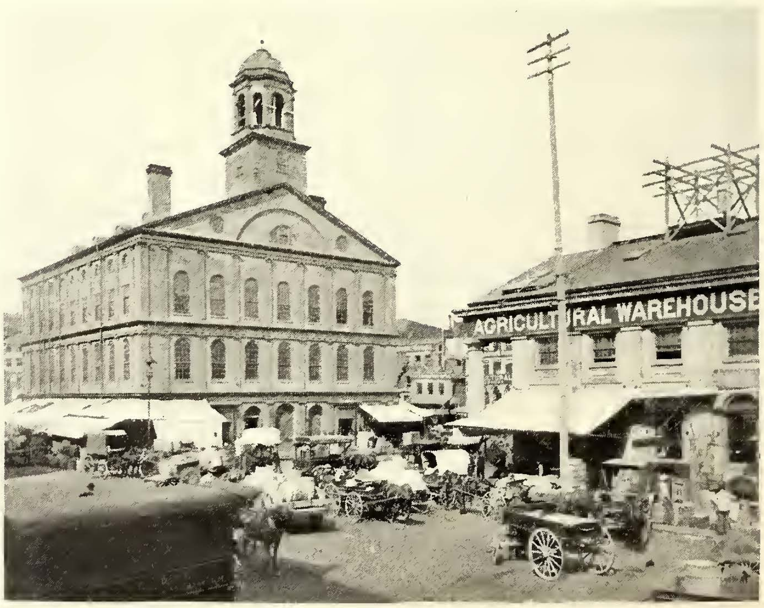
When all these plans are carried into effect, central Boston should be a very different thing from what it is at present, and the improvement will be felt to the uttermost suburban regions. The aggregate value of the time saved to the people by these improvements will be incalculable.

The general balance sheet of the West End Street Railway Company on Sept. 30, 1897, showed that the total permanent investment in the property amounted to $25,138,913, equivalent to $97,666 per mile of main track. Of this amount, $32,384 per mile was spent on construction of roadbed, track and electric distribution system, $25,114 per mile for equipment and $40,169 per mile for land, buildings (including power station and plant) and other permanent property. The investment in land, buildings and all equipment, exclusive of roadbed, track and distribution system, amounted to $6,346 per car owned. The total capital liabilities against the Boston system are much less than those of any other important street railway system in the country, while the percentage of interest charges to gross receipts is also extremely small, being on the West End system in 1897 but 5.6 per cent.

The Boston system earned in its last financial year (September 30, 1897) $8,719,032, equivalent to $56,700 per mile of route operated, $.2927 per car mile and $.0505 per passenger carried. This earning power per mile of road is exceeded by that of the Metropolitan Street Railway Company and the Third Avenue Railroad Company, of New York City, and the Capital Traction Company, of Washington, only among the important properties of the country, though the North Chicago Street Railroad, of Chicago, has an earning power about the same. The earning power per car mile is very large, but is considerably less in this year than the West End Company's own record, which is $.3611, made in 1892, and to this earning power there is a strong probability that the company will return with increase of population and greater inducements to local riding by reason of the subway and elevated railway, and the relief from street congestion caused thereby.

The Boston Elevated Railway (West End) Company's earnings from operation applicable to return on investment amounted last year to $2,118,167, equivalent to $.071 per car mile, and to a return of 8.44 per cent on the total permanent investment. Eight per cent was declared last year on the preferred stock and $7\frac{1}{2}$ per cent on the common stock, leaving a surplus for the year of $431,573. This property is very conservatively handled financially, many charges being made to operating expenses, which on some properties would be charged, though probably incorrectly, to construction accounts. So long as it deals fairly with the city it is practically secure from competition, as there are no valuable routes in the heart of the city possible to obtain for a rival system, which are not pre-empted by its tracks.

For a system of this kind there are two policies which could be followed regarding further extensions into the surrounding country. One is to build for its own benefit practically every connecting line or extension where there



FANEUIL HALL SQUARE

is a possibility of profit, and the other is to allow other capital to make these further extensions and build feeders for the main system. The West End Company has always pursued the latter policy, which will probably be continued by the Boston Elevated Railway Company. All of the groups of railways presently to be described are connected with the Boston Elevated Railway lines, as indicated upon the accompanying maps. To the consideration of these outlying groups we now proceed, and will find them extremely interesting from many points of view.

THE LYNN & BOSTON SYSTEM

The Lynn & Boston Railroad Company now controls practically the entire street railway system of the famous North Shore of Massachusetts and connects twenty-one cities and towns with each other and with Boston, entrance to the heart of the city (Scollay Square) being gained through Charlestown by a traffic agreement with the Boston Elevated Railway Company. Included in the area served by its lines is the important manufacturing city of Lynn, with a population of 62,000, one of the largest shoe towns in the world, and long noted as the headquarters of great electrical manufacturing interests; the residential and manufacturing suburb of Chelsea, with 31,000 population; the quaint old cities of Salem, Beverly and Marblehead, with 54,000 population in toto; and sixteen other cities and towns tributary to these various centers. This section forms one of the most delightful and popular summer resorts in the Eastern States, and Beverly, Magnolia, Marblehead and Swampscott are the seats of large summer colonies, the sight of whose beautiful cottages forms a great attraction for the less wealthy residents of the manufacturing towns. Marblehead is a great yachting center, the headquarters of two great yacht clubs, and their annual regattas and races are held in the waters of Massachusetts Bay near by. One of these clubs built the yachts "Puritan," "Mayflower" and "Volunteer," successful defenders of the America's cup against British challengers. Nahant, Revere Beach and Winthrop are the pleasure grounds of the people, and on pleasant Saturdays, Sundays and holidays are visited by thousands from Boston and vicinity. The entire Lynn & Boston system forms a mass of closely woven interurban lines of the highest interest to the student of street railway finance.

WASHINGTON STREET

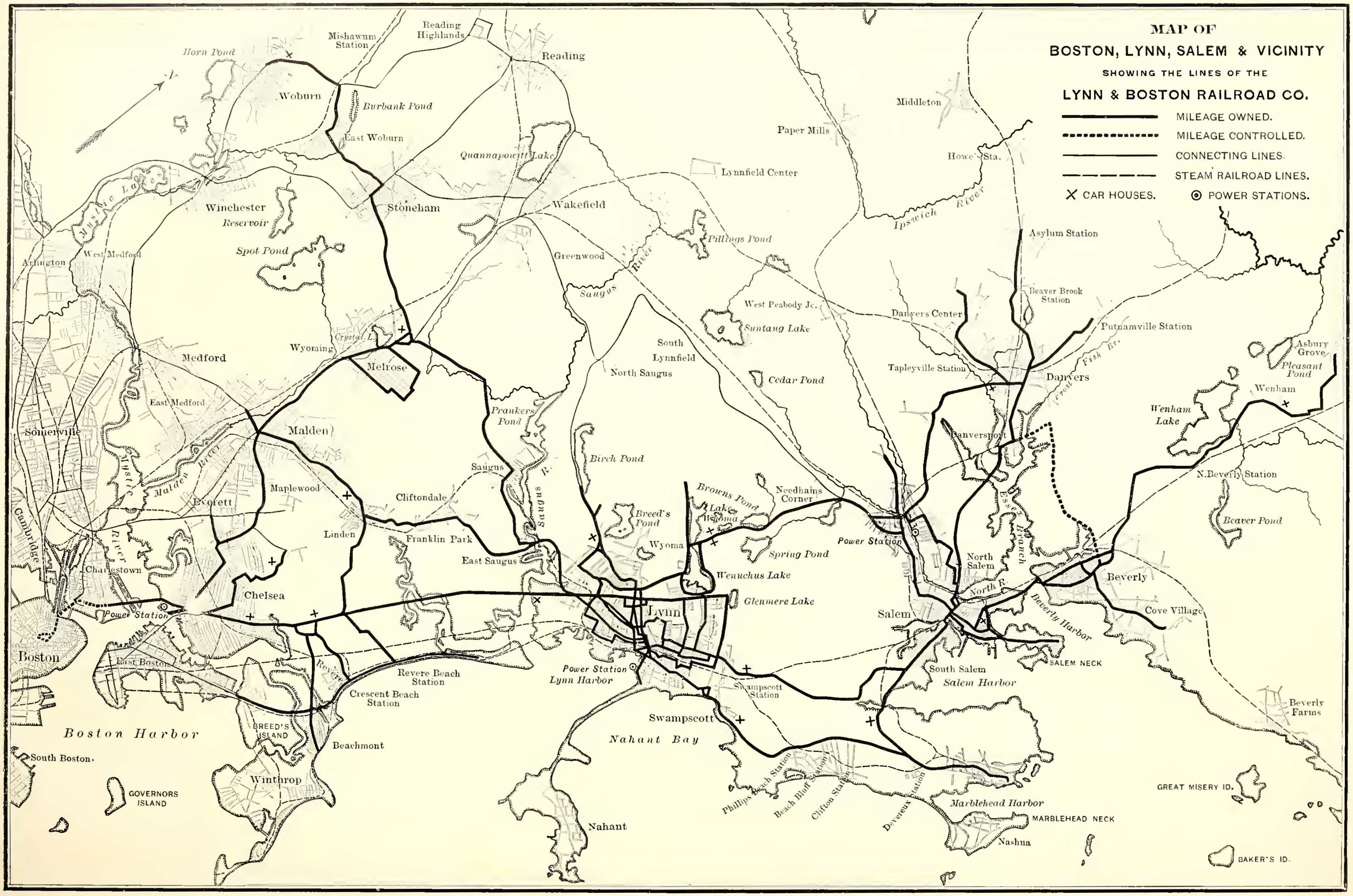
STATE STREET

The system as it exists to-day is a virtual consolidation of six street railway properties, in independent operation up to 1892, when the first general consolidation was effected. The Lynn & Boston Company prior to that year was in possession of the line from Lynn to Scollay Square, Boston, of the Chelsea local lines, of nearly all the local lines in Lynn, of the Revere Beach lines, and of a line to Marblehead. The Naumkeag Street Railway Company centered in Salem and operated nearly all the entire northern portion of the present system, including the lines in Salem, Danvers, Peabody, Beverly, Wenham and Hamilton, and owned a line from Salem to Marblehead. The East Middlesex system centered at Malden and owned the principal lines west of Chelsea and Saugus, located in Chelsea, Everett, Malden and Saugus, as well as a line from Malden to Revere Beach direct The Lynn Belt Line Street Railway Company owned several local lines in Lynn. The Essex Electric Street Railway Company owned a line from Salem to Peabody, and one from a point in Salem to Salem Willows. The Boston & Revere Electric Street Railway owned a line from a point on Crescent Beach to Winthrop Junction and Ocean Pier.

An idea of the relative earning capacity of these five components of the present system (whose locations on the accompanying map may be easily understood by the foregoing) may be obtained from the following figures based upon the horse railway traffic of the year ending September 30, 1892:

	Miles Track.		Passenger Receipts.			
	Each System.	Per Cent to Total.	Each System.	Per Cent to Total.	Per Mile Track.	Per Car Mile.
Lynn & Boston	63.3	45	$612,185	58	$9,700	$.315
Naumkeag	37.9	27	240,936	23	6,400	.333
East Middlesex	18.3	13	101,401	9	5,500	.311
Lynn Belt Line	10.4	8	76,087	7	7,300	.206
Two pleasure lines	9 6	7	25,258	2	2,600	.335

It will be seen that, as might readily be supposed, the old Lynn & Boston system proper is the best portion of the present larger system. In the old horse railway days with but 45 per cent of the total mileage it earned 58 per cent of the total receipts and $9,700 per mile of track, which is a


MAP OF
BOSTON, LYNN, SALEM & VICINITY
SHOWING THE LINES OF THE
LYNN & BOSTON RAILROAD CO.
MILEAGE OWNED.
MILEAGE CONTROLLED.
CONNECTING LINES.
STEAM RAILROAD LINES.
CAR HOUSES.
POWER STATIONS.


BOSTON ELEVATED RAILWAY CO.
SURFACE LINES
PROPOSED ELEVATED LINES
CONNECTING SURFACE LINES
ROUTE OF SUBWAY
SCALE
1 MILE
MALDEN
MEDFORD
EVERETT
ARLINGTON
BELMONT
CAMBRIDGE
SOMERVILLE
CHARLESTOWN
CHELSEA
EAST BOSTON
WATERTOWN
BRIGHTON
NEWTON
BROOKLINE
ROXBURY
DORCHESTER
WEST ROXBURY
SOUTH BOSTON
BOSTON HARBOR
MALDEN SQUARE
MEDFORD SQUARE
EVERETT SQUARE
HARVARD SQ.
CENTRAL SQUARE
UNION SQ.
SPY POND
FRESH POND
MT. AUBURN CEMETERY
CHESTNUT HILL RESERVOIR
JAMAICA POND
ARNOLD ARBORETUM
FRANKLIN PARK
FIELD'S CORNER
MOUNT BOWDOIN
MILTON LOWER MILLS
STONY BROOK RESERVATION
Central Power Station
Arlington Heights C.H.
Salem St. C.H.
Reservoir C.H.
Sewall St. C.H.
Green Hill C.H.
Jamaica Plain C.H.
Forest Hills C.H.
Ashmont C.H.
Neponset C.H.
Hammonds Pond
Mt. Hope Cem.
Calvary Cem.

considerably greater earning power per mile than any of the other components. The Lynn Belt Line appears to have been a valuable local property, as its traffic density was equal to $7,300 per mile of track, and it earned nearly its due proportion of the entire traffic of the system. Its net earnings were small, however. The traffic of the East Middlesex system was too largely local in character, and presented too little inducements, except for the Revere

MASSACHUSETTS STATE HOUSE

Beach travel, to achieve a large earning power per mile of track, but its cars were run in such a way as to give a fairly large return per car mile. The travel of the pleasure lines, whose principal business was in the summer, was naturally small per mile of track and large per car mile.

The backbone of the present Lynn & Boston system is the long, nearly straight line passing from Lynn through Chelsea and Charlestown to Scollay Square, Boston. This is by far the greatest revenue producing line of the system. A 1½-minute service is given to Chelsea and a fifteen-minute service to Lynn, while between Boston and Revere is a 2½-minute local service. It is two and one-half miles from Scollay Square, Boston, to Chelsea; six and one-half miles to Revere, and ten miles to Lynn. The fare to Revere is five cents and to Lynn ten cents. The company's Chelsea line probably obtains more than half of the regular daily traffic between Boston, Chelsea and Revere, and nearly half of that between Boston and Lynn. Its competitors for the Chelsea traffic are the Chelsea Ferry, which charges a 2½-cent fare, and lands its passengers at the foot of Hanover Street, Boston, connecting with the cars of the Boston Elevated Railway Company; and the latter's lines direct from Broadway, Chelsea, through East Boston via East Boston Ferry to Boston proper—a comparatively roundabout and little used line for Chelsea traffic, though valuable for East Boston. The company's cars between Boston and Lynn are run at good speed (eight miles per hour schedule), and that fact, together with the distribution facilities offered by the local lines of Lynn, free transfer to which is given, the convenient Scollay Square terminus in Boston, and a 25 per cent saving in fares has been successful in diverting to the electric lines a large portion of the travel formerly going by steam railroad. Of course nearly all this through travel between Boston and Lynn has been built up since the introduction of electric traction, and is a direct result of the higher speeds possible with it.

The Revere Beach portion of this old Lynn & Boston system has been already referred to as being one of its most important and profitable sources of revenue. The traffic on the old East Middlesex system serving Chelsea, Everett, Malden and Melrose does not call for a very large car service, a fifteen-minute service only being necessary between Chelsea and Melrose via Malden, a half-hour service from Woburn to Lynn and Revere Beach via Stoneham, Melrose and Saugus, and a ten-minute service along the beaches.

The company's lines north of Lynn obtain still the great pleasure traffic of the system with a little all-the-year-round traffic. A ten-minute service is given between Lynn and Salem, a fifteen-minute service between Lynn and Marblehead, a fifteen-minute service from Salem to Marblehead and to Salem Willows, a twelve-minute service from Salem to Danvers, a fifteen-minute service to Beverly and thirty-minute to Wenham.

The general balance sheet of the Lynn & Boston Railroad Company of Sept. 30, 1897, showed that the total permanent investment in the property amounted to $6,926,044, equivalent to $57,334 per mile of main track. Of this amount $34,690 per mile was spent on construction of roadbed, track and electric distribution system, $11,174 per mile for equipment, and $11,471 per mile for land and buildings (including three power stations and plant) and other permanent property. The investment in land, buildings and all equipment, exclusive of roadbed, track and distribution system amounted to $5,271 per car owned. The total capital liabilities against the Lynn & Boston system amount to about $58,000 per mile.

The Lynn & Boston system earned in the year ending

BOSTON PUBLIC LIBRARY

September 30, 1897, $1,431,936, equivalent to $11,465 per mile of route operated, $.261 per car mile and $.052 per passenger carried. The fact that this earning power per passenger so little exceeded the normal five-cent fare shows that the proportion of the passengers paying a sum greater than this five cents must be but moderate. The earning power per car mile is less than the company's best record, which is $.2814 earned in 1895. The earnings per mile of road have neither increased nor decreased materially since the horse railway days. The entire profits of the system are earned during the six summer months, the traffic of the remaining six months hardly paying operating expenses.

THE FROG POND ON BOSTON COMMON

The company's earnings from operation applicable to return on investment amounted last year to $396,387, equivalent to 5.72 per cent upon the total permanent investment. Eight per cent was declared upon the capital stock, leaving a surplus for the year of $4,218.

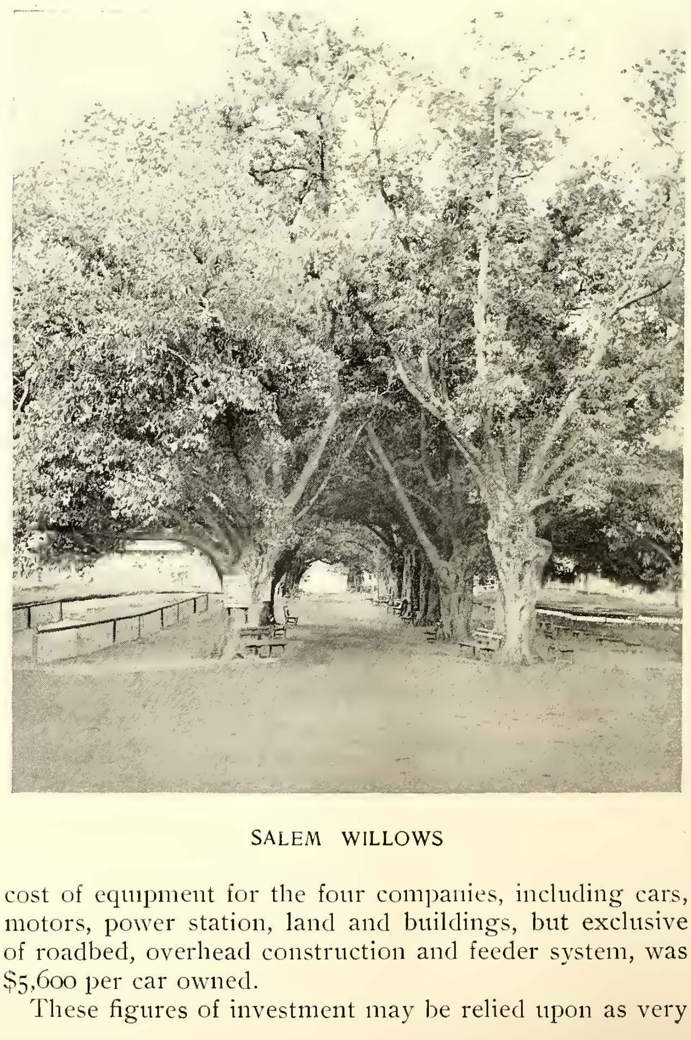
This is evidently one of the most valuable street railway properties of the interurban class in the world. It is difficult to see how the territory could possibly be excelled from a street railway point of view, except, perhaps, that a somewhat larger proportion of manufacturing to residential and pleasuring interests would be desirable. There is no question that the section which this system serves will always be largely residential, and manufacturing interests will probably not develop very greatly, but there will surely be a steady and perhaps even rapid growth of travel throughout this whole North Shore district with the increase of population brought about by greater facilities of transit, and by the delights of summer residence.

THE GLOUCESTER GROUP

North of the Lynn & Boston system and connected with it at Beverly are four lines serving five towns of about 54,000 total population lying along the Gloucester peninsula, the northern limit of Massachusetts Bay. This district was formerly given over almost entirely to fishing interests, Gloucester, Beverly and Ipswich being in especial ports from which many whaling boats were fitted out. Later, however, these interests have greatly declined and have not been replaced by others to any material extent, so that this section is chiefly residential and farming in character, with a large summer population attracted by the quaintness of these old towns.

The street railway system is composed of four separate companies, but is operated practically as one system, certain stockholders being largely interested in each company. The Gloucester Street Railway Company, the oldest and best developed of the four lines, dates from 1885 and until 1891 was owned locally and had built 5.4 miles of track. At about that time it was purchased by the present owners, who have since extended it by about five miles and have equipped it for electric operation. To this line is leased the Gloucester & Rockport Street Railway, a small branch 1½ mile in length running to a shore resort and built in 1895. The Rockport Street Railway was built in the early part of 1896 and was opened for operation on July 3 of that year. The Gloucester, Essex & Beverly Street Railway was opened for operation on Aug. 21, 1895, and construction was completed before Sept. 30, 1896.

The accumulated investment in the Gloucester Street Railway, including a fair allowance for the old horse railway property, is $11,600 per mile of track and roadbed, $4,000 per mile for overhead construction and $7,500 per mile for rolling stock. The net cost of building the twenty-three miles of the Gloucester, Essex & Beverly road was $8,100 per mile for roadbed and $3,600 for overhead construction, while its rolling stock cost $2,400 per mile. The net cost of building the Rockport Street Railway was $9,900 per mile of roadbed and tracks and $2,000 per mile for overhead construction, its rolling stock costing $2,600 per mile. The cost of building the 1.5 mile of the Gloucester & Rockport Street Railway was $11,400 per mile for roadbed and tracks and about $1,000 per mile for overhead construction. The cost of power stations for the entire system including land, power station buildings and equipment, amounts to $2,600 per mile of track and $1,900 per car owned. The cost of land and buildings other than for power station purposes for the complete system was nearly $1,200 per mile of track and $900 per car. The



SALEM WILLOWS

cost of equipment for the four companies, including cars, motors, power station, land and buildings, but exclusive of roadbed, overhead construction and feeder system, was $5,600 per car owned.

These figures of investment may be relied upon as very closely representing the actual net cash cost of these properties, as all construction accounts are most carefully inspected by the Board of Railroad Commissioners, and any attempt at padding as a basis for overcapitalization is rigorously checked. For this reason these and similar figures concerning other properties yet to come are of special significance and value to those who wish to obtain an accurate idea of the cost of electric railway building at the present time.

There is quite a little local traffic in Gloucester and in the near vicinity, particularly to the shore resorts close by. On the long lines to Lanesville and Ocean View via Rockport a thirty-minute service is given in summer and a forty-five-minute service in winter. The local fares are five cents, while the fare to Lanesville and Ocean View is ten cents. The gap between these two lines at the end of the peninsula is left closed perhaps with a view to increasing traffic by avoiding round trips. A summer visitor must evidently make a return trip on both lines if he expects to see all the scenery that Gloucester can afford to him by trolley cars. On the Gloucester, Essex & Beverly line a thirty-minute service is given in summer and a sixty-minute in winter. The fare between Gloucester and West Gloucester is five cents, Gloucester and Essex Falls ten cents, and Gloucester and Beverly thirty cents. The fare on the Ipswich branch from the trunk line to Ipswich is five cents, and a thirty-minute service is given.

As a result of this service the Gloucester Street Railway carried in 1896-7 4.9 passengers per car mile, earned 5.26 cents per passenger carried, 25.84 cents per car mile and $5,902 per mile of track operated. The Gloucester, Essex & Beverly carried only 3.3 passengers per car mile and earned on its twenty-three miles of track operated less in toto than the Gloucester system with its twelve miles, the earnings of this long interurban road being at the rate of $2,612 per mile of track, 17.35 cents per car mile and 5.23 cents per passenger. From this last figure it would seem that the traffic on the Gloucester, Essex & Beverly road must be chiefly local with comparatively little through business, as a large proportion of the ten and twenty-cent fares would otherwise have brought up the minimum five-cent fare to a much greater figure.

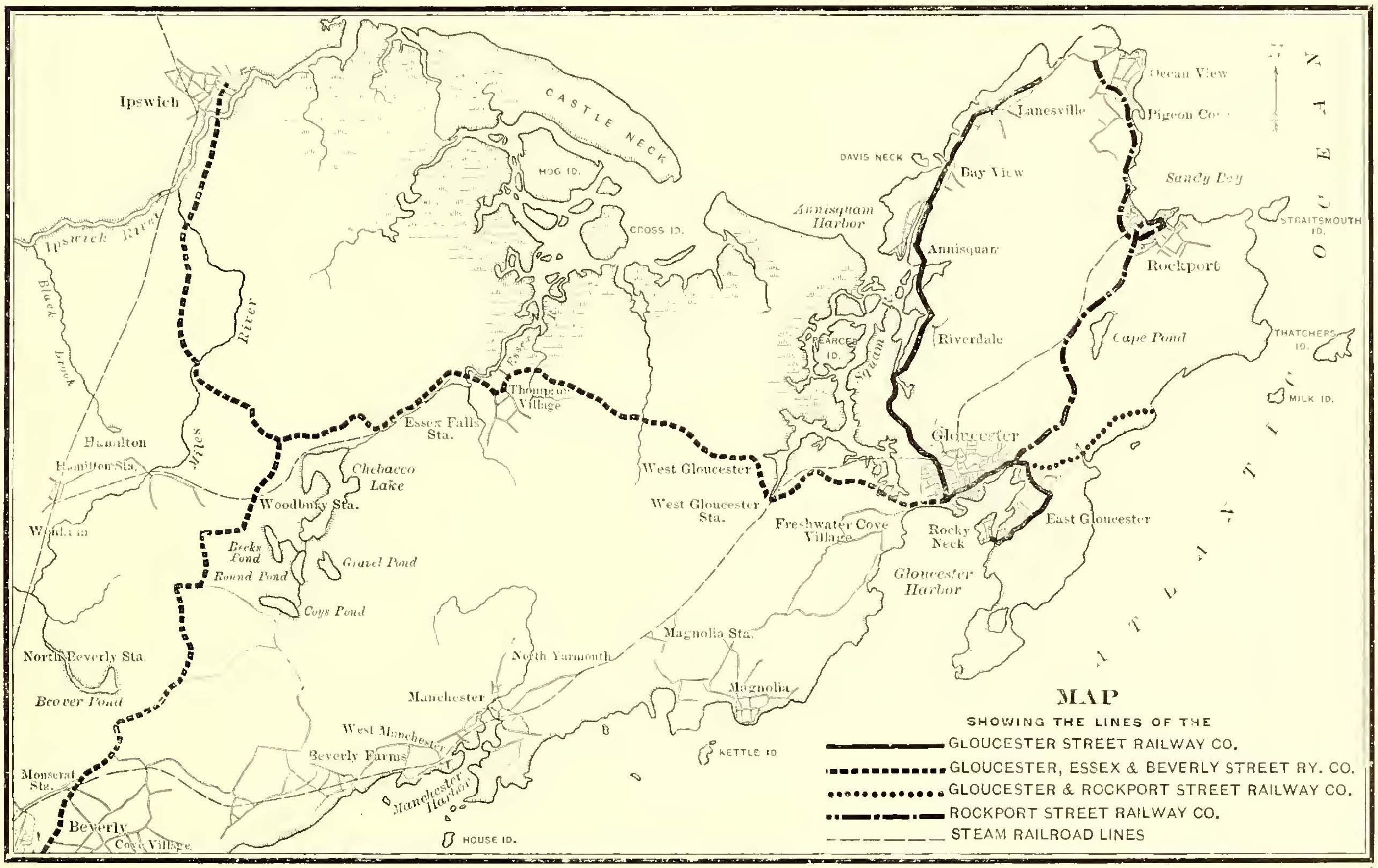
The Rockport Street Railway carried 3.9 passengers per car mile and earned $3,497 per mile of track operated, equivalent to 19.34 cents per car mile and 5 cents per passenger.

The net earnings of the Gloucester Street Railway applicable to return on investment amounted in 1896-7 to $24,541, equivalent to 7.3 per cent on its own investment and that of the Gloucester & Rockport Street Railway, which it leases. The Gloucester Company paid the Gloucester & Rockport Company as rental the sum of $1,800, or 6 per cent on its capital stock, and it paid 6 per cent upon its own stock, leaving a surplus for the year of $5,635 to be added to its previous surplus of $35,917.

The net earnings of the Gloucester, Essex & Beverly Street Railway Company amounted to $17,709, equivalent to 4.4 per cent upon its investment. This company declared a 2 per cent dividend, which left a surplus for the year of $4,332 to be added to its previous surplus of $8,717. The net earnings of the Rockport Street Railway Company were $6,924, equivalent to 5.5 per cent return on its investment. This company paid a dividend of 3 per cent on its stock and after doing so had a surplus for the year of $3,234 to be added to its previous surplus of $7,565.

The four companies composing this system earned as a whole $153,579 gross, equivalent to about $2.80 per capita served (not counting of course summer population); and $50,174 net, equivalent to a return of 5.7 per cent upon the total investment. The total balance sheet surplus of the four companies amounts to $82,079, equivalent to 9.4 per cent of their joint investment.

Altogether, while this system has the disadvantage of being located in a purely residential section without manufacturing interests of consequence to favor its larger growth, it is safe to expect a steady though perhaps slow development, which should make it always a reasonably profitable property if carefully managed.



THE WAKEFIELD-STONEHAM GROUP

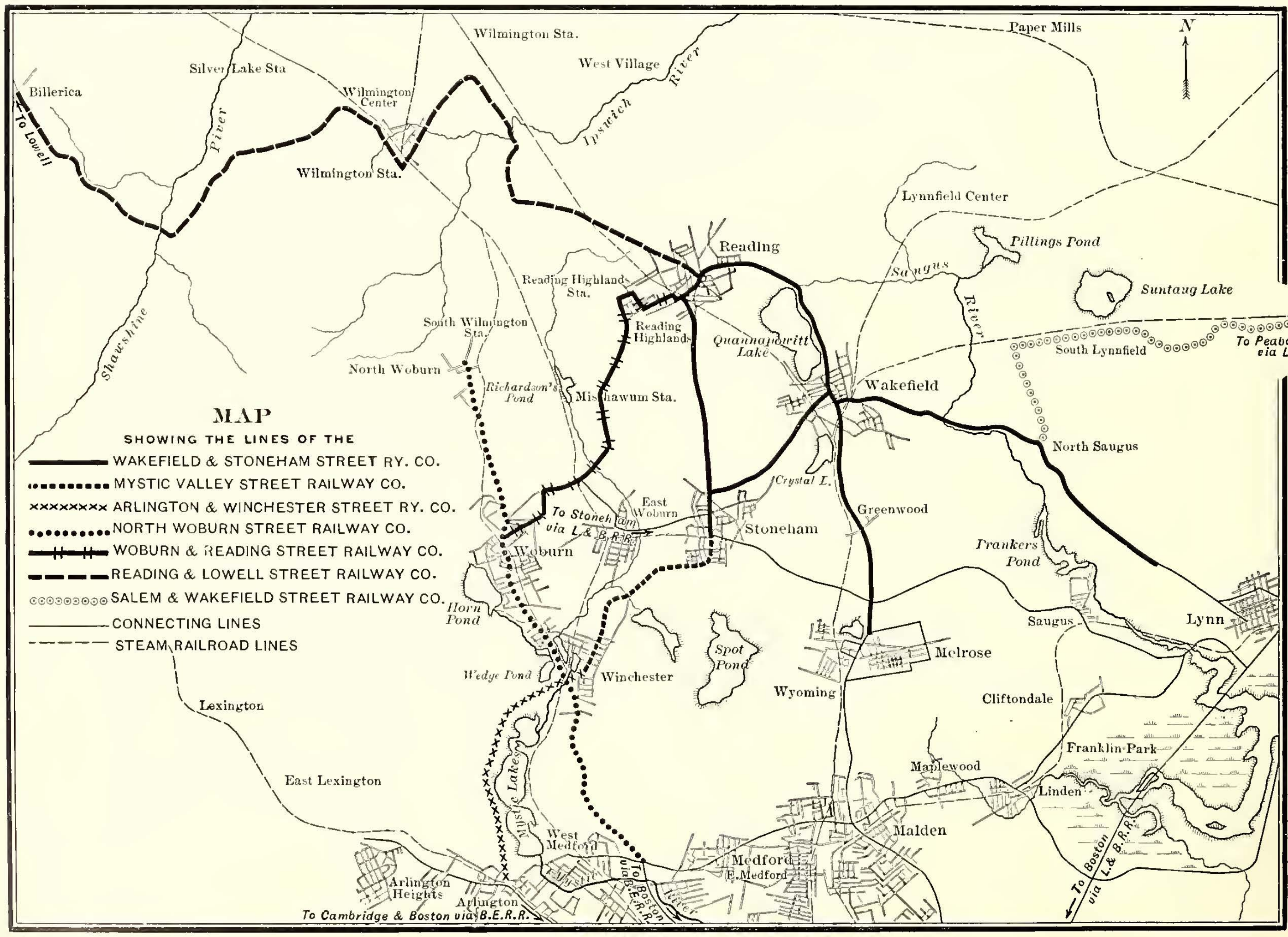
Seven independent lines of this group, operating about fifty-four miles of track in all, serve eleven cities and towns, with an aggregate population of 81,000 lying to the north of the Boston system and west of the Lynn & Boston system, and connected with these two systems at Arlington, Medford, Melrose, Stoneham, Woburn, Saugus and Lynn. The territory is chiefly residential suburban in character, but there are some large manufacturing interests, particularly in Wakefield and Stoneham. The traffic is largely of the "shuttle" order, except that there is considerable pleasure business in summer, the lines running generally through beautiful semi-country scenery along pleasant rivers and in quiet byways. Some effort is made to obtain North Shore traffic, but this has to pass over the Lynn & Boston lines before reaching the shore itself.

The oldest of these seven lines is the North Woburn Street Railway, which dates from the early '80's, and is a direct feeder to the Boston system connecting with it Winchester, Woburn and North Woburn. The remaining six lines form practically one system, the same parties being in control of all. The Wakefield & Stoneham Railway, the largest of the six, commenced operation in 1892, the Reading & Lowell in December, 1895, the Mystic Valley in May, 1896, the Woburn & Reading in June, 1896, the Arlington & Winchester in July, 1897, while the Salem & Wakefield is about ready for operation. From these dates it will be seen that the earning power of this system is not fully developed, but should be greater three or four years hence than at present.

Over all these lines the cars run at half-hour intervals, no greater frequency being considered necessary except on special days or special occasions. The fare charged from Reading to Billerica is fifteen cents and from Wakefield and Reading to Winchester and Arlington ten cents, but elsewhere on the system in general a five-cent fare is charged for each line irrespective of distance.

The investment and operating characteristics of the five properties in this group which have been in operation for one year or more are given in the table on page 488, and a number of interesting comparisons may be made by those who wish to draw deductions for use in other places. The comparative density of traffic is as follows:

	Gross Receipts Per Mile Track.	Gross Receipts Per Car Mile.
North Woburn	$4,652	$.1954
Wakefield & Stoneham	3,806	.1603
Mystic Valley	2,991	.1667
Woburn & Reading	1,940	.1483
Reading & Lowell	1,476	.1103



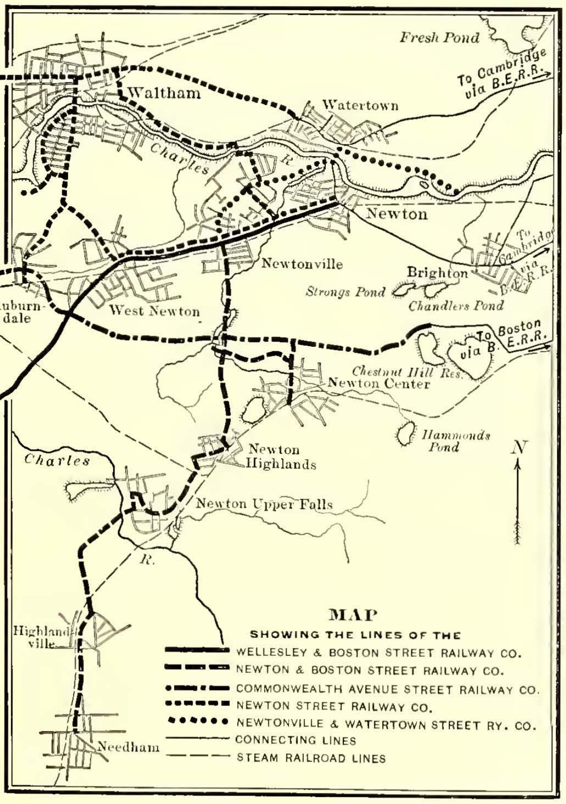
In the year ending Sept. 30, 1897, the North Woburn earned a surplus over fixed charges of $1,873 only, and its balance sheet shows a total deficit of $12,976; the Wakefield & Stoneham earned a surplus over charges of $20,583, paid a 5 per cent dividend and shows a total balance sheet surplus of $4,012; the Mystic Valley earned $1,051 net and shows a total surplus of but $843; the Reading & Lowell and the Woburn & Reading combined earned but $716 over operating expenses for the last year, and show a total deficit to date of about $5,100.

These five operating properties taken as a whole cost $19,600 per mile of track, of which $11,200 per mile was for roadbed, $2,700 for overhead construction, $2,900 for rolling stock, $2,000 for power station and equipment and $800 for other land and buildings. The cost of equipment, exclusive of roadbed and overhead construction, was $5,100 per car. The five railways together carried 3.2 passengers per car mile and earned $132,706 gross, equivalent to $1.64 per capita served (exclusive of earnings of competing lines in same territory), $3,100 per mile of track, $.158 per car mile and $.0501 per passenger carried. The earnings from operation were $28,668, equivalent to a return of 3.4 per cent upon the total investment.

The somewhat unsatisfactory results on this system are undoubtedly due to the fact that the seven lines of this group alone have built one mile of track for every 1500 inhabitants to be served, to say nothing of the Lynn & Boston and Boston Elevated Railways, which give additional service to several of the towns. The system is also unfortunate in offering comparatively little inducement to permanent daily traffic aside from pleasuring and occasional local business requirements. The competing lines give their patrons much longer rides for the same money and take them also to Boston and other large business and pleasuring centers. The new lines just built and building may improve these general results to some extent, particularly the Salem & Wakefield line, which will probably carry a good deal of pleasure travel from the entire territory.

THE NEWTON-WALTHAM GROUP

Newton City and the Newton villages are considered by many—particularly those who live there—as being among the most beautiful suburban residence places in the world. Certainly they are the most beautiful and highly developed around Boston, and in character of houses, highways and public service in general they can hardly be excelled as model suburban townships. All of these are



within thirty minutes of Boston by the "Newton Circuit Line" of the Boston & Albany Railroad, which gives an excellent service, and yet are so far away by street railway lines that even with electric speeds the latter can hardly hope to obtain much of the Boston travel except from those to whom time is no object and pleasure in riding desirable.

Three cities only are served by this system—Newton, Waltham and Needham—with a total population of 53,000. In Newton, however, are no less than twelve villages ranging in size from Thompsonville, with 77 population, to Newton proper, with 9000. For the service of this 53,000 population the five railways in this group have built forty-three miles of track, an average of one mile for each 1250 inhabitants. According to all or nearly all precedents so large a mileage in proportion to the population would mean disaster from the start, but this has not come about here, as will presently be seen.

HARVARD COLLEGE GATES

A fifteen-minute service is given on these lines from Newton to Newton Lower Falls, a twenty-minute service from Newtonville to the southern villages and a half-hour service from Newton and Watertown to Waltham. A five-cent fare is charged throughout. The Commonwealth Avenue line, the most recent of the five, going into operation in March, 1896, connects with the Boston Elevated Railway at Chestnut Hill Reservoir, and a good deal of Boston traffic will be obtained to Norumbega Park via Newton over this line.

In the table on page 488 will be found the financial characteristics of the separate railways forming this group. It should be stated that the Wellesley & Boston, the Newton & Boston and the Newtonville & Watertown Street Railway companies are practically identical in management and ownership and have a common power station, which also furnishes power to the Commonwealth Avenue Street Railway Company. The latter, though owned by a separate group of capitalists, is on friendly terms with the three companies just named, as is shown by the fact that they have given the Commonwealth Avenue a terminus at Newtonville over their tracks. The power station, as above stated, is used in common and one superintendent handles the four lines. The Newton Street Railway was the first one in this field and is entirely independent of the others.

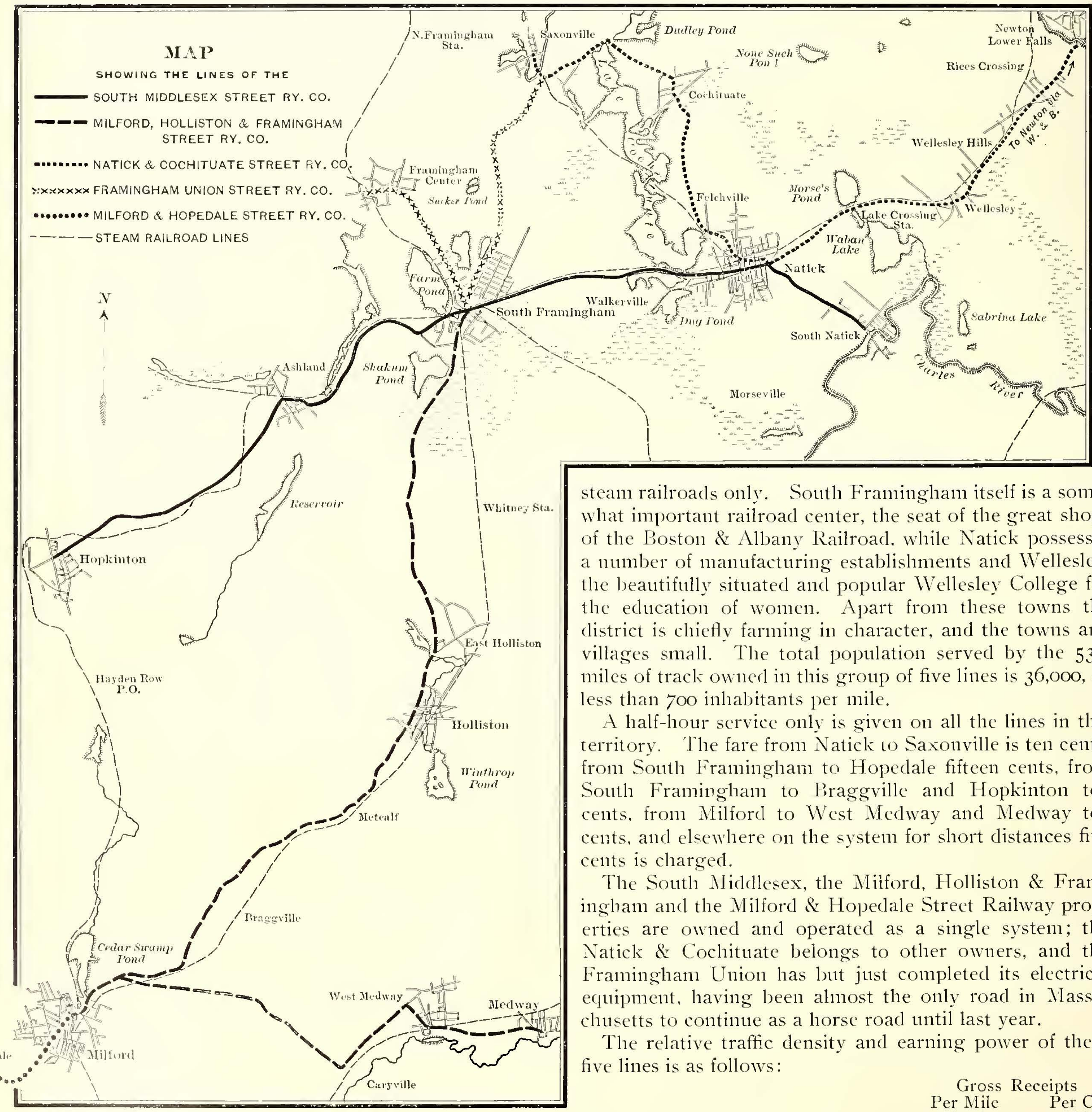
The relative earning power of these properties is as follows:

	Gross Receipts Per Mile Track.	Per Car Mile.
Newton Street Railway	$7,608	$.2467
Newton & Boston	4,723	.1953
Commonwealth Avenue	4,432	.1587
Wellesley & Boston	2,679	.1393
Newtonville & Watertown	2,657	.1397

Combining the investment and operating figures of the five properties we find that they have, as a whole, cost $25,100 per mile of track, of which $13,600 was for roadbed, $2,400 for overhead construction, $5,300 for rolling stock, $1,400 for power station and equipment, and $2,400 for other land and buildings. Their cars carried 3.7 passengers per car mile and their gross operating receipts were $214,574, equivalent to $4.05 per capita served, $4,800 per mile of track, $.1939 per car mile and $.0528 per passenger carried. The net earnings of the system, applicable to return of interest and dividends on bonds and stock, amounted last year to $54,720, equivalent to 4.9 per cent upon the total permanent investment. The Newtonville & Watertown alone of the five properties did not earn its operating expenses and taxes, its scale of operations being extremely small—$8,000 gross receipts per annum. The Wellesley & Boston paid a 7 per cent dividend, the Newton & Boston 3.8 per cent, the Newton 8 per cent and the Commonwealth Avenue nothing. The combined balance sheet surplus of the five properties is $29,086.

THE FRAMINGHAM-NATICK GROUP

Directly west of the Newton group are five lines connected with it at Newton Lower Falls, and running thence through Wellesley and Natick to South Framingham, the center of this group, whence a line runs still further west to Hopkinton and south to Milford and Hopedale. This territory is almost entirely independent of Boston, and carries practically no traffic to or from the Boston system. It is to some extent suburban in character, however, even as far west as South Framingham, but for the benefit of



steam railroads only. South Framingham itself is a somewhat important railroad center, the seat of the great shops of the Boston & Albany Railroad, while Natick possesses a number of manufacturing establishments and Wellesley, the beautifully situated and popular Wellesley College for the education of women. Apart from these towns the district is chiefly farming in character, and the towns and villages small. The total population served by the 53.5 miles of track owned in this group of five lines is 36,000, or less than 700 inhabitants per mile.

A half-hour service only is given on all the lines in this territory. The fare from Natick to Saxonville is ten cents, from South Framingham to Hopedale fifteen cents, from South Framingham to Braggville and Hopkinton ten cents, from Milford to West Medway and Medway ten cents, and elsewhere on the system for short distances five cents is charged.

The South Middlesex, the Milford, Holliston & Framingham and the Milford & Hopedale Street Railway properties are owned and operated as a single system; the Natick & Cochituate belongs to other owners, and the Framingham Union has but just completed its electrical equipment, having been almost the only road in Massachusetts to continue as a horse road until last year.

The relative traffic density and earning power of these five lines is as follows:

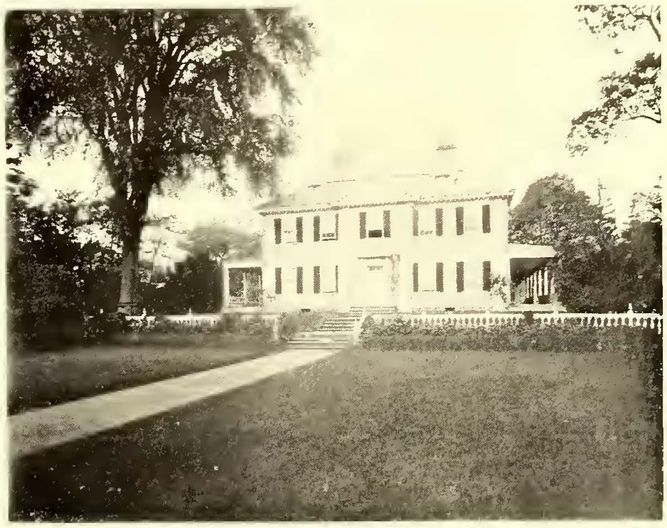
	Gross Receipts Per Mile Track.	Gross Receipts Per Car Mile.
Milford & Hopedale	$5,676	$.1827
Natick & Cochituate	4,158	.2194
South Middlesex	3,984	.2049
Framingham Union	2,884	.2289
Milford, Holliston & Framingham	2,616	.1826

Combining the investment and operating figures of the five lines (for details see table, page 488) it is found that as a whole they have cost $17,500 per mile of track owned, of which $9,500 was for roadbed, $2,200 for overhead construction, $2,900 for rolling stock, $2,000 for power station and equipment and $973 for other land and buildings. The system carried 4 passengers per car mile and earned $179,157 gross, equivalent to $4.98 per capita served, $3,300 per mile of track owned, $.2023 per car mile and $.0502 per passenger carried. The net earnings applicable to return of interest and dividends on bonds and stock amounted to $50,029, equivalent to 5.3 per cent on total permanent investment. The Milford & Hopedale and the Milford, Holliston & Framingham paid 5 per cent divi-

THE LOWELL HOUSE, CAMBRIDGE

THE OLD FAIRBANKS HOMESTEAD, DEDHAM

THE OLD SHIP MEETING HOUSE, HINGHAM



THE CRAIGIE MANSION, CAMBRIDGE

dends, the Natick & Cochituate 6 per cent, the South Middlesex 5.5 per cent, and the Framingham Union nothing. The joint balance sheet surplus of the five properties was $17,723.

THE NORFOLK SUBURBAN GROUP

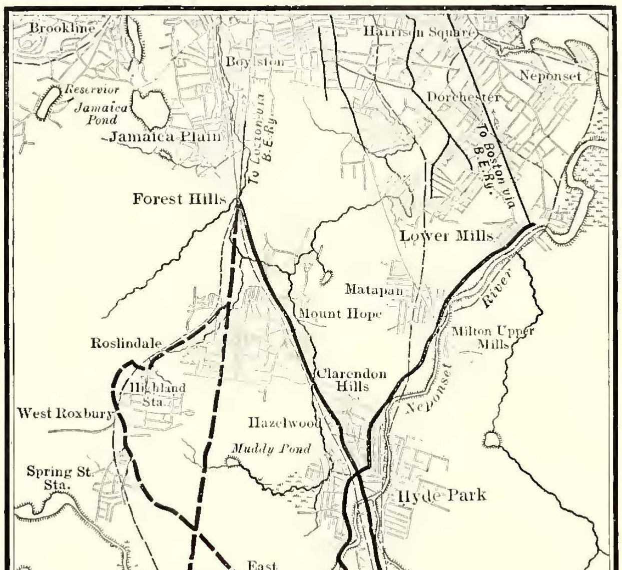
Southwest of the Boston system and connected with it at Forest Hills lie three lines, two of which are for a large part of their length in Boston proper. Altogether they serve nineteen towns and villages in Norfolk and Suffolk counties, having a total population of 60,000, equivalent to 2300 inhabitants for each of the twenty-six miles of track built. This is beautiful suburban territory, dependent exclusively upon Boston, and its population is growing more rapidly perhaps than in any other section around Boston. There is a large amount of both regular and pleasure travel, and the local traffic between so many villages is necessarily large. Thirty-four cars per hour are run by the Boston Elevated Railway Company between Boston and Forest Hills. A fifteen-minute service is given from Forest Hills to Hyde Park and Roslindale and a half-hour service from Forest Hills to Dedham and East Walpole, as well as from Hyde Park to Milton and Readville. Fifteen cents is charged from Forest Hills to East Walpole and five cents to Dedham and Hyde Park.

The density of traffic and earning power of the three systems as so far developed is as follows:

	Gross Receipts Per Mile Track.	Gross Receipts Per Car Mile.
Norfolk Suburban	$8,945	$.2356
West Roxbury & Roslindale	5,904	.1784
Norfolk Central	3,639	.1396

These are large earnings compared with any (except Lynn & Boston) so far investigated in suburban Boston, and show how important the regular daily business travel is to the prosperity of such roads.

There is one element of competition which may possibly enter into the question of the permanent prosperity of these properties in the near future, and that is the proposed equipment, by the New York, New Haven & Hartford Railroad Company, of its Dedham Circuit Line, which will run from the new Southern Union Station in Boston to Forest Hills and thence via Roslindale, West Roxbury, Dedham, Readville, Hyde Park and Forest Hills back to the Union Station. It is probable that an exceptionally good suburban service will be put upon this Circuit Line by the New Haven Company, with the idea of making direct issue with the street railway companies in the same territory as to traffic. It is possible even that the time interval between electric trains will be but ten or fifteen min-



utes instead of hourly, as at present; that the speeds will be great, and that some system of "chopping-box" ticket collecting will be used at stations along the line. All grade crossings on this circuit are being avoided and the run will be straight, clear and unimpeded. As before stated, this district is building up very rapidly and the influence on still further increases of such a novel experiment as this in suburban railroading will possibly bring into the territory so large a number of new residents that, though the street railways may temporarily suffer somewhat, they may quite possibly gain back eventually in local traffic all that they may lose at the start. In any event, the issue will doubtless be postponed for at least a year during the railroad equipment period.

The West Roxbury & Roslindale and the Norfolk Suburban lines cost $28,100 per mile of track, of which $18,000 was for roadbed, $3,700 for overhead construction, $4,300 for rolling stock, $600 for power station and equipment and $1,500 for other land and buildings. The cost of equipment, exclusive of roadbed and overhead construction, was $3,000 per car. The two railways together carried last year 4.3 passengers per car mile, and earned $149,090 gross, equivalent to about $2.70 per capita served, $7,000 per mile of track, $.2124 per car mile and $.0497 per passenger carried. The net earnings were $32,579, equivalent to 5.5 per cent on the total permanent investment. The Norfolk Suburban paid a dividend of 7 per cent, while the West Roxbury & Roslindale paid no dividend, though earning a little over 5 per cent on its capital stock. The combined balance sheet surplus of the two roads amounts to $19,978. As the Norfolk Central line has just been completed its construction and operating figures are not combined with the other two properties.

THE BROCKTON-BRIDGEWATER GROUP

The amount of street railway building in Brockton and west and south of Brockton is something astonishing. No less than seven separate properties are found here, of which four have been completed since Sept. 30, 1896, and have not yet developed their full earning power. The territory is manufacturing, suburban residential and farming in character. Brockton, Whitman, Holbrook and Stoughton are important and prosperous shoe towns. At North Easton are the great Ames factories, where three-fourths of all the shovels in the world are turned out. The Bridgewaters are chiefly residential, but have some manufacturing interests. The whole district is rich in historic associations connected with "the Old Colony" of Massachusetts, and is one of the most prosperous in the State.

There are thirty cities and villages (exclusive of Taunton) served by these seven systems, having a total population of 78,736, equivalent to 675 inhabitants per mile of track. The system is connected with Boston street railways through the Quincy-Hingham system on the north, and by means of the latter an outlet for the population of this district to the pleasure resorts on the shores of Massachusetts Bay is afforded and satisfactory traffic arrangements have been made by which through cars can be run on certain lines.

The Brockton Street Railway Company, the most important of all in this territory, is a consolidation in 1888 of several previously existing companies. The town of Brockton is narrow and all its business is concentrated on a single long street, while the highway north to Avon, Randolph and Holbrook is lined for a large portion of its length with residences which contribute largely to the receipts of the road. Until recently this system made little attempt to extend its lines largely, and allowed other interests to gain an entrance into the city and to build lines to East Bridgewater and Taunton. On Sept. 4, 1897, however, a friendly though independent extension, the Taunton & Brockton railway was opened, and has secured an entrance to Brockton over the Brockton Street Railway Company's lines, forming a shorter line to Taunton than the competing one via Bridgewater.

The Brockton, Bridgewater & Taunton, the Brockton & East Bridgewater and the Bridgewater, Whitman & Rockland are owned by practically the same parties. The Rockland & Abington and the Hanover properties are independent.

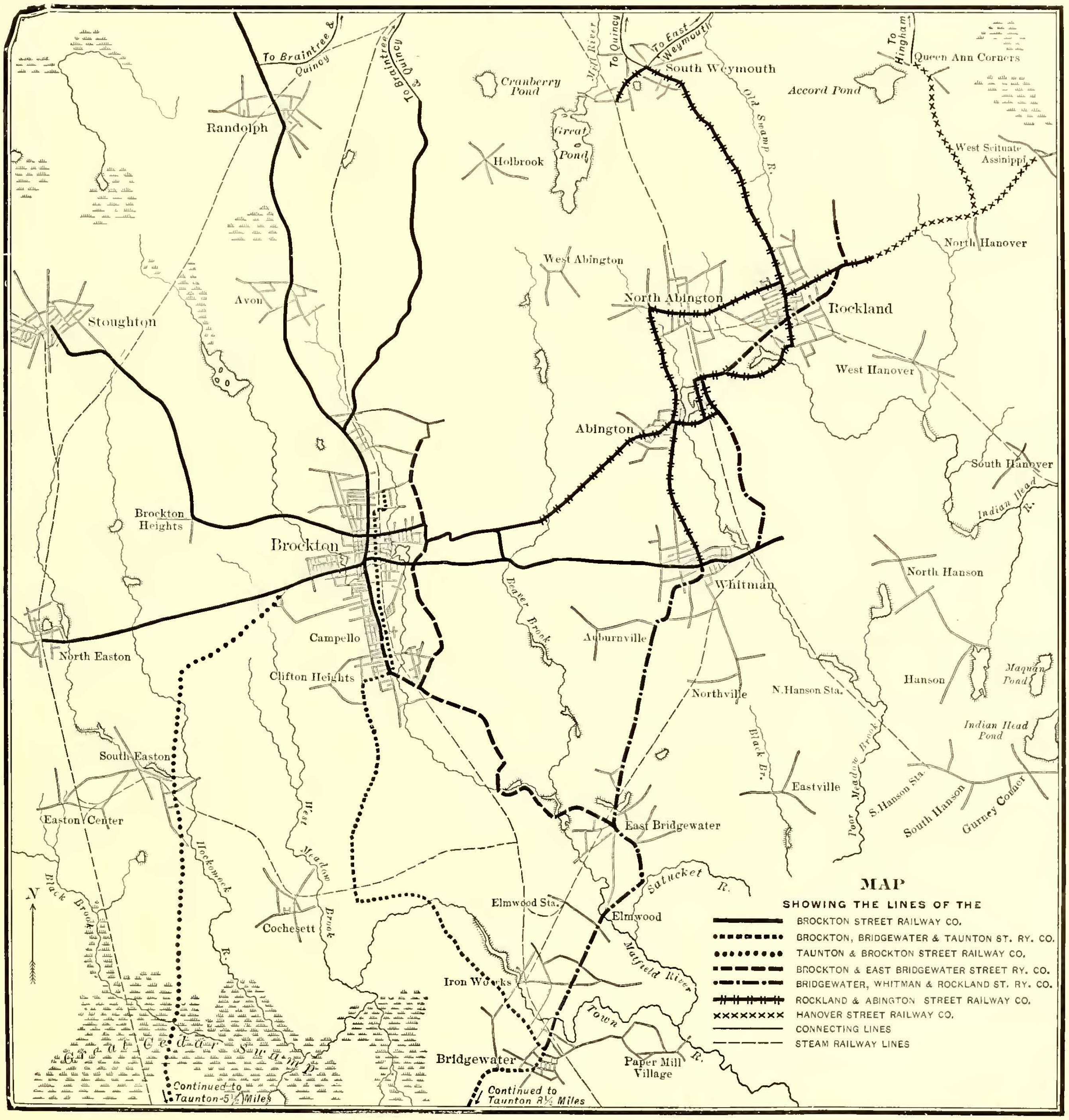
A half-hourly service is given between Brockton and Taunton via Bridgewater, a twenty-five cent fare is charged and the distance is made in one hour and fifteen minutes.

An hourly service is given from Brockton to Taunton via South Easton. The fare charged is twenty cents and the distance is made in one hour. A half-hourly service is given between Brockton and Rockland on the Rockland & Abington system, the fare being ten cents. From Brockton to Avon a fifteen-minute service is given by the Brockton Street Railway Company. From Brockton to Stoughton and elsewhere to surrounding towns cars run half-hourly.

The Brockton, Bridgewater & Taunton, the Brockton & East Bridgewater, the Taunton & Brockton and the equipment, and $900 for other land and buildings. The cost of equipment, exclusive of roadbed and overhead construction, was $4,100 per car.

The Brockton, the Rockland & Abington and the Hanover systems showed the following comparative earning power in the last financial year:

	Gross Receipts Per Mile Track.	Gross Receipts Per Car Mile.
Brockton	$8,010	$.2210
Rockland & Abington	4,610	.2121
Hanover	2,077	.1261



Bridgewater, Whitman & Rockland have been in operation only since the summer of 1897, and their operating figures are of little value as yet. Their investment figures, however, are interesting on account of the recent date at which they were built, and the presumably low prices at which they were able to obtain equipment and carry through construction. Taken as a whole, these four properties cost $17,900 per mile of track, of which $10,800 per mile was for roadbed, $2,700 for overhead construction, $2,300 for rolling stock, $1,200 for power stations and

In combination these three roads cost $27,400 per mile of track, of which $13,300 was for roadbed, $1,700 for overhead construction, $6,100 for rolling stock, $3,600 for power station and equipment, and $2,700 for other land and buildings. The cost of equipment, exclusive of roadbed and overhead construction, was $5,400 per car. The three railways carried 4.3 passengers per car mile and earned $420,498 gross, equivalent to $6.05 per capita served by them (exclusive of the population served by the four other companies in the same territory), $6,400 per

TABLE I.—INVESTMENT AND OPERATING STATISTICS OF THIRTY-ONE MASSACHUSETTS PROPERTIES.

	Case No.	Car Miles Run.	Passengers per Car Mile.	Miles of Track.		Number of Cars.	Investment per Mile Track.							Gross Operating Receipts.				Total Operating Expenses.				Earnings from Operation.				Per Cent Dividend Paid.
				Owned.	Operated.		Roadbed.	Overhead Construction.	Rolling Stock.	Power Station and Equipment.	Other Land and Buildings.	Miscellaneous.	Total.	Total.	Per Car Mile.	Per Pass. Carried.	Per Mile Main Track Operated.	Total.	Per Car Mile.	Per Passenger Carried.	Per Cent to Gross Operating Receipts.	Total.	Per Car Mile.	Per Passenger Carried.	Per Cent to Total Investment.	
							$	$	$	$	$	$	$	$	$	$	$	$	$	$		$	$	$		
Beverly & Danvers	1	49,197	2.5	3.2	4.4	2	6,400	700	1,200	....	900	500	9,700	6,312	.1283	.0506	1,470	5,441	.1106	.0436	86.2	800	.0163	.0065	2.6	..
Newtonville & Watertown	2	57,949	3.1	3.0	3.1	4	17,500	3,700	*a*	....	500	400	22,100	8,096	.1397	.0457	2,657	8,530	.1472	.0482	105.4	*d* 756	*d*.0130	*d*.0043	..	..
Mystic Valley	3	58,121	3.2	3.3	3.3	3	12,700	2,600	1,900	....	....	800	18,000	9,691	.1667	.0514	2,991	8,179	.1407	.0434	84.4	1,051	.0181	.0056	1.8	..
Milford & Hopedale	4	70,830	3.4	2.4	2.4	5	13,800	1,800	3,800	26,900	4,500	200	51,000	12,942	.1827	.0538	5,676	6,425	.0907	.0267	49.7	5,538	.0782	.0230	4.5	5.0
Woburn & Reading	5	74,306	3.0	5.2	6.0	5	10,100	2,600	1,900	....	1,200	500	16,300	11,022	.1483	.0498	1,940	10,407	.1400	.0470	94.4	*d* 320	*d*.0043	*d*.0014	..	..
Framingham Union	6	87,106	4.9	7.4	7.4	19	11,700	3,000	2,500	....	1,500	....	18,700	19,936	.2289	.0470	2,884	13,832	.1588	.0326	69.4	5,714	.0656	.0135	4.1	..
Wellesley & Boston	7	95,575	2.9	5.2	5.2	10	9,300	1,100	3,200	....	....	300	13,900	13,312	.1393	.0487	2,679	9,615	.1006	.0352	72.2	3,073	.0322	.0113	4.2	7.0
Hanover	8	106,730	2.5	5.4	6.8	8	5,600	2,200	2,900	....	700	300	11,700	13,455	.1261	.0495	2,077	14,591	.1367	.0537	108.4	*d* 1,942	*d*.0182	*d*.0071	..	..
Norfolk Central	9	120,890	2.8	4.7	4.7	11	12,300	3,000	4,500	3,000	1,700	1,400	25,900	16,876	.1396	.0496	3,639	16,535	.1368	.0486	98.0	207	.0017	.0006	0.2	..
Rockport	10	147,553	3.9	7.5	8.3	8	9,900	2,000	2,600	1,800	....	400	16,700	28,539	.1934	.0500	3,497	20,089	.1361	.0352	70 4	6,924	.0469	.0121	5.5	3.0
Reading & Lowell	11	158,415	2.2	12.0	12.0	7	9,900	1,400	1,200	....	....	300	12,800	17,474	.1103	.0505	1,476	17,373	.1097	.0502	99.4	*d* 1,054	*d*.0067	*d*.0030	..	..
North Woburn	12	185,725	3.9	7.6	8.0	15	14,700	5,100	3,700	....	1,500	....	25,000	36,294	.1954	.0499	4,652	27,330	.1471	.0376	75.3	8,409	.0453	.0116	4.4	..
Natick & Cochituate	13	208,461	4.4	11.5	11.5	16	6,100	1,300	2,600	....	800	100	10,900	45,739	.2194	.0504	4,158	36,381	.1745	.0401	79.5	7,739	.0371	.0085	6.2	6.0
Newton & Boston	14	228,043	3.0	10.1	10.1	21	13,400	2,900	7,100	6,000	3,000	500	32,900	44,542	.1953	.0656	4,723	26,292	.1153	.0387	59.0	16,954	.0743	.0250	5.1	3.8
Braintree *b*	15	247,338	3.5	11.6	13.0	12	8,100	1,800	2,700	200	1,100	800	14,700	43,466	.1757	.0506	3,436	30,374	.1228	.0353	69.9	12,986	.0525	.0151	7.6	3.0
South Middlesex	16	254,122	4.1	13.5	13.5	16	8,000	2,300	3,900	3,000	1,200	300	18,700	52,074	.2049	.0503	3,984	31,040	.1221	.0300	59.6	19,391	.0763	.0187	7.7	5.5
Gloucester *c*	17	256,940	4.9	12.0	12.0	25	11,500	3,600	7,000	3,500	2,800	700	29,100	66,398	.2584	.0526	5,902	38,634	.1504	.0306	58.2	25,541	.0994	.0202	7.3	6.0
Milford, Hollist'n & Framingh'm	18	265,370	3.6	18.2	18.7	18	11,100	2,500	2,400	....	300	200	16,500	48,466	.1826	.0504	2,616	34,651	.1307	.0360	71.5	11,545	.0435	.0120	3.9	5.0
Braintree & Weymouth	19	269,732	3.7	12.4	12.6	20	10,000	600	3,200	3,600	1,500	700	19,600	46,687	.1731	.0474	3,930	33,334	.1236	.0338	71.4	10,811	.0401	.0110	4.5	..
West Roxbury & Roslindale	20	285,534	3.7	9.5	9.5	16	20,600	4,500	3,400	1,300	2,000	2,000	33,800	50,940	.1784	.0488	5,904	35,024	.1227	.0336	68.8	15,291	.0536	.0146	4.8	..
Gloucester, Essex & Beverly	21	338,015	3.3	22.9	23.1	23	8,100	3,600	2,400	2,300	700	400	17,500	58,642	.1735	.0523	2,612	37,494	.1110	.0334	63.9	17,709	.0524	.0158	4.4	2.0
Commonwealth Avenue	22	343,744	3.2	11.3	12.8	25	9,200	1,500	4,900	....	3,900	1,200	20,700	54,552	.1587	.0501	4,432	42,800	.1245	.0393	78.5	10,813	.0315	.0099	4.6	..
Hingham *e*	23	350,864	2.8	18.6	18.6	30	11,400	2,100	3,300	2,200	1,400	300	20,700	49,322	.1406	.0504	2,835	45,952	.1310	.0469	93.2	1,802	.0051	.0018	0.5	..
Rockland & Abington	24	352,605	4.2	17.4	18.8	26	7,200	1,100	3,600	800	1,500	400	14,600	74,787	.2121	.0511	4,610	55,554	.1576	.0380	74.3	17,259	.0489	.0118	6.9	9.0
Wakefield & Stoneham	25	363,166	3.2	15.4	16.0	19	9,700	2,600	4,400	5,700	1,100	200	23,700	58,225	.1603	.0501	3,806	34,961	.0963	.0301	60.0	20,583	.0567	.0177	5.6	5.0
Newton Street	26	381,371	4.8	13.2	13.2	34	13,600	3,300	6,900	....	2,400	4,700	30,900	94,072	.2467	.0510	7,608	67,650	.1774	.0367	71.9	24,635	.0646	.0134	6.5	8.0
Norfolk Suburban	27	416,535	4.7	11.7	11.7	29	14,100	3,000	5,100	....	1,100	300	23,600	98,159	.2356	.0502	8,945	73,401	.1762	.0375	74.8	17,288	.0415	.0088	6.3	7.0
Quincy & Boston	28	499,555	4.7	27.4	27.4	43	10,800	1,600	3,400	2,900	2,500	400	21,600	118,395	.2370	.0502	4,451	79,113	.1584	.0335	66.8	35,361	.0708	.0150	6.0	7.0
Brockton	29	1,503,805	4.4	43.4	43.4	117	13,800	1,800	7,600	5,100	3,500	2,700	34,500	332,256	.2210	.0497	8,010	207,155	.1378	.0310	62.4	100,079	.0665	.0150	7.0	6.0
Lynn & Boston	30	5,480,489	5.0	128.1	162.9	519	27,500	2,900	10,500	7,200	3,600	2,300	54,000	1,425,211	.2601	.0520	9,320	818,626	.1494	.0299	57.4	396,387	.0723	.0145	5.7	4.0
West End	31	29,786,936	5.8	293.1	305.1	2,648	21,100	6,700	22,100	12,900	22,400	600	85,800	8,719,032	.2927	.0505	32,697	6,213,709	.2086	.0360	71.3	2,118,167	.0711	.0123	8.4	15.5

a Leases rolling stock. *b* Including Randolph. *c* Including Gloucester and Rockport. *d* Deficiency. *e* Including Hull and Nantasket Electric.

TABLE II.—DETAILED OPERATING STATISTICS OF THIRTY-ONE MASSACHUSETTS PROPERTIES.

	Case Number.	General Expenses.			Repairs of Roadbed and Track.			Repairs Line Construction.			Repairs Cars and Vehicles.			Repairs Electric Car Equipment.			Transportation.	
		Total.	Per Car Mile.	Per Cent to Gross Receipts.	Total.	Per Mile Track. *d*	Per Car Mile.	Total.	Per Mile Line.	Per Car Mile.	Total.	Per Car Owned.	Per Car Mile.	Total.	Per Motor Car Owned.	Per Car Mile.	Wages per Car Mile.	Cost of Electric Power per Car Mile.
Beverly & Danvers	1	$186	$.0038	2.9	$79	$25	$.0016	$1	$...	$.....	$73	$37	$.0015	$46	$23	$.0009	$.0465	$.0400
Newtonville & Watertown	2	958	.0165	11.8	10	3	.....	56	19	.0010	.....	...	.....	13	3	....	.0602	.0382
Mystic Valley	3	1,573	.0271	16.2	397	120	.0068	95	30	.0016	256	85	.0044	316	105	.0054	.0554	.0356
Milford & Hopedale	4	1,019	.0144	7.9	332	138	.0047	111	48	.0016	238	48	.0034	149	30	.0021	.0466	.0119
Woburn & Reading	5	1,647	.0222	14.9	137	26	.0019	87	18	.0012	257	51	.0035	220	44	.0030	.0501	.0369
Framingham Union	6	2,539	.0291	12.7	351	47	.0040	...	...	....	548	29	.0063	....	...	.....	.....	.....
Wellesley & Boston	7	1,166	.0122	8.8	94	18	.0010	28	6	.0003	172	17	.0018	245	25	.0026	.0480	.0301
Hanover	8	2,256	.0211	16.8	155	29	.0015	85	17	.0008	301	38	.0028	190	24	.0018	.0450	.0444
Norfolk Central	9	3,009	.0249	17.8	952	203	.0079	109	24	.0009	71	6	.0006	80	7	.0007	.0546	.0402
Rockport	10	1,457	.0099	5.1	727	97	.0049	229	31	.0016	289	36	.0020	876	110	.0060	.0460	.0500
Reading & Lowell	11	2,262	.0143	12.9	462	39	.0029	112	9	.0007	341	49	.0022	531	76	.0034	.0400	.0402
North Woburn	12	3,071	.0165	8.5	5,059	666	.0272	67	9	.0004	103	7	.0006	2,018	183	.0109	.0451	.0355
Natick & Cochituate	13	3,299	.0160	7.2	7,141	621	.0343	.....	...	.....	3,859	241	.0185	4,942	309	.0237	.0495	.0320
Newton & Boston	14	4,162	.0183	9.3	1,090	108	.0048	174	19	.0007	1,277	61	.0056	2,425	115	.0106	.0703	.....
Braintree *a*	15	2,404	.0097	5.5	2,468	213	.0100	198	18	.0008	3,630*e*	303*e*	.0147*e*	....	...	.....	.0493	.0101
South Middlesex	16	6,227	.0245	12.0	2,139	158	.0084	495	38	.0019	860	54	.0034	1,215	76	.0048	0585	.0174
Gloucester *b*	17	3,593	.0140	5.4	1,531	128	.0060	113	11	.0004	2,195	88	.0085	1,899	76	.0074	0641	.0284
Milford, Holliston & Framingham	18	3,970	.0150	8.2	1,327	73	.0050	444	25	.0017	951	53	.0036	597	33	.0023	.0498	.0437
Braintree & Weymouth	19	4,270	.0158	9.1	722	58	.0027	240	21	0009	2,602	130	.0096	1,122	56	.0042	.0512	.0256
West Roxbury & Roslindale	20	6,669	.0234	13.1	819	86	.0029	115	13	.0004	683	43	.0024	361	23	.0013	.0476	.0399
Gloucester, Essex & Beverly	21	6,519	.0193	11.1	2,311	101	.0068	607	27	.0018	642	28	.0019	1,032	45	.0031	.0448	.0250
Commonwealth Avenue	22	10,179	.0296	18.7	288	25	.0008	186	...	.0005	1,864	75	.0054	627	25	.0018	.0450	.0298
Hingham *c*	23	6,387	.0182	12.9	1,007	...	.0029	310	...	.0009	2,778	93	.0079	911	31	.0026	.0448	.0182
Rockland & Abington	24	6,010	.0170	8.0	789	45	.0023	1,333	82	.0038	2,437	94	.0069	2,316	89	.0066	.0587	.0447
Wakefield & Stoneham	25	7,914	.0218	13.6	2,031	132	.0056	251	17	.0007	1,142	60	.0031	2,667	140	.0073	.0444	.0079
Newton Street	26	14,300	.0375	15.2	9,495	719	.0249	947	76	.0025	3,753	110	.0098	5,628	182	.0147	.0610	.0206
Norfolk Suburban	27	10,603	.0255	10.8	11,520	985	.0277	780	71	.0019	4,043	140	.0097	2,084	72	.0050	.0590	.0380
Quincy & Boston	28	16,374	.0328	13.8	3,961	145	.0079	1,104	42	.0022	9,270*e*	216*e*	.0186*e*	.....	...	.....	.0612	.0174
Brockton	29	19,794	.0132	5.9	41,783	963	.0278	3,781	107	.0025	7,535	64	.0050	9,605	91	.0064	.0543	.0177
Lynn & Boston	30	76,344	.0139	5.4	81,635	512	.0149	15,349	125	.0028	70,628	136	.0129	37,195	81	.0068	.0642	.0180
West End	31	466,171	.0157	5.3	831,412	2,744	.0279	132,659	860	.0044	421,328	159	.0141	177,457	75	.0060	.0900	.0204

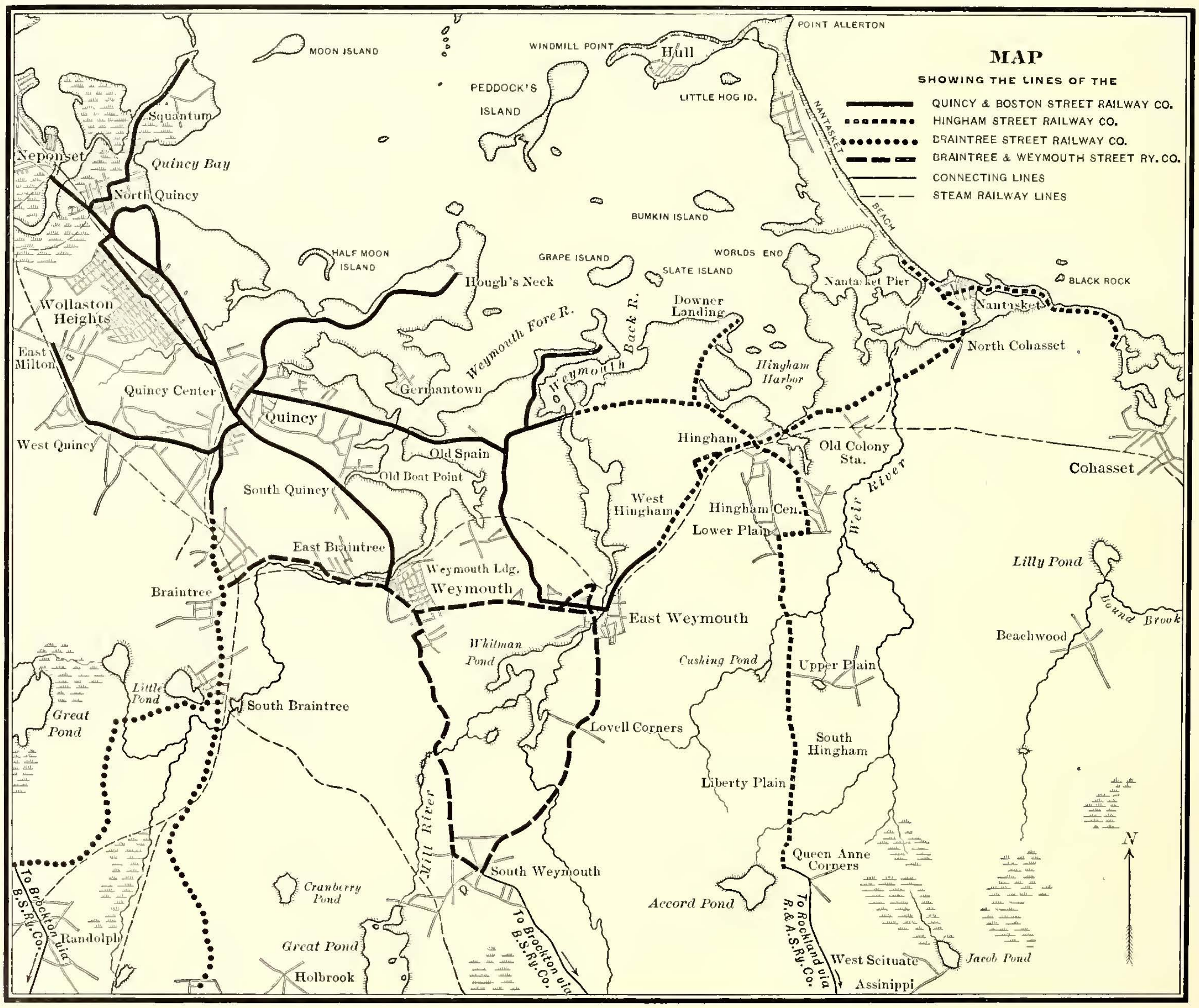
a Including Randolph. *b* Including Gloucester and Rockport. *c* Including Hull and Nantasket Elec. *d* Owned and leased. *e* Including repairs electric car equipment.

mile of track, \$.2142 per car mile and \$.05 per passenger carried. The earnings from operation were \$130,137, equivalent to a return of 7.2 per cent upon the total investment. The total balance sheet surplus of the three companies amounts to \$18,017. The Hanover Street Railway Company showed a deficit from operation amounting to \$1,136, and a total deficit for the year after paying charges on income of \$2,910. Its operations are on too small a scale to promise success in independent operation, but as a feeder to other lines such as the Rockland & Abington, the line would be valuable. The Brockton Street Railway Company paid dividends last year of 6 per cent and the Rockland & Abington paid 9 per cent.

It will be highly interesting to learn what the permanent traffic between Brockton and Taunton will in future be on the two lines connecting them, and how this will be divided between the two, one road possessing a better local traffic and running at higher speed, but for a considerably longer distance. The question as to whether the steam railroad traffic will be cut into by such lines as these is also an important one, and is probably to be answered decidedly in the affirmative. Another experiment of this same character is just being made in the opening of a line from Taunton to Providence by practically the same interests which own the Brockton, Bridgewater & Taunton line. Heavy cars, high speeds, comparatively frequent, and above all *regular*, time intervals between trains can hardly help securing the traffic even at a slight loss of time, but whether in such a section it can be built up to the point of supporting this new mileage and the better service to the public is the real question.

THE QUINCY-HINGHAM GROUP

To the north of the Brockton-Bridgewater system, and, as before stated, connecting it with the Boston system and the shore of Massachusetts Bay, is the Quincy-Hingham system, consisting of four important lines, of which two have been for some years in operation, and the other two, the Braintree and the Braintree & Weymouth, recently built. The district is almost entirely residential and pleasuring in character, though Quincy has extensive granite quarries and some manufacturing interests. Hingham, Hull, Nantasket Beach, Downer Landing and Cohasset are popular summer resorts which attract thousands from Boston and the Brockton district, and special traffic arrangements have been made by which through cars are run from Neponset Bridge over the Quincy and Hingham roads to Nantasket Beach in competition with steam railroad lines running by more circuitous routes. Nothing can be more charming than a ride through this district on the trolley cars, and such trips are increasingly popular with the people of Boston and vicinity.



These four lines operate about seventy miles of track, and serve 49,000 permanent population, exclusive of summer pleasuring travel, or one mile for each 700 inhabitants. There are twenty-five cities and villages in the territory. The Boston Elevated Railway Company runs fifteen cars per hour to Neponset; the Quincy Street Railway Company gives a fifteen-minute service from Neponset to Quincy, Quincy Point and North Weymouth, and a half-hour service to East Weymouth, East Milton and Hough's Neck; the Hingham Street Railway Company gives a fifteen-minute service from Hingham to Nantasket, and a half-hour service elsewhere on its lines; the Braintree Street Railway gives a half-hour service from Quincy to Holbrook (and thence to Brockton over the Brockton Street Railway), and the Braintree & Weymouth Street Railway gives a half-hour service on its lines.

The fares from Neponset are as follows: To Quincy, five cents; to Braintree and North Weymouth, eight cents; to Hingham, East Weymouth, Randolph and Holbrook, thirteen cents; to South Weymouth and Nantasket, eighteen cents, and to Queen Anne's Corner, twenty-three cents.

The comparative density of traffic on these four lines is as follows:

	Gross Receipts Per Mile Track.	Gross Receipts Per Car Mile.
Quincy & Boston	$4,451	$.2370
Braintree & Weymouth	3,930	.1731
Braintree	3,747	.1758
Hingham	2,652	.1406

The Quincy & Boston earned $35,360 for interest and dividends in its last financial year, while the Hingham, which includes the Hull and Nantasket roads, leased to it, showed a combined surplus over operating expenses of but $3,479. The Braintree, which includes the Randolph Street Railway leased to it, earned $12,986 above operating expenses, and the Braintree & Weymouth earned $10,811.

Taken as a whole, these four properties cost $19,800 per mile of track, of which $10,900 per mile was for roadbed, $1,600 for overhead construction, $3,200 for rolling stock, $2,400 for power station and equipment, and $1,800 for other land and buildings. The cost of equipment exclusive of roadbed and overhead construction was $4,800 per car. The four systems carried 3.8 passengers per car mile and earned $257,870 gross, equivalent to $5.26 per capita served; $3,700 per mile of track, $.1887 per car mile and $.0498 per passenger carried. The combined earnings from operation were $62,636, equivalent to a return of 4.5 per cent on the total investment. Seven per cent dividends were paid by the Quincy & Boston, 3 per cent by the Braintree and 6 per cent by the Randolph (rental from Braintree).

OPERATING EXPENSES

In the table, page 489, are found the principal operating expenses of the thirty-one systems heretofore described, which have been in operation for a year or more. These figures will repay careful study, as, properly interpreted, they contain the essence of electric railway practice in this district, and indicate the comparative policies of the different managements with respect to details of operation. A few words of suggestion may help to bring out these points more clearly, but no attempt will here be made to enter into a careful analysis of the figures, as they are practically self-explanatory, so far as explanation is possible.

General Expenses.—In Massachusetts this item covers "salaries of general officers and clerks," "general office expenses and supplies," "legal expenses," "insurance" and "other general expenses" (damages are included in transportation expenses). General expenses are to a large extent a function of gross receipts, *i. e.*, with systems having equal gross receipts the percentages of general expenses should be approximately the same, or, if not so, inquiry should be instituted to find out the reason. With small systems, however, much larger percentages and much greater fluctuations in practice are reasonably to be expected, as the proportionate expense of managing a small property is necessarily greater than with a larger one, and an official who owns a large interest in a property may often be willing to forego a salary, taking his profits through stock dividends.

Repairs of Roadbed and Track.—This item follows no rule or reason, and, in the absence of the most careful and detailed explanation, is worthless for comparison of one road with another. On the other hand, the item may be small because of lack of sufficient and much needed repairs, or it may be small because of exceptionally good roadbed. It may be large in any one year through the charging to this account of a considerable length of new track replacing old, or because of an honest attempt to provide for depreciation. In other ways there may be differences in practice between roads, and from year to year on the same road, bringing about great apparent confusion in results. Much better comparisons can, of course, be made by taking the averages of five or ten year periods, but these are rarely possible in electric railroading on account of the comparatively recent date at which electric equipment has taken place. Moreover, even this would not tell very much about comparative policies of maintaining track and roadbed. The figures given in the table,

NANTASKET BEACH

therefore, may be considered of no value whatever, except for the slight interest coming from seeing the wide differences found in practice.

Repairs of Line Construction.—This item is of much more value than that of maintenance of roadbed and tracks because, as a rule, repairs of line construction are made necessary immediately upon the development of trouble. Nevertheless, without an accurate knowledge of conditions and inspection of the structure correct judgments cannot possibly be formed.

Repairs of Cars and Vehicles.—These figures per car owned and per car mile are of considerable interest and some value. There is no reason why the amount of money spent by the different companies in keeping up their equipment should not be approximately the same, even with considerable difference in magnitude of operations, though, of course, it makes much difference how well built a car is when new. When we see, however, an old road, which is spending but fifteen or twenty dollars a year per car for maintenance, we know that the cars cannot even be properly painted and varnished, much less kept in good repair, and if they are paying two hundred dollars or more it is well to find out why. Improper charges to "construction" accounts may probably be responsible for small figures.

Repairs of Electrical Equipment.—This item covers repairs of car equipment only, not of power station, distribution system, etc., the former being charged to "electric power." These figures per motor car owned and per car mile are quite valuable, for here again, the electric equipment must be repaired as soon as trouble is developed, and cannot be allowed to go along indefinitely, as can, for example, track and roadbed. In the early days of electric traction repairs of electrical car equipment were very large, oftentimes amounting to from $.015 to $.025 per car mile.

TABLE III.—COST OF ELECTRIC POWER GENERATION

Group.	Car Mileage.	Cost Electric Power.	
		Total.	Per Car Mile.
Natick & Cochituate (hired)	208,461	$6,664	$.0320
South Middlesex	254,122	4,423	.0173
Braintree & Weymouth	269,732	6,897	.0256
Milford, Holliston & Framingham	336,200	12,429	.0370
Gloucester, Essex & Beverly	338,015	8,456	.0250
Hingham	350,864	6,813	.0194
Newton Street Railway (hired)	381,371	7,855	.0206
Gloucester (two companies)	404,493	14,658	.0362
Rockland & Abington (two comp'ies)	459,335	20,492	.0446
Wakefield & Stoneham (four cos.)	654,008	14,057	.0215
Newton (four companies)	725,311	15,319	.0211
Quincy & Boston (two companies)	746,893	11,218	.0150
Dedham-Hyde Park (three cos., hired)	822,959	32,053	.0389
Brockton	1,503,805	26,611	.0177
Lynn & Boston (three companies)	5,715,411	107,351	.0188
Boston Elevated	29,786,936	608,048	.0204

To-day, with the modern motors, they are much smaller, as will be seen by this table, and it is probable that pure repairs, exclusive of general depreciation, ought not to exceed, with the best motors of to-day, $.005 per car mile. The car mileage figure is much better than the figure per car owned, as speed naturally makes a great difference in repairs and depreciation. Moreover, what is expected from motors is car mileage, not time service, *i. e.*, if a motor moves its car 250,000 miles it has just as surely fulfilled its mission if that distance be accomplished in five years, as if in eight or ten.

Electric Power.—The figures in this table for electric power per car mile mean simply what electric power is costing each road, irrespective of whether that company generates its power itself or purchases it elsewhere. It is not a test of economy in generation. In several cases a power station for a group of companies is owned by one of them, which sells power to the others at its own price—a price sometimes regulated by cost of production and sometimes intended to yield a greater or less profit, perhaps even a loss. By the Massachusetts system of street railway bookkeeping all amounts received by any company for sale of power must be credited on its books to its total cost of power generation, and does not appear in "other income," consequently the entire cost of power generation for a group of roads may be obtained by adding together the "cost of electric power" of all the separate roads and dividing by the total mileage of the cars moved from that power station. As this figure of economy in power generation is interesting Table III. has been prepared. The total cost of electric power includes fuel and water and incidental expenses at power station; and repairs and renewals of steam and electric plant, and power station buildings. It does not include, of course, interest on power station investment.

Transportation Wages per Car Mile.—This is an extremely valuable figure, but the causes of variations between the practice of different roads may be many. The one having the greatest effect is, of course, schedule speed of cars, for if the wages per car hour of a motorman and conductor on a car are divided by ten or twelve (miles) instead of eight, the difference is material. Another reason for differences, too, is found, of course, in the varying rates of wages paid, and to the fact that lower wages and higher speeds are usually found in the smaller towns in country districts, particularly on interurban roads, is due the small total operating expenses per car mile found on many of such systems as compared with the larger city properties.

GENERAL RESUME

In the accompanying table are found the principal financial and operating characteristics of the nine different groups of railways in this Massachusetts metropolitan district, brought together here for purposes of more direct comparison and reference.

TABLE IV.—GENERAL RESUME OF INVESTMENT AND OPERATING STATISTICS BY GROUPS

	Population Served.	Cost of Construction Per Mile Track.						Cost of Equipment per Car Owned.	Passengers per Car Mile.	Gross Receipts.					Earnings from Operation.	
		Roadbed.	Overhead Construction.	Rolling Stock.	Power Station.	Land and Buildings.	Total.			Total.	Per Capita Served.	Per Mile Track.	Per Car Mile.	Per Passenger.	Total.	PerCent. Total Investment.
		$	$	$	$	$	$	$		$	$	$	$	$	$	
Boston Elevated Ry.	788,000	24,700	7,700	25,100	14,700	25,500	97,700	6,400	5.7	8,719,032	11.06	56,700	.2927	0.505	2,118,167	8.4
Lynn & Boston Group	319,000	28,100	2,400	9,300	5,900	3,300	49,000	5,300	5.0	1,431,936	4.49	11,500	.2610	0.520	396,387	5.7
Gloucester Group.	54,000	9,800	3,300	3,700	2,600	1,200	20,600	5,600	4.0	153,579	2.80	3,600	.2069	.0520	50,174	5.7
Wakefield-Stoneham Grp.	81,000	11,200	2,700	2,900	2,000	800	19,600	5,100	3.2	132,706	1.64	3,100	.1580	.0501	28,668	3.4
Newton Group	53,000	13,600	2,400	5,300	1,400	2,400	25,100	4,300	3.7	214,574	4.05	4,800	.1939	.0528	54,720	4.9
Framingham Group	36,000	9,500	2,200	2,900	2,000	973	17,500	4,200	4.0	179,157	4.98	3,300	.2023	.0502	50,029	5.3
Dedham Group	60,000	18,000	3,700	4,300	600	1,500	28,100	3,000	4.3	149,090	2.70	7,000	.2124	.0497	32,579	5.5
Brockton-Bridg'water Gp.	79,000	13,300	1,700	6,100	3,600	2,700	27,400	5,400	4.3	420,498	6.05	6,400	.2142	.0500	130,137	7.2
Quincy-Hingham Group	49,000	10,900	1,600	3,200	2,400	1,800	19,800	4,800	3.8	257,870	5.26	3,700	.1887	.0498	62,636	4.5

As before stated, Massachusetts is far in advance of most of the other American States in methods of preventing over-capitalization or undue expansion of construction costs, and the foregoing figures and comparisons are, therefore, among the truest measures of value of both construction costs and earning power which can be found for street railways in America. The large differences in costs per mile of track are due to many entirely reasonable causes, among them being change from old horse railway road and equipment to the new electric standards; cost of bridge work and important engineering construction in the principal cities; and the cost of complicated track special work, curves, crossings, turnouts, etc., in the larger systems.

THE BOSTON SUBWAY

When the Boston Transit Commission settled down to work soon after its appointment by the Governor in 1894, it found itself charged with the heavy responsibility of relieving the traffic congestion in the business district of the city of Boston. It had the benefit of important preliminary investigations of the general subject made by other commissions between 1891 and 1894, as a result of which the difficult situation at Causeway Street, due to the entrance of a number of railroads at four different stations, was being improved by the construction of a Union Station; and previous commissions had recommended, also, the building of an elevated railway on the east side and a subway along the line of Tremont Street.

The legislative act establishing the Boston Transit Commission authorized, but did not require it to build a subway or subways between Pleasant Street on the south, and Causeway Street on the north, with a branch to Park Square, or to any outlet in that vicinity; authorized it to build a tunnel under Beacon Hill; authorized and required it to build a tunnel from the vicinity of Scollay Square to East Boston; and required it to construct a bridge over the Charles River at whatever cost might be necessary. It will be seen that great discretionary power was vested in the commission, and that its responsibilities were heavy. The limit of expenditure for the subway fixed by the act was $7,000,000.

SUBWAY STATION AT SCOLLAY SQUARE

The commission attacked the problem with great energy. A large amount of preliminary engineering work was, of course, essential, and may be classified as follows:

1. Surface surveys were made locating the buildings, vaults under sidewalks, manholes, poles, surface tracks and all other surface objects along the proposed route of the subway.

2. Sub-surface surveys were made by borings and by excavations or tunnels. Eighty-five borings were made along the line of the subway at intervals of from 25 ft. to 200 ft., showing the precise character of the ground to be excavated in each portion of the route. Excavations were made in nearly every cellar along the route in order to determine exactly the character and dimensions of the foundations, and other tunnels and excavations were carried under the streets at certain points to locate the pipes, sewers, conduits and other sub-surface obstructions. As a result of this work complete underground maps and cross-sections of the streets were obtained.

3. Detailed studies were made with regard to the methods and cost of caring for and making disposition of such pipes, sewers and conduits as might be interfered with in the construction of the subway.

4. Studies and estimates were made of various methods of construction involving many matters of detail with reference to materials, dimensions, etc.

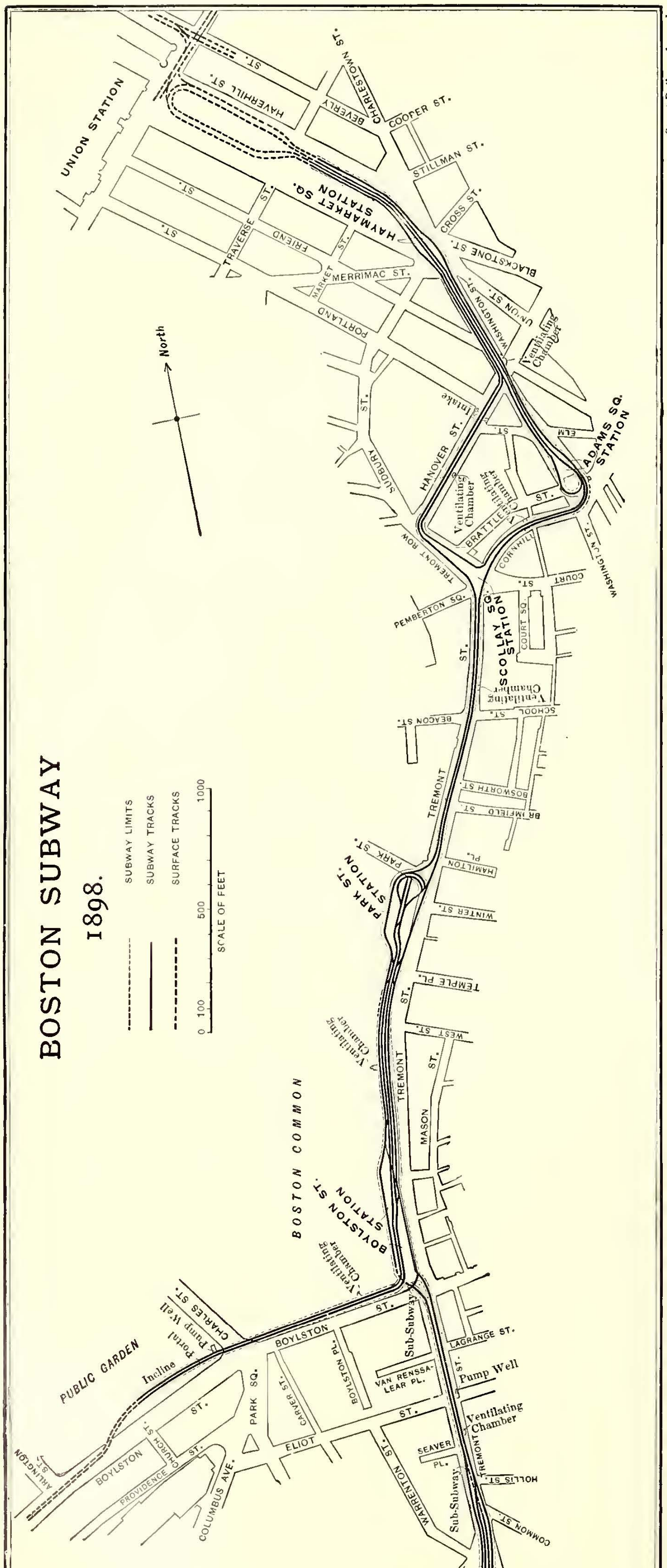
These initial investigations led the commission to the final conclusion that the subway presented no insurmountable engineering difficulties; that it could be constructed within the cost allowed by the act; that it would render possible a large increase of traffic at a higher rate of speed; that by reason of its capacity for traffic and the economy of railway operations within it, it would reasonably command a rental sufficient to meet the interest on its cost and the sinking fund requirements; and that, finally, it was the best method of dealing with the transit problem on the Tremont Street route. The commission decided, therefore, to make use of the authority conferred upon it by the act, and to proceed with the work of construction.

TRAFFIC TO BE PROVIDED FOR

In the beginning of its work the commission made most exhaustive investigations into the traffic conditions which the subway was intended to improve. On Dec. 22, 1894, a pleasant Saturday before Christmas, when the traffic and out of Boston would naturally reach enormous proportions, it had a count of cars and passengers on the route of the subway made, by which it appeared that within eighteen hours 79,944 passengers got off and 96,590 passengers got on cars passing. During their passage along the subway route the maximum movement in any one hour at three different points on the route was as follows:

	Park Street Station.	Scollay Square Station.	Union Station.
On outward. .	5 to 6 P.M., 3406	6 to 7 P.M., 1950	10 to 11 A.M., 1613
Off inward. .	8 to 9 A.M., 3450	8 to 9 A.M., 1447	5 to 6 P.M., 1568

At the point on the route where the car traffic is the heaviest, namely, at Tremont Street and Temple Place, 215 north-bound cars and 191 south-bound cars passed



in one hour, and 2613 north-bound cars and 2219 south-bound cars in the day. These figures give a general idea of the traffic to be handled by the subway.

In order to understand the scheme of the subway and of its track arrangement and to form some idea of the remarkable skill and ingenuity displayed by the commission in dealing with the traffic problem, a brief explanation of the conditions in Boston as affecting the use of the subway by street cars is needed. Reference to the map of Boston between pages 478 and 479 will show that street railway lines enter the heart of Boston from the north, west and south. A majority of the passengers probably leave the cars before or upon reaching the natural termini of the lines at the edges of the business section, but no inconsiderable portion wish to continue their journey through the city to other districts or suburbs. Transfers must be avoided, of course, wherever possible, in the interest of both the public and the transportation agencies.

The first step in laying out the trackage plan of the system, upon which, of course, depended the physical conformation of the subway, was, therefore, to provide both termini and through routes within the subway, and to do this with the least possible danger of accidents or obstructions to traffic. It was originally expected by the commission that the subway would be used for cars of the street railway type only, either single or in two-car trains, entering the subway from surface or elevated tracks. Certain decisions regarding the running of elevated railway trains recently made by the Boston Elevated Railway Company have introduced some complications presently to be referred to, but the following explanation is of the trackage plan made by the commission on the basis of electric cars running at moderate speeds in the subway.

The subway terminals for lines entering from the north are at Adams Square and Scollay Square, and the terminal for lines entering from the south is at Park Street Station. These termini have always been the natural ones for surface railway travel.

The Scollay Square and Adams Square lines take the inside tracks at the Union Station, and pass around loops, as shown in the diagram. A switchman is required to divide the Scollay Square from the Adams Square cars. Through cars from north to south take the outside tracks at the Union Station, pass on the outside of the "island" platforms, and have an unobstructed run without switching till they reach the Boylston Street Station, when a switch determines whether they will continue on the Tremont Street line or go to the Public Garden exit on Boylston Street. If the former, they pass through a sub-subway under the Boylston Street tracks, and if for Shawmut Avenue through another sub-subway under the Tremont Street tracks, so that grade crossings everywhere are avoided.

The cars on lines terminating at Park Street Station may enter from Boylston Street, Shawmut Avenue and Tremont Street, and by means of switches at Boylston Street are transferred to the inner tracks, which are completed by the Park Street loop. North-bound through cars from south and west pass to the outer tracks by switches at Boylston Street.

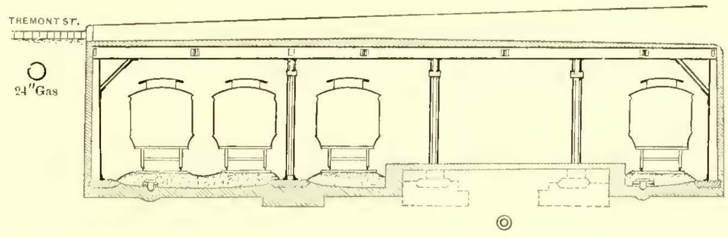
The avoidance of grade crossings and minimizing the switches is one of the most excellent features in the subway plan, and the convenience to the passenger in making any desired combination of lines is another.

The decision of the Boston Elevated Railway Company to run electric trains through the subway at a comparatively high speed makes it advisable, in the opinion of its managers, to devote the two through (outer) tracks in the subway to this character of work, and to confine the ordinary street car travel to the inside tracks. This will make it necessary for passengers to the Union Station reaching the Tremont Street and Shawmut Avenue entrances to the subway to change to the elevated cars and so, also, going from Union Station south of Scollay Square. Boylston Street passengers from the north must change to the elevated cars at Union Station, and to the surface cars again at Park Street or Boylston Street Station.

It is presumed that the saving of time involved in using the faster trains will be a sufficient compensation for the additional trouble in transferring, but the simplicity of the original plan of the Transit Commission is certainly much in its favor, and the compensation must be made clearly evident to the people of Boston if the new plan is to meet with favor.

PLATFORMS AND STATIONS

A great many studies of platform arrangements (twenty-three of the Boylston Street Station alone) have been made at various times by the commission's engineers. The officials of the West End Street Railway Company, which was from the first recognized as the probable lessee of the subway, were consulted before final selection of designs, and many of the latter were also submitted to experts for criticism and suggestions. It was early decided that the two easterly tracks of the four-track subway should be for north-bound cars, and should have island platforms between them; that the two westerly tracks should be for south-bound cars, and should also have island platforms between them; that the platforms should be as wide and as long as the law, and due regard for the preservation of trees on the Common, permitted; that the stairways on the Common should be fifteen feet wide; that the distance between the top of the track and the roof of the subway should be 14 ft., and that the platforms should be placed as near the surface of the ground as practicable, in order that the stairways should be short. It was pro-



CROSS SECTION AT C.-D.
LOOKING SOUTH

vided in the contract drawings that the passenger platforms of the stations should be at the level of the track. This would enable every portion of the edge of the platform, whether straight or curved, to be used by the cars in receiving and discharging passengers. At a later time, after a conference with railway officials, it was decided to make the platforms about a foot higher than the rails, although this would result in throwing out of use a portion of the edge of the platform where the curvature was considerable. The requirements of wide platforms and wide stairways, combined with the legal and other limitations, involved much curvature of tracks, and the position of the platforms near the surface of the ground taken in connection with the sub-subway, for the avoidance of grade crossings, required steep grades in several places. These grades are exceeded in many instances, however, on electric surface railways, and no difficulty has been, or is expected to be, experienced on them.

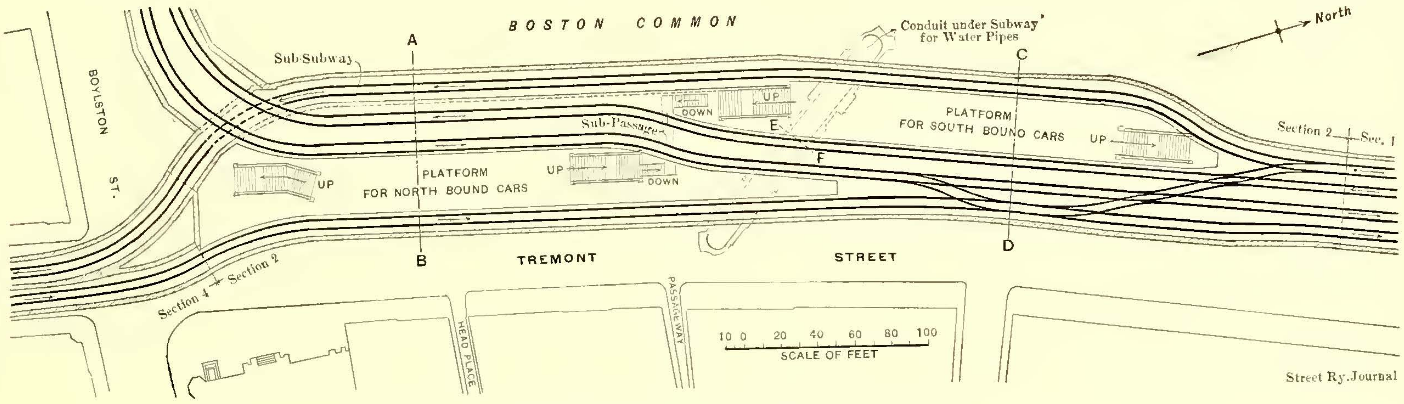
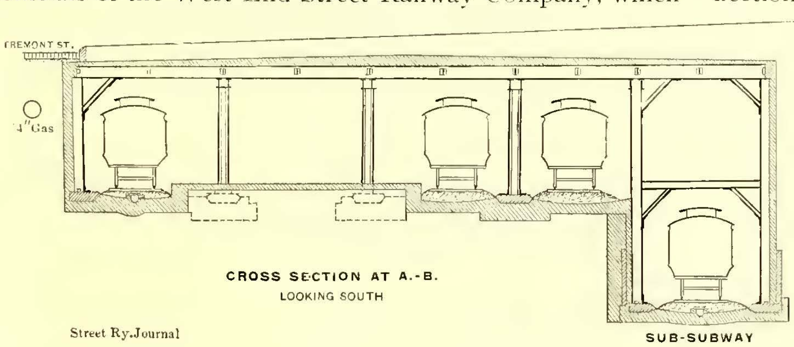


FIG. 1.—PLAN OF BOYLSTON STREET STATION



CROSS SECTION AT A.-B.
LOOKING SOUTH

The final station plans decided upon are shown in Figs. 1 to 5, and in the accompanying general views of the station interiors. The capacity of the platforms, while not expected to be such as to forever prevent overcrowding on special days, when several times the normal pressure may be thrown upon them, is nevertheless far in excess of the usual requirements, as shown by the careful and repeated counting of the street car passengers on present surface routes along the subway. As before intimated, the platform arrangement is such that the regular patrons of the subway will soon come to know the platform where their own particular car may be found, while the difficulties to strangers are likewise reduced to a minimum.

The sides of the subway near the stations are lined with white enameled brick. The stairways are covered with buildings of classic if somewhat stolid design, and with ample provision for light. There are eight of these station coverings on the Common, and one each in Scollay Square, in Adams Square and in Haymarket Square.

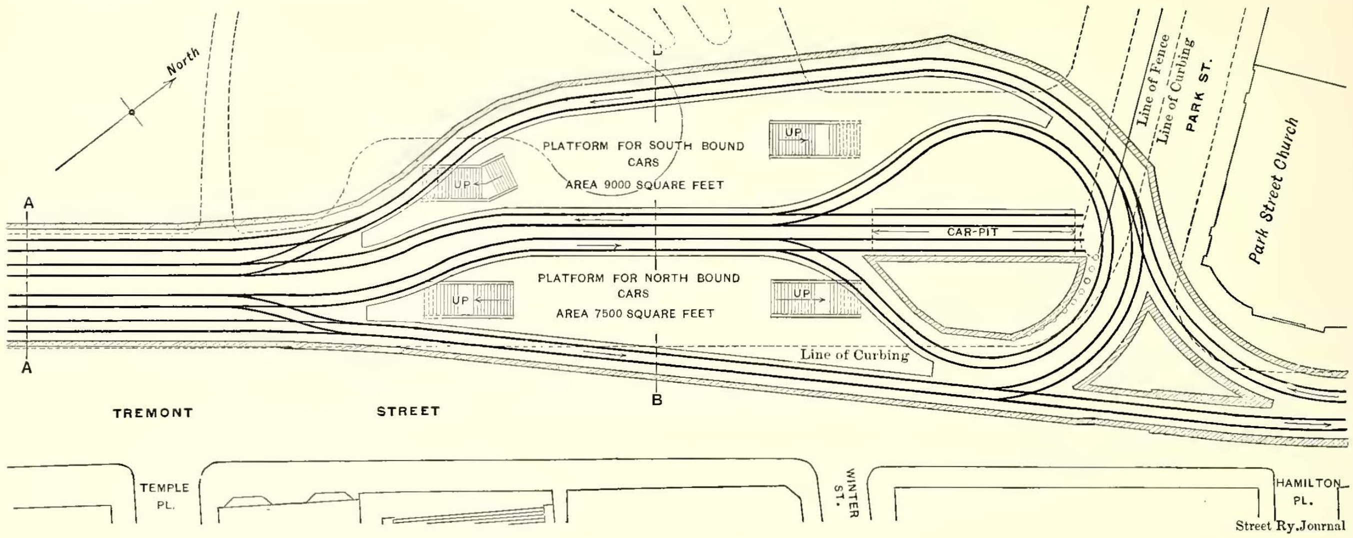
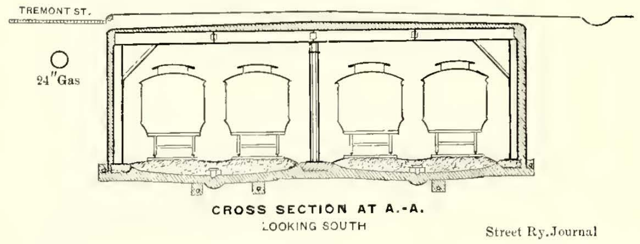
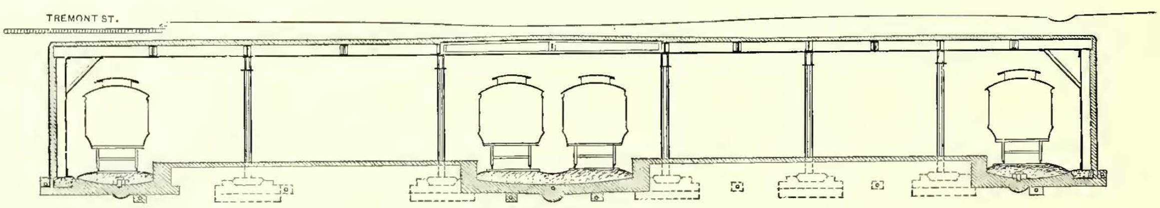


FIG. 2.—PLAN OF PARK STREET STATION



CROSS SECTION AT A.-A.
LOOKING SOUTH



CROSS SECTION AT B.-B.
LOOKING SOUTH

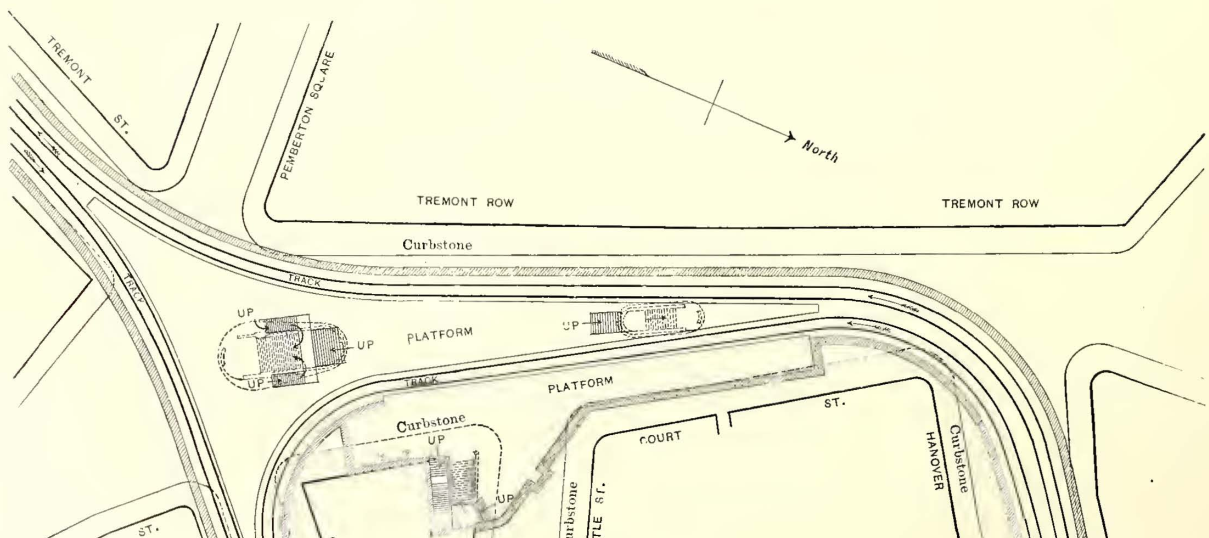


FIG. 3.—PLAN OF SCOLLAY SQUARE STATION

CONSTRUCTION AND EQUIPMENT

An excellent idea of the subway throughout its entire length (as at present open) may be obtained from the accompanying engravings. It will be seen that two types of construction have been adopted, one consisting of steel I beams imbedded in concrete, supporting a roof of transverse steel beams or girders with brick and concrete arches between them. The standard height in this construction is 14 ft. clear above the top of the rail, the width for two tracks 24 ft. and for four tracks 48 ft. The four-track subway has a line of steel posts along the center. The top of the rail is about 17 ft. below the surface of the street, and the station platforms about 16 ft. The second form of construction consists of masonry side walls and a masonry roof with an axis parallel to that of the subway. This last form is used where the tunnel can be placed at a sufficient depth below the surface of the ground to provide for necessary strength and stability, and where digging for sewers will not cause it to be injured.

Provision for the drainage of whatever water may find its way into the subway, which, however, is, and will be, small in amount, is made by drains laid in the ballast and leading to the lowest points, where pumps operated by electric motors are placed. Dryness in the subway is almost perfectly secured by the use of a concrete invert or bottom, and by covering the entire top and sides of the subway with a waterproof coating. Special precautions have also been taken in wet places to prevent any percolation of water through the walls of the subway.

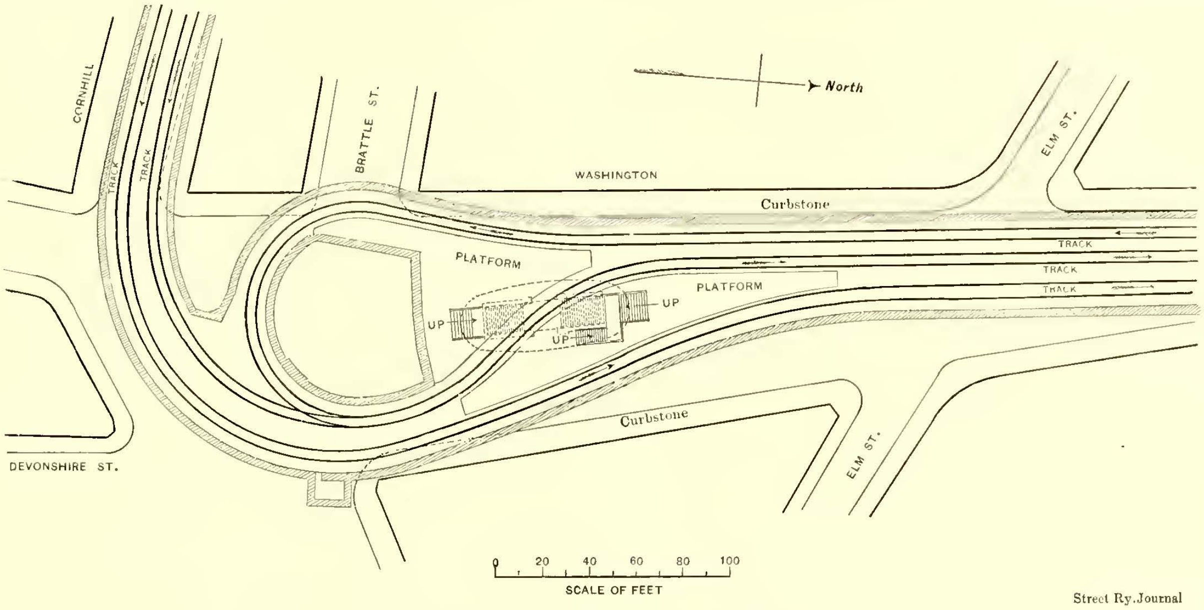


FIG. 4.—PLAN OF ADAMS SQUARE STATION

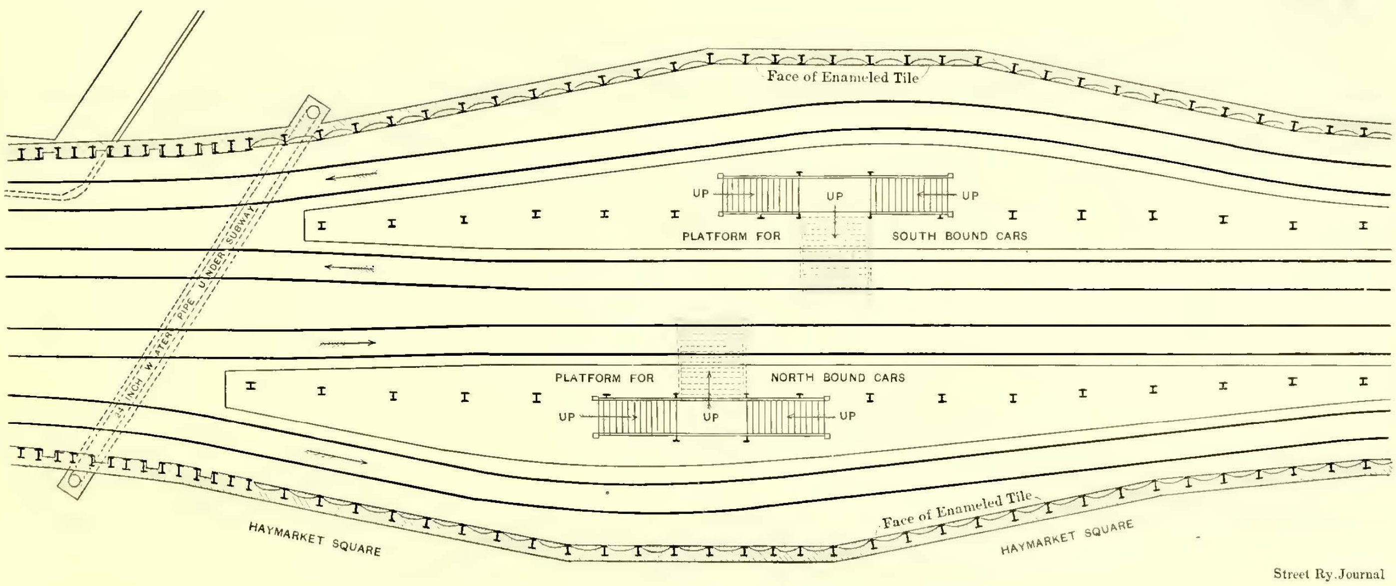


FIG. 5.—PLAN OF HAYMARKET SQUARE STATION

The pump chamber in the Public Garden is nearly opposite the lowest place in the immediate vicinity. The chamber is 9 ft. 11 ins. wide x 10 ft. 8 ins. long. The side walls are similar to those of the subway. In the lower part of the chamber is a well, the bottom of which is about $4\frac{1}{2}$ ft. below the lowest part of the subway. This is connected by 15-in. pipe to the channel drain laid along the center of the subway invert. The side walls and bottom of the well are made of Portland cement, with an 8-in. lining of brick masonry. The water pumped from this well by the electric pumps is discharged into the Church Street sewer.

The plans for ventilating the tunnel are, of course, radically different from and on a far smaller scale than those required for such subways as are found in London, Glasgow and elsewhere where steam locomotives are to be used. It is computed that one of the New York elevated railway locomotives vitiates the air as much as 25,000 people, while an ordinary steam railroad engine vitiates it as much as 87,000 people. It is obviously, therefore, far easier to secure pure air by artificial ventilation in a subway operated and lighted by electricity. Suction fans are used between the stations to exhaust the air, the fresh air being drawn in at the stations, and circulating in each direction to the ventilating fans, whence it passes through special openings at the side of the subway to the street above.

The subway is lighted by electric arc and incandescent lamps, the current for which is derived from the trolley wires, though connections are also made to the mains of the Boston Edison Company, so that there shall always be a source of supply in reserve. The actual work of carrying on the construction of the subway has been most ingeniously laid out to interfere as little as possible with public traffic and convenience. It is impossible, of course, within the present limits to describe the engineering difficulties met with and overcome during the construction of the subway. A description of the "slice method" used in the excavation will be of interest, however, and the following extract from the specifications for section 4 is copied verbatim:

"Trenches about 12 ft. wide shall be excavated across the street to as great a distance and depth as is necessary for the construction of the subway. The top of this excavation shall be bridged by strong beams and timbering, whose upper surface is flush with the surface of the street. (These beams usually consist of hard pine 10 ins. x 8 ins. to 12 ins., 20 ft. long, placed side by side lengthwise of the street. Two or more 6-in. I beams are used for supporting each rail of the street railway. The ties of the railway are usually under these beams and fastened to them with bolts. The surface of the beams are covered with plank, precisely flush with the paving of the street.) These beams shall be used to support the railway track as well as the ordinary traffic. Portions of the bridging can be removed day and night. In each trench a small portion, or *slice*, of the subway shall be constructed. Each slice of the subway thus built is to be properly joined in due time to the contiguous slices. The contractor shall at all times have as many slice-trenches in process of excavation, in process of being filled with masonry, and in process of being backfilled with earth above the completed masonry, as is necessary for the even and steady progress of the work toward completion at the time named in the contract."

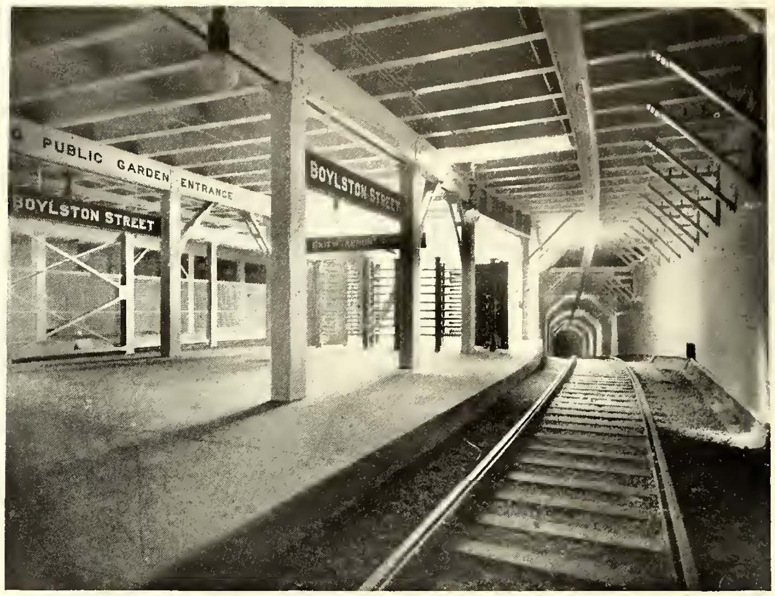
This method did not disturb the street railway tracks at all, and left the whole surface of the street free in the day-

PARK STREET STATION

time for normal traffic. In Tremont Street a double track railway service was constantly maintained during the entire process of construction, some of the cars weighing nearly eighteen tons, including passengers.

The Public Garden incline is an open avenue descending from the surface of the ground to the subway portal, a distance of 318 ft., in which the descent is about 17 ft., or 5 per cent. It has granite side walls, back of which is concrete masonry. All the deeper portion near the subway is on a pile foundation. Its invert is of concrete, also resting on a pile foundation. The total number of piles in the foundation of the incline is 1267, and their average length is about 29 ft.

The excavation in the Public Gardens was through ash,



BOYLSTON STREET STATION SHOWING ENTRANCE TO SUB-SUBWAY

sand, gravel, oyster shell filling and fibrous peat, the latter being the composition of the salt marsh on which the entire Public Garden was built, and many square miles of which are to be found about the city. Near Charles Street the excavation was through hard clay, and in the Boylston Street mall of the Common the excavation was through gravel for about 12 ft. down, and below that through sand. For the four-track subway in the Tremont Street mall, the excavation was through loam, gravel and oyster shells through the first three feet from the surface, and then mostly sand.

The method of carrying on the excavation was as follows: for about the first 10 ft. in depth on the Public Garden work the material was loaded into carts and hauled out at one end of the trench. After this depth was reached four derricks were erected along the side of the trench, their booms covering the whole work for a distance of 42.5 ft. The earth was shoveled into skips, lifted to the surface and dumped into carts. The stones in the retaining walls, the timber, the piles and the pile driver were handled with these derricks.

Much of the surplus earth excavated from the subway was used in regrading parts of the Public Garden and the Common, according to plans prepared by the city's landscape architects. The new surface is in some places 6 ft. higher than the old. About 3500 sq. ft. of new paths have been made in the Public Garden, using surface materials from the discontinued paths there and on the Common.

An old burial ground exists in the Boston Common parallel to Boylston Street, but no interments have been made in this ground for nearly sixty years. Through this burying ground the subway had to be built. Anticipating that human remains would be found there, the commission made arrangements to have them properly taken care of and reinterred elsewhere in the ground. In all, the remains of approximately nine hundred bodies were disturbed by the work of excavation.

COST OF CONSTRUCTION

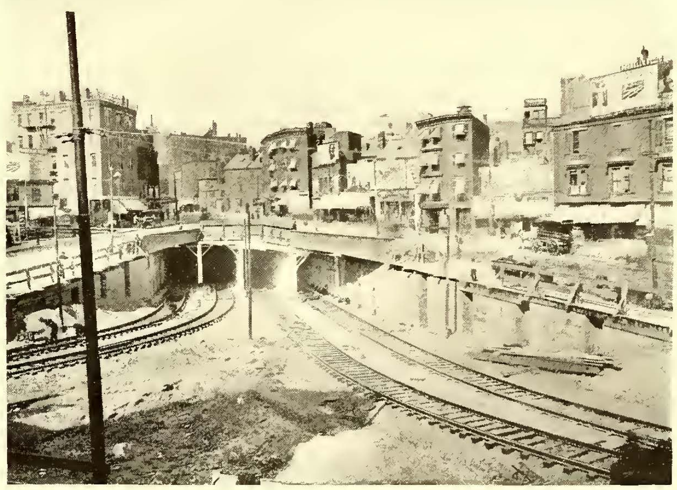
Bids for the construction of section 1, which included that portion of the subway on Boylston Street and on Tremont Street from the corner of Boylston to West, with the exception of Boylston Street station, were opened on March 20, 1895, and March 28 the first spadeful of earth was removed in the Public Garden by the chairman of the commission. On Sept. 1, 1897, the entire southern portion of the subway from Park Street to the Public Garden and to the Tremont Street and Shawmut Avenue exits was opened to the public, and since that time has been used for all street railway lines terminating at Park Street, the through cars to Union Station continuing for the present on Tremont and Washington Streets, as before. Work on the remaining portion to Union Station has been rapidly pushed, and it has just been decided to open this on Sept. 1, 1898, everything being practically completed.

The Transit Commission and the city of Boston were extremely fortunate in being able to purchase the old Boston & Maine Railroad station property extending from Haymarket Square to Union Station, by means of which an excellent exit for the subway is provided at the station, and the streets on the surface are also greatly widened for wagon traffic. The cost of this property was but $750,000, and the amount taken was 124,214 sq. ft. A building will be put up over the incline from which a good rental is expected. In order to get an exit at the southern end of the subway the commission condemned a block of land at the junction of Shawmut Avenue and Tremont Street containing 18,831 sq. ft. The incline to the Boylston Street terminus was made in the Public Gardens, which is city property, and although, owing to the opposition of certain Boston citizens who desired to preserve the Public Gardens intact, some litigation was encountered, the final outcome was favorable to the commission's plan, and no land damages were necessary for this exit. Instead of spending $7,000,000, the amount authorized by the Legislature, it is believed that the commission will have the proud satisfaction of turning over to the city of Boston the completed structure at a cost of but about $5,000,000, or $2,000,000 less than the estimated cost. This is, indeed, a remarkable instance of wisdom and honesty in the administration of an important public trust, and shows the kind of men who are willing to do public business in Massachusetts.

BELLMOUTHS UNDER TREMONT STREET, PASSAGE OF SOUTH-BOUND SHAWMUT AVENUE TRACK UNDER NORTH-BOUND TREMONT STREET TRACK

FOUR-TRACK SUBWAY STEEL WALL CONSTRUCTION

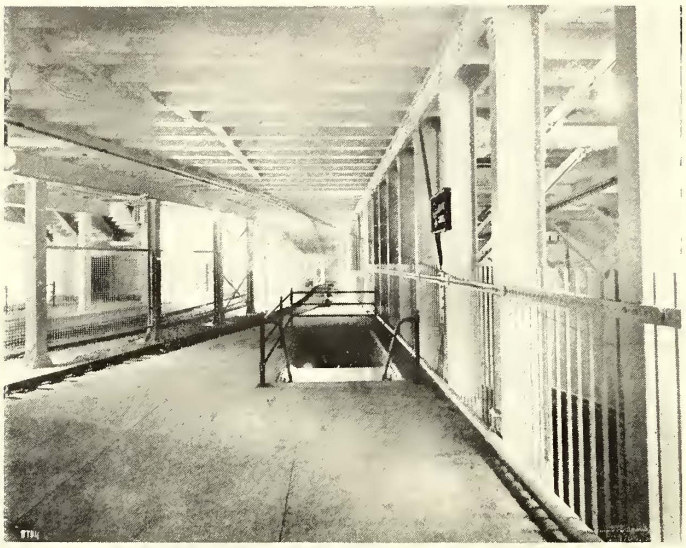
PUBLIC GARDEN INCLINE



SHAWMUT AVENUE INCLINE

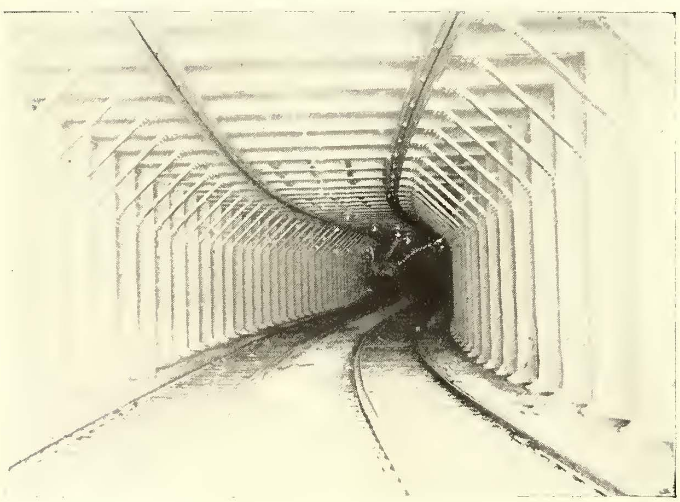
The subway has become immediately and most remarkably popular with the Boston traveling public, and there are few discordant notes in the chorus of praise given to the Boston Transit Commission for the way in which it has carried out its trust. The subway is well lighted throughout the route. It is cool in summer and warm in winter, the temperature being much more equable, of course, than that outside, and the saving of time is indeed remarkable. Under the old conditions it would ordinarily take at least thirteen minutes to go from the present subway entrance on Boylston Street to Park Street. Now, the time is but three minutes, including a stop at the Boylston Street Station. There are no blockades and everything is working in the most satisfactory manner.

The subway has been built with the money of the city of Boston, obtained by the issue of the latter's bonds at



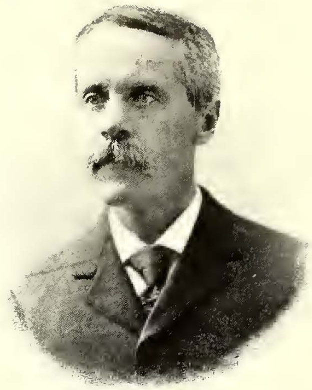
BOYLSTON STREET STATION, ENTRANCE TO SUB-PASSAGE BETWEEN PLATFORMS

the times, and to the amounts requested by the Boston Transit Commission, subject to the limitations of the legislative enactment. The subway, therefore, belongs to the city of Boston. By a contract made on Dec. 7, 1896, the city leased to the West End Street Railway Company, of Boston, the exclusive right to use the subway, then under construction, for a term of twenty years. As com-



SINGLE TRACK SUBWAY SHOWING STEEL WALL CONSTRUCTION

pensation for such use the railway company agreed to pay to the city annually a sum equal to $4\frac{7}{8}$ per cent of the net cost of the subway. A second (alternative) basis for the rental is also specified, however, by means of which the railway company is to pay to the city after it obtains the full use of the subway, an annual amount not less "than a sum computed by charging a toll of five cents for each passage made through the subway by a car not exceeding 25 ft. in body length, and at a proportionally greater rate for each car of greater length, it being understood that any car which enters or passes through the subway or a portion thereof in one direction, and then reverses its direction within the subway and makes a return trip shall be considered as making two passages, but otherwise the passage through the subway shall be considered as a single passage only." United States mail cars and construction and repair cars are not included among the number upon which the company is required to pay tolls. The effect of this double alternative provision for compensation is to make certain that the city shall receive at least a sum sufficient to cover interest upon the borrowed money, and repairs and depreciation, while if the railway company makes an extraordinarily large use of the subway, the



HOWARD A. CARSON
Chief Engineer Boston Transit Commission.

compensation will be made upon the car-toll basis, and the city will receive more. The method of determining the net cost of the subway is set forth at length in the contract. The city assumes the burden of repairs made necessary by the act of God, public enemies, mob riots, the falling or settling of buildings, bursting of pipes outside the subway, explosions of gas or works or excavations carried on or permitted by the city or other public authority, or by the location, maintenance or use of the wires or other apparatus which the city reserves the right to maintain in the

BELLMOUTH AND DOUBLE BARREL SUBWAY SHOWING MASONRY SIDE WALL CONSTRUCTION

subway. All other repairs are to be made by the railway company.

The original members of the Boston Transit Commission were George G. Crocker (chairman), Charles H. Dalton, Thomas J. Gargan, George F. Swain and Albert C. Burrage. Mr. Burrage resigned in November, 1896, and Horace G. Allen was appointed in his place. Howard A. Carson has been the commission's chief engineer, and B. Leighton Beal its secretary since the beginning.

THE PROPOSED NEW ELECTRIC ELEVATED RAILWAY IN BOSTON

For nearly, or quite ten years, the building of an elevated railway in the city of Boston has been discussed by legislators and capitalists as a partial solution to the congestion in the center of the city, but until recently no practical scheme has been devised, although one or two charters have been granted in times past to parties who were unable

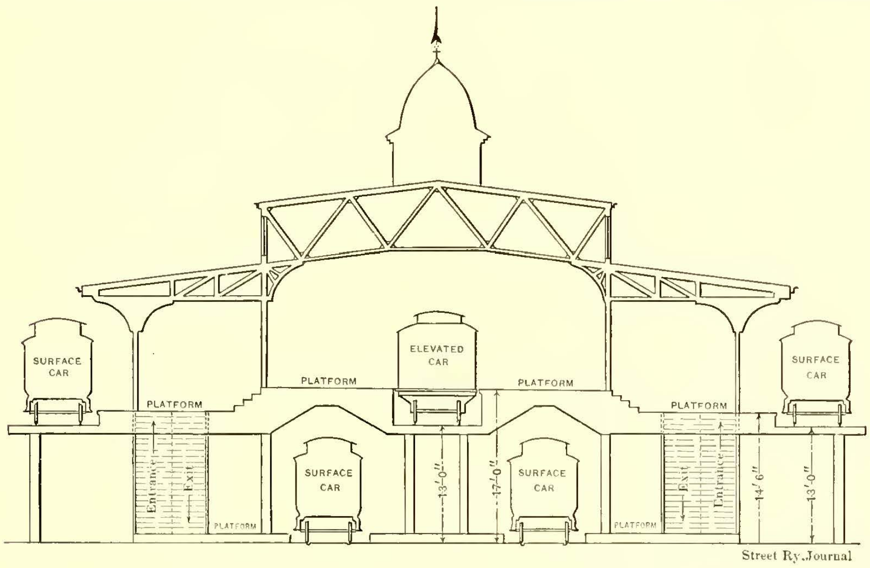


FIG. 1.—CROSS SECTION OF THE ROXBURY TERMINAL STATION

in the end to secure the necessary support. The difficulties of the problem were fourfold: in the first place, it has seemed impossible to lay out a long route to any of the suburbs which would promise sufficient traffic to warrant the investment; in the second place, the narrow and crooked streets of Boston bring about more or less serious engineering difficulties; in the third place, the people of Boston are proud of their city, and would greatly oppose the putting up of an elevated railroad in any of the principal streets; and finally, the possession by the West End Street Railway Company of practically all the available routes through the business center of Boston has had the effect of deterring capital from entering into competition with it, and has practically placed upon the West End Company itself the responsibility for taking the initiative.

The reports of the various Rapid Transit Commissions appointed to study the problem of relieving Boston's congestion have brought about a solution of the vexed question of elevated railways, the building of a subway being the key to the situation. There is no objection to having electric cars travel over elevated structures in certain parts of the city and suburbs, and through the subway on Tremont Street, and the general plan for the relief of the congested district provides for such a railway. The subway being valuable chiefly to the West End Street Railway Company, and having no independent significance, the company became the lessee from the city of the subway for twenty years. This made it necessary either for the West End Company to itself build the elevated railway, or for any new company which might be formed to do so, to acquire possession, by lease or otherwise, of the entire West End System. The latter plan was followed. The Boston Elevated Railway Company was incorporated with a list of stockholders and directors which commanded the instant and unfaltering support of the entire financial community of Boston, and a lease of the West End system was effected upon a basis satisfactory to lessor and lessee, and to the public, whose interests were carefully safeguarded by the Massachusetts Railroad Commission. In due time plans were submitted to the Railroad Commission and now await the latter's consideration.

The new elevated railway system, as at present planned, will be seven miles in length, and will connect Sullivan Square in Charlestown with Dudley Street in Roxbury. It will be double tracked, with eleven stations, including the two terminals. The location of the line is shown in the large map, between pages 478-479. As will be seen, there are two routes in the business portion of the city. Coming from the south they diverge at Castle Square on Washington Street, whence one line passes east through Harrison Avenue and Beach Street to Atlantic Avenue, and thence by Commercial and Causeway Streets to the North Union Station; the other route extends west from the Castle Square junction and enters the Tremont Street subway at Pleasant Street and reaches the northern Union Station by the subway route. From the Union Station the line crosses the Charles River by way of the new Charlestown Bridge, and passes through Main Street to Sullivan Square, Charlestown.

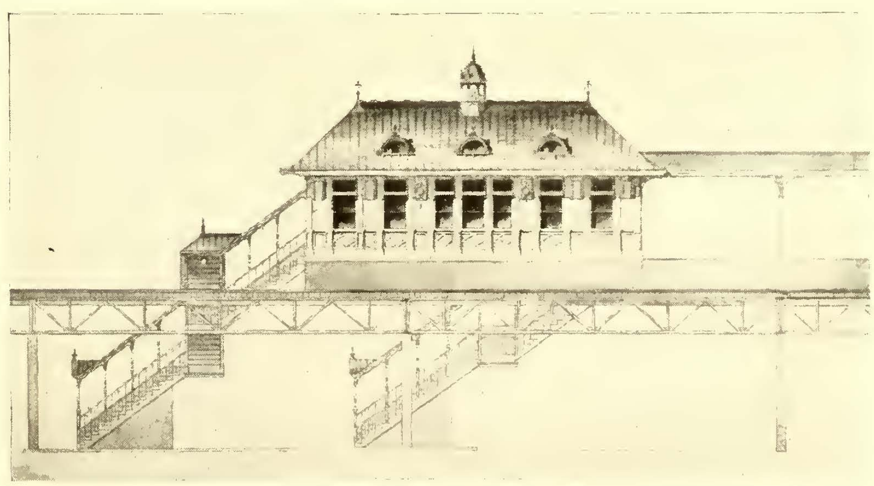


FIG. 2.—DESIGN FOR ELEVATED RAILWAY STATION

The distance between the two termini is 5.02 miles by the subway and 5.20 miles by the Atlantic Avenue route.

The running time between the Roxbury and Charlestown terminals will be twenty-two minutes by both routes, the number of stops being the same in each case. This allows for a train speed of nearly sixteen miles an hour with ten second stops at stations. The schedule time of the surface cars at present between the two termini is fifty minutes, but in practice the time required to cover the distance is

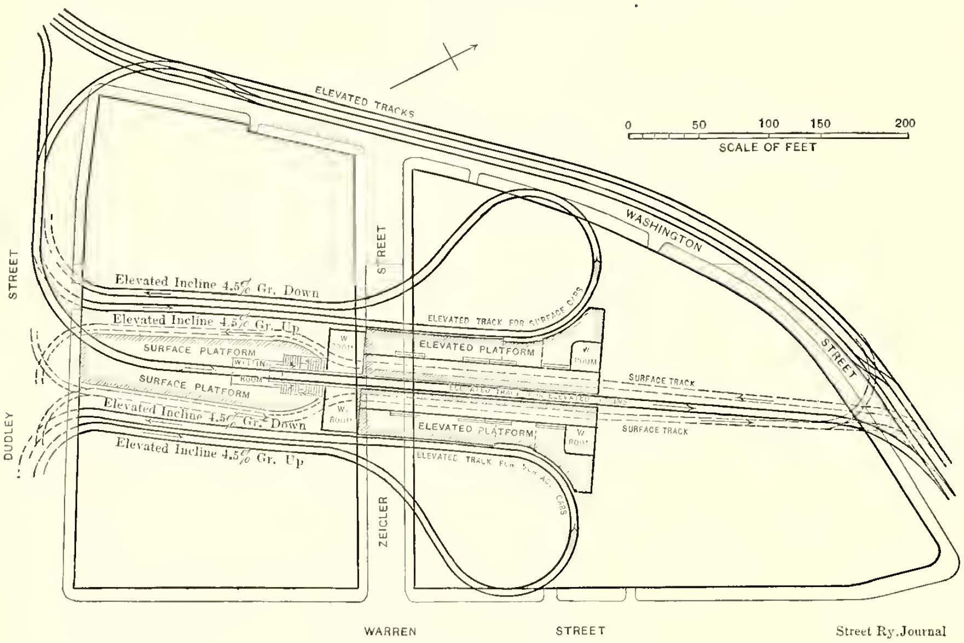


FIG. 3.—ROXBURY TERMINAL

often greater. The maximum speed expected between stations on the elevated structure is from twenty-two to thirty miles an hour. In the subway the elevated trains will make about ten miles an hour with four stops to the mile; whereas the surface cars in the subway will average eight and one-half miles per hour. According to the present plans the surface cars will not pass through the whole of the subway, but will be excluded from the portion between Scollay Square and Park Street, and from Boylston Street south on Tremont.

From the foregoing it will be seen that the elevated system as planned will accomplish a marked saving in running time over the present system, and will relieve greatly the congestion of traffic in the central part of the city where, of course, it is extreme.

As previously stated, the elevated system will be run in conjunction with the surface system, and free transfers will be given between the cars. To facilitate the transfer of passengers at the terminal stations of the elevated system, the tracks of the street cars will be raised at these points to the level of the elevated tracks, as shown in Fig. 1, which is a section of the Roxbury terminal station. This will allow a quick transfer of passengers.

The plan of the Roxbury terminal is shown in Fig. 3, the tracks of the elevated railway being shown by heavy lines, and those used by the surface cars by light lines. Both are arranged in loops, and the elevated trains will discharge and receive passengers from platforms on both sides, the surface car tracks being on the outside of each platform. Surface cars will also run underneath the elevated station, which is connected with the ground by four stairways, two for exit and two for entrance. In this way, it is thought, the time required in transferring will be reduced to a minimum. The Roxbury station will occupy the greater part of two blocks, and will measure 700 ft. x 125 ft.

The Charlestown terminal is somewhat differently arranged, as may be seen from the plan, Fig. 4. Here the elevated cars run in a loop, but the street cars are run on stub tracks, four in number on each side, each side having a capacity for thirteen cars. Below the elevated platforms are other tracks for the surface cars, as in the Roxbury terminal. This station is also on private property, and measures 175 ft. x 150 ft. Both terminal stations are at important junctions, and are distributing points for the surface railway system.

Wherever the width of the street permits, the intermediate elevated railway stations will be located between the two tracks, the entrance and exit in every case being kept separate. They will be of the character shown in Fig. 2, which is a reproduction from the prize drawing for which $1,000 was paid A. W. Longfellow, architect, who submitted the best design in competition. The stations will be of steel frame work, will be sheathed in copper, and will be quite ornamental. In narrow streets the stations will be outside the tracks.

The form of the elevated structure adopted is also shown

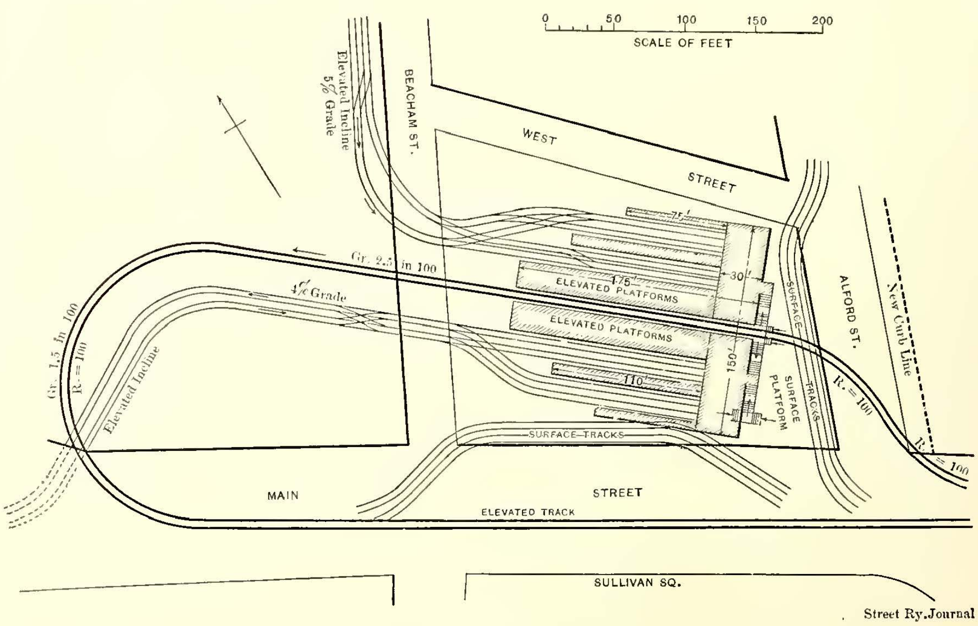


FIG. 4.—CHARLESTOWN TERMINAL

in Fig. 2. It consists of longitudinal and transverse girders supported on a double row of posts. The character of the transverse girders is varied somewhat, depending on the width of the street. Where the latter are narrow the girders are flat and the posts are set on the curb line on either side. In wide streets the posts are set 24 ft. apart and the tracks are carried directly above the posts. Here the transverse girders act as stiffeners only against lateral motion, and are arched. Plate girders are used at one place, on the Charlestown bridge, and the whole structure is designed to be sufficiently strong to support the third track in case that should be necessary. The posts are 15 ins. square and consist of two 15-in. channels connected by a made-up beam. At the stations the top of the rails will be 20 ft. above the street level and the lowest point of the girders is 14 ft. above the street level.

Ninety-pound T rails will be used, laid on 61-in. by 8-in. sawed ties with wooden guard rails.

Electricity will be the motive power for the new elevated railway, and the current will be taken by a third rail laid outside of the tracks. The cars will weigh approximately 33,000 lbs. each, without motors, and will measure 47 ft. 4 ins. over buffers. They will be of substantially the same arrangement and construction as those on the Manhattan Elevated Railroad, of New York, and on the Metropolitan Elevated Railroad, of Chicago. Trains of from three to five cars each will be run and the stations will be built for the accommodation of five-car trains. The type of electric system has not fully been determined upon.

The estimated cost of construction, exclusive of real estate and equipment, is $400,000 a mile, or $2,800,000 for the seven miles of track now arranged for. The plans for the system have been drawn up by George A. Kimball, engineer in charge. Work will be commenced immediately, and it is hoped that the line will be in operation within a year. The officers of the Boston Elevated Railway Company are as follows: president, William A. Gaston; first vice-president and general manager, William A. Bancroft; second vice-president, C. S. Sergeant; comptroller, J. H. Goodspeed; auditor, H. L. Wilson; secretary, John T. Burnett. On its staff are, Henry E. Woods, purchasing agent; J. E. Rugg, superintendent of transportation; Chas. F. Baker, superintendent of motive power, and Roger W. Conant, electrical engineer.

THE MASSACHUSETTS RAILROAD COMMISSION

The Board of Railroad Commissioners of the State of Massachusetts deserves a high place among American official commissions appointed to protect, in one way and another, the people's interests. Its members have been wise without being arrogant, conservative without being narrow, and reasonable if not generous in their treatment of capital invested in the railroads and street railways of the Commonwealth. For twenty-nine years this board has been in existence. For twenty-nine years the records of transportation in Massachusetts have been kept by it with great accuracy and consistency, so that they form a body of comparative figures concerning the growth of transportation interests in their varied phases which are equaled by those of no other State in the Union.

The chairman of the commission, John E. Sanford, of Taunton, has been a railroad commissioner since 1892. He is considered one of the ablest men in the State, and is, withal, so careful a student of details that it is asserted by the street railway companies whose applications for increase of capital stock and funded indebtedness have to pass in review before the board, that he has most accurate and annoying information upon market prices of street railway equipment to the smallest items.

George W. Bishop, of Newtonville, next oldest member in the board, has been in service on the commission since 1895, and Hersey B. Goodwin, of Cambridge, the junior member, since 1896. William A. Crafts has been clerk of the commission since its organization in 1869.

Prof. George F. Swain, of Boston, the commission's bridge engineer, is Heyward professor of civil engineering in the Massachusetts Institute of Technology. He is also a member of the Boston Transit Commission, where his fine engineering ability has doubtless had an important influence on the success of the subway. Prof. Swain's reports upon the physical condition of Massachusetts railroads have been almost as valuable to the latter as to the commission.

GEORGE W. BISHOP

JOHN E. SANFORD

HERSEY B. GOODWIN

GEORGE F. SWAIN

WM. A. CRAFTS

STREET RAILWAY JOURNAL

SEPTEMBER, 1898.

PUBLISHED MONTHLY BY

THE STREET RAILWAY PUBLISHING COMPANY,

HAVEMEYER BUILDING,

26 CORTLANDT STREET, NEW YORK.

WESTERN OFFICE:

MONADNOCK BLOCK, CHICAGO, ILL.

EUROPEAN OFFICE:

39 VICTORIA STREET, WESTMINSTER, LONDON, ENGLAND.

Long Distance Telephone, "New York, 2664 Cortlandt,"

Cable Address, "Stryjourn, New York."

TERMS OF SUBSCRIPTION.

In the United States and Canada.. $4.00 per annum.

In all Foreign Countries, per annum... $6.00 / £1 5s 0 / 31 fr

Subscriptions payable always in advance, by check (preferred), money order or postal note, to order of C. E. WHITTLESEY, Treasurer.

EDITORIAL NOTICE.

Papers and correspondence on all subjects of practical interest to our readers are cordially invited. Our columns are always open for the discussion of problems of operation, construction, engineering, finance and invention.

Special effort will be made to answer promptly, and without charge, any reasonable request for information which may be received from our readers and advertisers, answers being given through the columns of the JOURNAL *when of general interest, otherwise by letter.*

Street railway news and all information regarding changes of officers, new equipment, extensions, financial changes, etc., will be greatly appreciated for use in our Directory, our Financial Supplement, or our news columns.

All matters intended for publication in the current issues must be received at our office not later than the twenty-second of each month.

Address all communications to

The Street Railway Publishing Co.,

Havemeyer Building, 26 Cortlandt St., New York.

But five months ago we were looking forward with some anxiety, though with firmness, to the prospect of a war, the effect of which, on business and on national prestige, could not be foretold with any approach to certainty. The five months have passed and have brought with them to the country occasion only for gratitude and renewed hope for the future. A truce in hostilities, if not final peace, has come to the country, with but slight chance that hostilities may be renewed. Americans stand firmer on their feet to-day than ever before, more self-reliant, more confident in their strength. Our navy has achieved a series of victories which are little short of marvelous, and have suffered not one single reverse. Our army, also, has done well, and it has been proved that in cheerfulness in discipline, courage in battle and calm endurance of hardship and privation there are no superiors to the American soldier. The war will bring to us substantial increase of territory and new markets for our products. It has brought and will bring a greater respect for the American character from foreign nations. Not the least of the advantages which we have gained is the knowledge of certain weaknesses in our army organization, particularly in its commissary and medical departments, which we shall, of course, correct and that immediately, so as to avoid the slightest chance of such weaknesses in the future. Altogether this war, which so many true Americans have from the first deplored from one cause and another, seems destined to bring to us many great advantages of position, even though there may also be increased cares and responsibilities of government.

Even during these four months of war, business has been far from stagnant or uncertain. In fact, in many, and perhaps in most lines of trade it is positively good, and is rapidly increasing. Clearing house returns show far larger business transactions this year than last; the volume of railroad traffic has been for many months steadily increasing, and railroad prosperity is now beginning to show to some extent in increased dividends; the crops of the country last year were exceptionally good and prices high, while those of this year will be even larger, though they will probably be marketed at somewhat lower prices; the iron and steel industries are under full headway, and the foreign consumption of our products is increasing enormously; and these and other of the great "staple" industries of the country upon whose initial prosperity depends that of a thousand other smaller trade and manufacturing branches, seem certainly to give promise of a year of great activity. In our own special lines only the most cheerful optimism is found. The great electrical manufacturing companies are employing more men than since 1892; car and truck builders are taking many orders, though the business pendulum has not swung full in their direction as yet; builders of engines and boilers are in some cases working from twenty to twenty-four hours a day, and report orders already taken which will consume their entire output for this year; and the makers of railroad iron are having difficulty in keeping up with their orders, particularly in view of the large foreign demand and of the new orders for battle-ships, torpedo-boats and destroyers which the Government is placing. For the first time since 1893, manufacturing profits on a reasonable scale appear to be in sight and cheerfulness and hope are in the air. If other indications were lacking, the appearance of this issue of the STREET RAILWAY JOURNAL, containing no less than 250 pages of advertising matter, would point to a revival of business in street railway lines.

The American Street Railway Association meets this month in Boston, where it first came into being sixteen years ago, and where its first president, H. H. Littell, was elected. No less than twenty-eight of the 165 companies now members of the association were represented, either in their present name or in that of some constituent company, at this first meeting, and among those present at the latter were many who have been regular attendants at the annual conventions ever since. The association is thriving, is doing thoroughly good work, and the convention this year will be a decided success, both in numbers and in the variety and character of the exhibits.

Don't forget the Accountants' Convention, which is to be held at the same time and place as the American Street Railway Association. Although the Association of Street Railway Accountants of America was formed only eighteen months ago, its members and committees have, by painstaking and conscientious work, laid the foundation of a complete standard system of classification of accounts. The original scheme which was presented at last year's convention at Niagara Falls will be somewhat modified in the report of the committee this year, and it is believed that the classification finally determined upon, which is the result of a conference with a large number of experts, will be accepted by the association and approved for immediate and practical use.

The successive managements of the great street railway system in Boston, long known throughout the length and breadth of the country and in foreign lands as well, as the West End Street Railway Company, but now as the Boston Elevated Railway Company, have always been most kind and generous in their treatment of other street railway managements which have desired information at their hands concerning the results, in major and minor details, of electricity as a motive power. It was in 1888 that Henry M. Whitney, then president of the West End Company, determined, after a visit to the large electric railway at Richmond, to introduce this new and attractive motive power on his system instead of the cable, which had been in contemplation. This action on the part of so powerful and conservative a company as that in Boston probably advanced by several years the "electric boom" which almost immediately took place in America, and which has had such far-reaching influence on urban life. The West End managements have doubtless made some of the engineering and operating mistakes to which all great corporate enterprises are liable, but they have never sought to conceal the mistakes, nor their effects, but have, on the contrary, learned lessons from them and, with the greatest frankness and generosity, have pointed out to their brother managers the better ways of doing things to avoid results from which they themselves have suffered. There has been with them none of the narrowness which seeks to jealously guard "trade secrets," but the right hand of fellowship has been given with clear good will in every case, and it is by no means impossible that their influence may have been potent in bringing about the similar spirit of common brotherhood which pervades the entire street railway industry to-day, and which the American Street Railway Association also has fostered. Few industries have this feeling to the same extent. Certainly there is far less of it among steam railroads than among the street railways, and far less of it, too, in tramway circles abroad. All honor, we say, to the *broad-minded* men, the men who are willing to give as well as to receive, the men who will cheerfully laugh at their own blunders and warn others against them. It is by these that progress is made in the world, not by the self-sufficient and narrow.

A clean-cut, well-executed and thoroughly satisfactory public enterprise is that which has just been brought to completion in Boston—the building of the Boston subway. Simple in conception, it has yet called for the best engineering ability to work out details. It is hard to see how the route chosen, the plan decided upon or the execution of the work could have been greatly improved upon. It has already relieved the frightful congestion in Boston's business center to a remarkable degree, although but half its length is so far used for traffic. Its track and station plans are most ingenious and satisfactory, and the Boston subway will doubtless be, in nearly all respects, a model upon which similar public works in other cities will be formed. Rarely in this country or abroad has there been found an instance of a great public improvement of this kind being carried through at a cost of but five-sevenths the original estimates and appropriations. Public morality in Massachusetts is high, and has accomplished this result. With the completion of the new elevated railway, of the Charles River bridge, the tunnel to East Boston from Scollay Square and the tunnel and subway to Harvard Square, Cambridge, there will have been accomplished in Boston by joint public and private means, such improvements in facilities for "getting about in the world" as no city has yet obtained, certainly in so short a space of time.

It is a common saying that Americans are prodigal and that they waste about as much as they consume. There is undoubtedly some truth in this charge, for, as a rule, our countrymen are fairly prosperous, and at the same time extremely busy, so that often they do not devote as much time to the small economies as they otherwise would. What is true of Americans in general, and, in fact, of individuals in general, is also true of corporations. There are many economies which could be practiced upon our different railway systems, and there are still leaks and wasteful methods in most systems which add directly to cost of operation and the extent of which is not always realized by managers. The margin between a profit and none at all is getting narrower, and as an able financier once said, "eternal vigilance is the price of dividends." One place where there is often considerable waste is in a careless use by the motorman of current. Of course this is made more painfully evident when current is purchased on a meter basis than when it is generated by a railway company itself, but it is nevertheless a direct loss from which not only no return is secured, but which is often a prolific cause of motor troubles and wheel and brake shoe wear. An interesting article by E. G. Connette in another column will prove something of a revelation, we think, to those who have not given much thought to the subject, and who consider that little, if any, power can be saved by judicious motormen. Owing to the fact that the company with which this writer is connected purchases its power from another company, it decided to equip each of its cars with a watt meter, from which the record of each motorman in his use of current is taken. By a comparison of the power consumption of different motormen on the same route a fairly close watch can be kept of the economy which each practices of current. As a consequence, each man has a direct incentive to employ a minimum quantity per car mile, and the aggregate of this constant care was a saving of from 35 to 40 per cent in the bill for power paid for the same car mileage in Nashville. As will be seen, this would constitute an important economy in the operation of any road, and it simply shows, if additional testimony were necessary, the value of carefully watching every avenue of outgo.

Some Suggestions to European Electric Railway Builders

If America may presume to make Europe certain suggestions regarding the building of electric railways, a patient hearing may be hoped for, as it is generally recognized in all countries, we believe, that American experience in this particular branch of engineering is quite complete, though by no means wholly admirable. America has wasted—if we can call it wasting—so many millions in experiments that it observes with something like a shudder, the danger that the same old weary course of trial and failure may be gone over again abroad.

First, as to roadbed. This is the foundation not only of a railway plant, but of its financial success as well. Nearly always by far the largest single item in the investment account, it is likewise almost the largest in the operating account if proper charges for repairs and depreciation are annually made. While by no means sure that the best present American practice is final or will be justified by results, we are confident that European practice in track building is in important respects less conservative and is inadequate for electric traction. European engineers do not appreciate, we believe, the tremendous pounding which the electric railway tracks have to stand from the motor cars, to say nothing of wagon traffic. It is true that there is no reciprocating motion in the motor as in steam locomotives to promote this pounding, but the slightest imperfection in the joint creates differences of level between the rails which cause the car to fall upon the following rail and hit it a blow which greatly increases the trouble. With single track roads, both rails at an imperfect joint are hammered, and a hollow is thereby formed. Electric cars are always popular, are nearly always crowded with people, or are run at short intervals, and the blows thus being multiplied, either in weight or in frequency, and their quickness of application being increased by high speed, the result, as we have found it in America, is that the best construction which we can make for joints and rails is hardly strong enough. It may be urged that the concrete foundations for track usual in Europe will cure this trouble, but this has not been American experience where tried, though there is undoubtedly some advantage in concrete foundations. The true remedy, as near as we can now judge, is, first, to use 60-ft. rails, and so reduce the number of joints; second, to butt the joints together in paved streets; third, to increase the carbon in the rail, thereby giving it a hardness which will prevent the battering of the head; and finally, to use a "square shouldered" section, so as to permit of accurate fitting of the joint plates and a strong vertical support—this whether the support be of iron cast around the joint or of wrought iron girder fish plates. Brittleness in the rail due to hardness is not so much to be feared in tramway practice as softness, for a broken rail does not mean an accident, as on steam railroads, but merely the replacing of the rail. Hardness is advantageous not only at the joints but along the entire rail, since rails which have been in service longest show a wearing away of the rail head far greater than in horse railway practice, due, of course, to the self-propelling motive power employed.

Track special work—frogs, crossings, switches, etc.—ought, also, to be made of the best material, and with the greatest care. Some of the capitalists who are building electric tramways in foreign countries complain that they cannot get good special work from European makers, the latter still using cast iron largely and following the old horse tramway methods, with results disastrous, both to wheels and the special work itself. Transition curves should, of course, be made in all cases, and the greatest pains taken to provide for the easy movement of the car at all points on the road, curves as well as tangents.

Great Britain is undoubtedly ahead of America in the care taken with track return circuits, and, in fact, has gone to an extreme in demanding low voltage drop in the earth. While a seven-volt drop generally means less electrolytic effect with pipes and wires it does not always do so, since it is *current* which produces these troubles and current can be obtained from low voltage in quite as great quantity as from high, providing only that the earth resistance be sufficiently low.

In overhead construction, Europe has paid more attention, perhaps, to the ornamental than has America, and this is certainly right. With attractive poles and a simple and unobtrusive wire structure there can be no reasonable complaint on the part of municipalities with the overhead electric system, certainly in view of the great advantages of electric traction.

Power station equipment should be in the fewest possible units consistent with reliability of service. In early American practice we had stations with twenty and thirty small units. To-day, these have nearly all been replaced, at heavy expense, by fewer and larger ones. Perhaps an ideal station for most conditions is one made up of five units, of which four are of the same size, and one but half that size. The small unit takes care of the night service, two of the larger should handle the everyday traffic at its maximum, a third may be added on holidays and special occasions, and a fourth is always in reserve. A station arrangement of this character requires foresight in determining the probable maximum requirements of the future, as to load, but when this is once estimated it is better to determine the ultimate sizes of the units and purchase two (one for reserve), even in the beginning of the re-equipment than to buy smaller units to be replaced afterward by larger ones. It is needless to say that direct connected units should always be employed, as belts are out of date for street railway work.

No fixed rules can be laid down for rolling stock except that all cars should be made as strong and durable as possible—far more so than for horse railway traffic. The tastes and habits of the people and local conditions otherwise must govern the seating arrangements and forms of cars chosen. Roof seats are popular almost everywhere, and though little used in America, it is not because people would not like them, but because, in the long run, it is believed that they would prefer speed of car and comparative immunity from accident. Americans have not been educated to climbing up and down a stairway to the car roof, and there would doubtless be serious accidents for a long while after their introduction in any place.

It is impossible, of course, to speak within these limits in any but the most superficial and fragmentary way upon this general subject of adaptation of American experience to European conditions. In a thousand or more details it is worth studying, and should be studied by foreign engineers either by personal visits or by careful reading of the pages of the technical journals.

W. C. ELY

J. A. RIGG

J. M. ROACH

A. E. LANG

E. G. CONNETTE

ROBT. McCULLOH

OFFICERS AND EXECUTIVE COMMITTEE, AMERICAN STREET RAILWAY ASSOCIATION

C. D. WYMAN

H. C. MOORE

T. C. PENINGTON

R. S. GOFF

THE BOSTON CONVENTIONS

AMERICAN STREET RAILWAY ASSOCIATION

The following is the programme of the convention at Boston, September 6-9:

TUESDAY MORNING

Meeting called to order at 10 A. M. by Albion E. Lang, president.

Calling of the roll.

Invitation extended to join the association.

Address of the president.

Report of the executive committee.

Report of the secretary and treasurer.

Reading of paper on "The Comparative Earnings and Economy of Operation Between Single and Double Truck Cars for City Use." Richard McCulloch, electrical engineer, Cass Avenue & Citizens' Street Railway Company, St. Louis, Mo.

Reading of paper, "Municipal Ownership of Street Railways."

TUESDAY AFTERNOON AND EVENING

Leaving Boston about 2:30 P. M. a trip will be made to Concord and Lexington, in order that the points of historical interest may be shown to the visitors.

In the evening a reception will be given at Paul Revere Hall, in the Mechanics' Building.

NOTE: The exact hour of starting on the different trips will be announced each day in the convention.

WEDNESDAY MORNING

Convene at 9:30 A. M.

Reading of paper on "Maintenance and Equipment of Electric Cars for Street Railway." M. S. Hopkins, electrician, Columbus Street Railway Company, Columbus, Ohio.

Reading of paper on "Carrying of United States Mail Matter on Street Railways." W. S. Dimmock, general superintendent, Omaha & Council Bluffs Railway & Bridge Company, Council Bluffs, Iowa.

Appointment of committee on nomination of officers and next place of meeting.

In the morning the ladies with escorts will be shown the local points of interest in and around Boston.

WEDNESDAY AFTERNOON

In the afternoon, leaving Boston at 2:30, a trip will be made by boat to Nantasket Beach, where a clam-bake will be served and the various amusements at the place will be open to the visitors.

THURSDAY MORNING

Convene at 9:30 A. M.

Reading of paper on "To What Extent Should Street Railway Companies Engage in the Amusement Business?" Walton H. Holmes, general manager, Metropolitan Street Railway Company, Kansas City, Mo.

Reading of paper on "Inspection and Testing of Motors and Car Equipments by Street Railway Companies." Frederick D. Perkins, electrical engineer, Toledo Traction Company, Toledo, Ohio.

Election of officers.

In the morning the ladies and officers of the association will be taken for a drive through the Boston parkways.

THURSDAY AFTERNOON AND EVENING

In the afternoon a trip by special train will be made to Plymouth.

In the evening the regular banquet will be held at 7 P. M. at Hotel Brunswick.

FRIDAY MORNING

Convene at 9:30 A. M.

Reading of paper: "Cost of Electric Power for Street Railways at Switchboard, both Steam and Water." R. W. Conant, electrical engineer, Boston Elevated Railway Company, Boston, Mass.

Report of committee on standing rules for government of conductors and motormen.

Unfinished business.

Installation of officers.

Adjournment.

In the morning the ladies will be taken shopping.

FRIDAY AFTERNOON

In the afternoon a trip will be made to Norumbega Park in Auburndale.

The following are the committees in charge:

General Committee

C. S. Sergeant, 101 Milk Street, Boston, Mass., Chairman.
E. C. Foster, 333 Union Street, Lynn.
J. E. Rugg, 101 Milk Street, Boston.
C. S. Clark, 8 Oliver Street, Boston.
A. A. Glasier, 104 Ames Building, Boston.
C. Q. Richmond, North Adams.
John R. Graham, 280 Washington Street, Boston.
Robert S. Goff, Fall River.
P. L. Saltonstall, 28 Exchange Building, Boston.
E. P. Shaw, 316 Exchange Building, Boston.
F. H. Dewey, Wor. Cons. St. Ry. Co., Worcester.

Committee on Entertainment

P. L. Saltonstall, Boston, Chairman.
H. F. Eldridge, Portsmouth.
A. B. Bruce, Lawrence.
C. C. Pierce, Boston.
C. E. Barnes, Boston.
C. W. Wilson, Boston.
J. F. Shaw, Boston.
J. H. Goodspeed, Boston.
J. H. Cunningham, Boston.
B. J. Weeks, Quincy.
W. W. Sargent, Fitchburg.
A. C. Gardner, New Bedford.
Edwin S. Webster, Boston.
W. F. Pope, Boston.

Committee on Transportation and Information

Julius E. Rugg, Chairman.
N. H. Heft, Boston.
H. B. Rogers, Brockton.
J. F. Wattles, Boston.
Fred H. Smith, Quincy
A. E. Gordon, Boston.
N. E. Morton, Lawrence.
C. E. Woodward, Wakefield.
Winthrop Coffin, Boston.
H. H. Reed, Fall River.
H. F. Grant, Boston.

Banquet Committee

A. A. Glasier, Chairman.
W. A. Bancroft, Boston.
Prentiss Cummings, Boston.
C. S. Clark, Boston.
E. P. Shaw, Boston.
E. C. Foster, Lynn.
S. M. Thomas, Taunton.

Committee on Hall, Hotels and Registration

E. C. Foster, 333 Union Street, Lynn, Chairman.
John F. Morrill, Quincy.
J. N. Akarman, Worcester.
J. H. Studley, Jr., Boston.
J. E. Rugg, Boston.
W. F. Pope, Boston.
R. N. Wallis, Fitchburg.
H. B. Parker, Boston.
A. E. Smith, Springfield.
George F. Seibel, Taunton.

Committee on Exhibits

Charles S. Clark, Chairman.
H. F. Woods, Boston.
E. C. Foster, Lynn.
C. F. Baker, Boston.
E. P. Shaw, Jr., Boston.
Franklin Woodman, Haverhill.
R. S. Goff, Fall River.
J. H. Studley, Jr., Boston.
Maurice Hoopes, Lynn.

THE STREET RAILWAY ACCOUNTANTS' ASSOCIATION OF AMERICA

The second annual meeting of the Street Railway Accountants' Association of America will also be held at Boston, Sept. 6-9. As at the last convention the meetings will be held in the same building as those of the American Street Railway Association, the banquet hall of Mechanics' Hall having been secured for the use of the accountants. The badges of the American Street Railway Association will be furnished the members of the Accountants' Association, and in matters of entertainment and admission to meetings, etc., the same opportunities will be enjoyed. A special feature of the convention will be an exhibit of blanks and forms used in accounting, and attendants are requested to bring to the meeting any forms which they may have in use.

The official programme adopted is as follows:

MONDAY

7:30 P. M. Meeting of the executive committee at the Hotel Brunswick.

TUESDAY

10 A. M. (Mechanics' Association Banquet Hall).

Opening business session. Reports of officers.

Appointment of committees, etc.

Paper on "Statistics, Their Use and Abuse," by E. D. Hibbs, auditor, North Jersey Street Railway Company, Jersey City, N. J.

WEDNESDAY

10 A. M. (Mechanics' Association Banquet Hall).

Paper on "Car Mileage; How Arrived at and Its Use," by A. H. Ford, secretary and treasurer, New Orleans Traction Company, New Orleans, La.

Report of the permanent committee, on "A Standard System of Street Railway Accounting, Covering the Classification of Operating Expenses, Classification of Construction and Equipment Accounts and Form of Annual Report."

Chairman—C. N. Duffy, secretary, Citizens' Railway Company, St. Louis, Mo.

H. L. Wilson, auditor, Boston Elevated Railway, Boston, Mass.

Wm. F. Ham, secretary, Nassau Electric Railroad Company, Brooklyn, N. Y.

J. F. Calderwood, auditor, Twin City Rapid Transit Company, Mineapolis, Minn.

H. J. Davies, assistant secretary, Cleveland Electric Railway Company, Cleveland, Ohio.

THURSDAY

10 A. M. (Mechanics' Association Banquet Hall).

Report of the permanent committee, on "A Standard System of Street Railway Accounting"—Continued.

FRIDAY

10 A. M. (Mechanics' Association Banquet Hall).

Informal discussion of questions relating to street railway accounting.

Leader—S. H. Bennett, secretary and treasurer, Atlanta Railway, Atlanta, Ga.

Closing business session:

Report of convention committees.

Election of officers for 1898-1899.

The exhibition of blanks and forms will be in charge of this committee:

Chairman—F. E. Smith, auditor, Lynn & Boston Railway Company, Lynn, Mass.

G. E. Tripp, treasurer, Lowell, Lawrence & Haverhill Street Railway Company, Lawrence, Mass.

R. N. Wallis, treasurer, Fitchburg & Leominster Railway, Fitchburg, Mass.

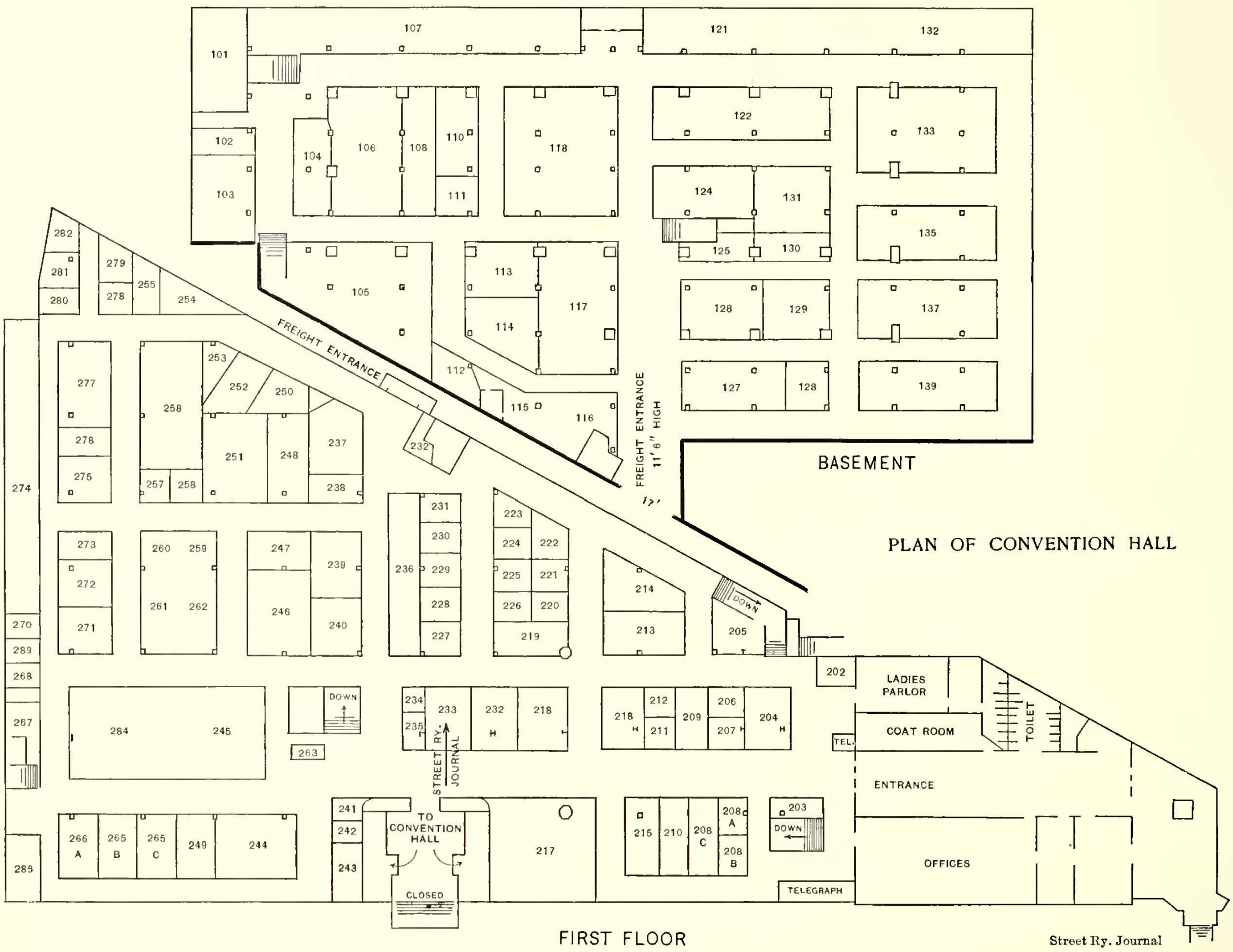
THE EXHIBITS

The Exhibition Hall is in Mechanics' Building, Huntington Avenue, Boston, about five minutes' walk from the Brunswick hotel, and accessible also by street cars. It is probably the largest and best appointed building for exhibits of the kind shown at street railway conventions which has been employed in the history of the association. The exhibits will occupy two floors, the basement and first floor. A diagram of the building, with the spaces occupied by the different exhibitors, is shown on page 510. The headquarters of the STREET RAILWAY JOURNAL are close to the stairs leading to the convention hall, and cannot be missed by anybody. The meetings of the two associations will be held on different floors from those devoted to the exhibits, so that noise from the latter will not disturb the delegates.

The following is a list of the exhibitors who have already engaged space:

Space.	Name.	Area.
102	McCardell, West & Company	220
103	Rochester Car Wheel Works	600
104	New York Car Wheel Works	400
105	Taunton Locomotive Manufacturing Company	1450
106	Laconia Car Company Works	819
107	Peckham Motor Truck & Wheel Company	1500
108	Barney & Smith Car Company	429
110	Briggs Carriage Company	360
111	James L. Kimball	108
112	Graham Equipment Company	100
113	The Wells & French Company	414
117	McGuire Manufacturing Company	920
118	J. G. Brill Company	1248
121	Walker Company	1450
122	Taylor Electric Truck Company	853
124	Pennsylvania Car Wheel Company	420
126	Hampden Corundum Wheel Company	416
127	Springfield Manufacturing Company	300
131	Baltimore Car Wheel Company	440
133-134	The Johnson Company	1635
203	Samson Cordage Works	100
204	Ohio Brass Company	300
205	New Haven Car Register Company	275
206	Corning Brake Shoe Company	100
207	Ashton Valve Company	100
208 A	Ham Sand Box Company	100
B	Wadsworth, Howland & Company	100
C	American Mason Safety Tread Company	100
D	C. W. Trainer Manufacturing Company	100
209	Creaghead Engineering Company	200
210 A	A. O. Norton	100
B	Forsyth Brothers & Company	100
211	American Railway Supply Company	100
212	Adam Cook's Sons	100
213	Pantasote Company	264
214	Thayer & Company, Incorporated	350
215	Albert & J. M. Anderson Manufacturing Company	240
216	H. W. Johns Manufacturing Company	300
217	Westinghouse Electric & Manufacturing Company	1024
218	Bureau of Information	280
219	Harold P. Brown	200
220	F. H. Newcomb	100
221	W. T. Van Dorn Company	100
222	Falk Manufacturing Company	150
223	Frederick C. McLewis	110
224	Beverly Machine Works	100
225	Boardman Tucker Company	100
226	Stanley & Miles	100
227	J. T. McRoy	100
228	Standard Underground Cable Company	100
229	Pearson Jack Company	100
230	The Wagner Electric Manufacturing Company	100
231 A	E. F. deWitt & Company	100
232	Street Railway Review	300
233	STREET RAILWAY JOURNAL	300
234	Railway World	120
235	Electrical Review	120
236	Ornamite Veneer Company	550
237	Pennsylvania Steel Company	336
238	Weber Railway Joint Manufacturing Company	120
239	The Adams & Westlake Company	350
240	Bibber-White Company	182
241	C. F. Orr & Company	100
243	William F. Ellis	200
244	Pettingill, Andrews Company	402
245-264	General Electric Company (see 264)	1653
246	Consolidated Car Fender Company	497
247	Christensen Engineering Company	263
248	Barbour, Stockwell Company	318
249	Billings & Spencer Company	200
250-253	Sherburn & Company	530

Space.	Name.	Area.
251	William Wharton, Jr., & Company, Inc.	503
256	The Cleveland Frog & Crossing Company	800
257	Cambria Iron Company	100
258	American Rail Joint & Manufacturing Company	100
259	Van Wagoner & Williams Hardware Company	170
260	International Register Company	170
261	Frank Ridlon Company	170
262	R. D. Nuttall Company	170
263	John Stephenson Company, Limited	100
265 A	Consolidated Car Heating Company	200
B	Heywood Brothers & Wakefield Company	200
C	Boston Artificial Leather Company	200
266	Burdett & Johnson	180
268	Crosby Steam Gage & Valve Company	100
269	R. Woodman Manufacturing & Supply Company	100
270	Columbia Machine Works	100
271	Charles Scott Spring Company	210
272	Pratt & Letchworth Company	210
273	E. T. Burrowes Company	150
274	Elmer P. Morris	1080
275	Meaker Manufacturing Company	200
277	Sterling Supply & Manufacturing Company	400
278	Williams Truss Rail Joint Company	100
289	John F. Ohmer	100
281	J. A. Lakin & Company	100



TRANSPORTATION TO BOSTON

A special rate of a fare and one-third for the round trip will be granted to attendants at the convention, as usual. Persons purchasing tickets will pay full fare one way and ask the ticket agent for a certificate, which, when properly countersigned at Boston, will entitle the holder to a return ticket at one-third fare.

The Wabash Railroad Company and Lake Shore Railroad Company have already announced that they will run special trains from Chicago to Boston for the convention if they can secure enough passengers, and that in any event they will run special cars. Other railroads will probably do the same where the number of delegates attending the convention will warrant it.

ECONOMIZING ELECTRICAL POWER

BY E. G. CONNETTE

The subject of economy in the use of electric power as applied to street railways has not been developed generally to such an extent as to give the management of street railways an intelligent record of the details of the consumption of power. Steam railroads keep an account of the number of pounds of coal furnished each locomotive, and are able to tell at the end of each month how many pounds of coal have been consumed by each engine per mile run in proportion to the tonnage hauled. By this record they are enabled to know the engineers and firemen who are the most economical in the use of fuel, and the writer knows of one railroad which a few years ago paid a cash premium each month to the engineer and fireman who showed the best record for economy of fuel.

Street railways provide each car with a fare register for the purpose of checking the number of fares collected by conductors, but what check is there on the motorman to prevent a useless waste of electrical energy? Power costs money, and it is therefore essential to keep a check on every avenue of consumption.

Light companies have almost entirely ceased to make "flat rate" contracts, but sell power by meter measurement for all kinds of purposes, and they are thus enabled to know how much power is used by each "consumer" and if they are getting value received. Motormen are consumers and street railways should know the amount of power used by each "consumer" in proportion to work done.

An inefficient or indifferent motorman will cost a company from 10 to 15 per cent of the amount of his wages by a reckless and thoughtless waste of power, because there is no check on him. He will approach a stopping point with current on and then use the brake to make a quick stop, thus overcoming and wasting the energy unnecessarily used in approaching the stopping point instead of shutting off the current and allowing the momentum of the car to carry it to the stopping place and thus be able to stop the car with only a slight application of the brake. Some motormen keep the slack taken up in their brake chains so that the brake shoes do not fully clear the tread of the wheel in order that a half-turn or a turn of the brake handle will stop the car; this is a bad practice unless done with caution, as if the brake shoe drags on the wheels at all there is a waste of power. Other practices are indulged in by motormen which result in a loss of energy, such as allowing current to remain on when car is going down grade, applying brake before current is shut off, applying current before brakes are released, failure to use economical points of controller, applying the current too rapidly when car is started, not allowing the car to attain the full speed of a point of the controller before applying the next point. This not only causes a waste of power but creates an extra strain on the motors.

The Nashville Street Railway made a contract with a power company a few years ago to furnish the power for its use on a car mileage basis. This road operates from forty-five to sixty 16-ft. to 22-ft. single truck cars daily, making from 5000 to 7000 car miles per day. Upon a mileage basis there was no incentive to economize in the use of power, and little attention was given to the economical application of the current. On Feb. 1 this year a new contract was made on a meter basis, and since that time a thorough system has been inaugurated for the attainment of the greatest economy in the use of power. A large watt meter was installed in the power house and the record of this meter is taken as a basis of settlement each month; the feeder lines were inspected carefully and tested, the return grounds were examined and all weak places strengthened.

A watt meter was placed on each car over the door opposite the register ends of the car. The meters are read both when a car comes into the shed and when motormen change at relief time, and a daily report is made, showing:

Number of car.	Name of road.	Schedule number.
Name of motorman.	Number of trips.	Number of miles.
K.w. hours.	K.w. hours per car mile.	

From this report the record of each motorman as to the k.w. hours used per car mile on each car on each division of the system is shown and the comparison of the records of each man running on the same division is the basis of rating the men as to efficiency in the use of power. The comparison necessarily has to be made by divisions or for cars running over the same lines, as the grades and curves make a difference in the amount of power required to run a car over one road as compared with a car run over another road. From this report a record is made in a book, each motorman's record being entered daily. At the end of the month a statement is compiled from this record showing the average k.w. hours used per car mile by each motorman during the month on each division of the road, and this statement is posted on the bulletin board so that the motormen may see the record of each.

The record of the power house meter is taken daily at midnight, simultaneously with the reading of the car meters, and a daily record is made for comparison. Since the weak places in the lines have been strengthened and intelligent and diligent application has been given to the subject of saving power, there is only a difference of from 4 to 6 per cent between the reading of the car meters and the meters at the power house, the car meters of course reading less than the station meter, owing to loss in the lines to power house.

The following rules were issued to motormen when the new contract was made:

1.—When starting car let it run for at least one car length on each notch of the controller before moving the handle to the next notch.

2.—Do not run over three car lengths on first, second, fourth and fifth notches.

3.—Use the third notch on level track and light grades when speed is unnecessary. Use sixth notch going up grades and for full speed. The third notch is economical and should be used as much as possible.

4.—Do not use seventh notch under any circumstances.

5.—Do not reverse the controller to stop car except to avoid accidents.

6.—Do not apply the brakes when the current is on.

7.—Do not apply current when brakes are applied.

8.—Do not stop on curves except where there is a foot walk and only then when the street is muddy.

9.—Do not allow the current to remain on when car is going down grade.

10.—Endeavor to make the trips with the least amount of power by using third notch of controller and allowing the car to roll without the use of the current.

11.—Do not burn the lights in the cars unnecessarily.

These rules principally apply to the G. E. type K. controller, but can be modified so as to apply to any form of controller.

Under the system of paying for power on a mileage basis, the consumption of current was from 1.75 to 1.90 k.w. hours per car mile, while now after a lapse of six months under the meter system the power has been reduced to from 1.10 to 1.15 k.w. hours per car mile, or from 35 to 40 per cent, saving in consumption of power and a relative saving of expense in its production.

The Nashville Street Railway abounds in curves and grades; there are scarcely five miles of level track in the whole city, while there are curves galore; some are of very small radius, which makes the conditions unfavorable for a minimum consumption of power per car mile. Roads using cars 16 ft. to 20 ft. long with single trucks and double motor equipments, where there are few grades and curves, should run on less than 1 k.w. hour per car mile.

A saving of from 35 to 40 per cent in the amount of power used per car mile reduces the quantity of feeder wire necessary to hold the potential up under a given load in the same proportion, thus saving a large original outlay for copper and the interest on its cost. Where roads have too much copper feeder already erected a portion of it can be taken down and used to strengthen the weak lines or in the construction of new lines or extensions.

The efficient and economical application of the current to motor cars not only works a large saving in the expense of power but also lengthens the life of the vital parts of the motor in proportion to the reduction of the amount of work required of them, which in the course of a year will result in a large saving in motor repairs. The proper application of the current when starting a car will reduce the risk of personal injury caused by the sudden starting and jerking of the car. A steady and uniform rate of speed and careful and proper handling of the cars will tend to increase the receipts, as motormen will not be so liable to run by passengers. They will use the time allowed per schedule on the road instead of running fast, missing passengers and killing time at the end of the road.

Car meters not only serve as a check on the motormen in the use of power, but also aid in detecting defects in the motors, which cause an abnormal flow of current, such as the deterioration of the field insulation, causing a partial short circuit which is invisible and has not developed to such an extent as to interfere with the running of the car but causes a waste of energy, sparking at the brushes, tight bearings, loose connections worn trolley wheels or bad contact causing sparking at the trolley wire, tight brakes, brake shoes dragging on the wheels and improper lubrication of bearings, all of which are inimical to the saving of power. When one car shows for three consecutive days a larger consumption of power than another, running on the same line, the motormen are changed. If the car still shows an increase over the other cars we know that it is no fault of the motorman but that there is something wrong with the car, and it is stopped at once for a thorough inspection and overhauling until the trouble is discovered.

Curves should be greased daily from one to three times, the frequency depending on the amount of traffic; the method and arrangement for doing the work most economically varies with different conditions and locality. The percentage of saving of expense of power by greasing curves is considerably in excess of the expense of doing the work, besides lengthening the life of the curved rails.

The use of efficient sand boxes saves power as well as prevents accidents. Wheels slipping on slick track indicate a want of traction and creates a loss of power; sand on the hills and curves when track is slick will save a large number of k.w. hours.

Our car meters have now been in service for four months and only two have needed attention. They are simple in design, durable when properly handled and are easily tested and calibrated by being operated in series with another meter which is known to be correct or with a portable volt meter and ampere meter. The method of testing is simple and inexpensive, and its accuracy has been demonstrated within a very small per cent.

The contract to buy power on a meter basis was the main motive which impelled the introduction of car meters, in order to use the sum total of the readings of the car meters as a check against the power station meter. Another was to restrain the motormen from the extravagant use of the current. But the practical execution of the plan for a complete street car meter system has developed other advantages, as set out in this paper. The benefits derived from the meter system apply to roads which operate their own power house as well as roads which rent power on a meter basis; but the saving is greater on roads buying power, because there are *fixed* charges and expenses connected with a power house, whether the consumption of power is great or little, and the reduction of expenses in proportion to the reduction of the quantity of current used is not in the same ratio. It is safe, however, to calculate on a saving of at least 25 per cent in the amount of power used per car mile by using meters and by educating the motormen to a system of power economy, and with this saving in the amount of power used it is an easy matter to ascertain the actual saving of coal, oil, water, labor, etc., which make up the expense of a power house.

THE ROTARY CONVERTER IN STREET RAILWAY WORK

BY LOUIS BELL, PH. D.

In the development of street railways and their extension into interurban and suburban systems the time frequently arrives when feeder copper becomes a burden too heavy to be borne. Some radical change in the feeding system has to be made, and the manager, always bedevilled by puzzling questions, has to face a new and intricate problem. Somehow power must be delivered at a distant point with a reasonable degree of economy. Until within a very few years a subsidiary station at or near that point was the only way out of the difficulty, but since the growth of long distance power transmission by alternating currents the rotary converter has afforded a new and sometimes very useful means of escape.

It is the purpose of this article to explain what the rotary converter is, how it operates in practice, and under what circumstances it becomes economically available for railway work.

For the general purposes of electric power transmission we have at present to depend on alternating currents, while nearly all the electric railway work of the world is done by continuous current motors. Hence, to render transmitted energy available for the purpose in hand it must be represented by continuous current derived in some practical and economical way from the alternating current. In a general way this has been and is accomplished by one of three well-defined methods. In the first place, one can utilize the alternating current in a suitable motor and thence drive a continuous current generator; second, one can rectify the current by a commutator driven by a synchronous motor; and finally the alternating current can be changed to continuous current by a rotary converter. The first method involves driving two machines and adding the losses therein, a process obviously not of the highest efficiency, although sometimes advisable. On the other hand, to rectify alternating current by a commutator, while very highly efficient, brings in certain grave inherent difficulties which have never yet been successfully surmounted on any considerable scale. Chief among these difficulties is destructive sparking, due to the fact that it is practically impossible so to time the revolution of the commutator that the brushes shall pass from one segment to the next, thus rectifying the current, at the moment when the alternating current is passing through zero and when there is, simultaneously, no difference of potential between the segments.

On a small scale one can work a commutator so that both current and potential difference will be small when the brushes pass to the next segment, and so the sparking will be small, but the moment one deals with large currents and considerable voltages, that is, with large outputs, the sparking becomes destructive, particularly if the load changes rapidly. Thus while synchronous commutators have proved fairly successful in small units, say of 5 to 20 k.w., for charging storage batteries and the like, they give very little promise of success on the scale required for railway work.

Now the rotary converter is an apparatus for commuting alternating current under the same conditions that exist in the armature of an ordinary continuous current generator. We must remember that, fundamentally, all armatures generate alternating current, and that the sole function of the ordinary commutator is to so reverse the connections of the armature with respect to the external circuit that the current delivered to the latter shall be uni-directional. This commutation is done piecemeal, as it were, each individual armature coil being reversed in connection as it passes under the brush, so that the reversal deals with only a small portion of the total voltage—a few volts or even a fraction of a volt. We all know what trouble from sparking ensues when the voltage between commutator segments is too great.

Now the commutator neither knows nor cares what is the source of the current with which it deals—whether it is being generated in the armature or fifty miles away—so long as it is being delivered to it in the systematic way for which it was designed. Therefore, if just such alternating current is delivered to the armature as the latter was designed to deliver to the commutator, the process of commutation will go on in the regular way. And this is the essence of the rotary converter—it is a dynamo adapted to receive from an external source and to turn over to its commutator just such alternating current as it would necessarily generate if driven by its own engine.

Fig. 1 gives a clear idea of the connections which would be found in a simple single phase rotary converter. The armature there shown in diagram is a Gramme ring with sixteen armature coils and the same number of commutator segments. In addition to the commutator the armature is provided with two collecting rings *C C*, permanently connected to two diametrically opposite points of the armature winding. Now if the fields pertaining to this armature were excited and the armature were driven by a pulley, it would evidently produce continuous current if an external circuit were connected to the regular brushes *B B*.

Similarly, if these brushes were disconnected and the circuit were connected to the brushes bearing on the collecting rings *C C*, we should get an alternating current, for there would be no commutation and the current in each half of the armature would be reversed at each half revolution, that is, at each pole. If the speed of the armature were 1500 r.p.m., there would be in the resulting alternating current 3000 reversals per minute, which amounts to twenty-five complete cycles per second, which is the frequency employed in the great Niagara plant.

We may thus consider that every continuous current armature generates within its coils an alternating current which has a definite frequency dependent on the number of poles and the r.p.m. We may commute this current or not, as we please, but it is always there and ready to be used if we put on collecting rings and take it out. The higher the speed and the greater the number of poles, the greater the intrinsic frequency of the machine. With four poles and 1500 r.p.m. the frequency would be fifty cycles, and in general for any machine it is, in cycles per second

$$\frac{\text{Number of poles x r.p.m.}}{120.}$$

Now suppose that we send into the armature of Fig. 1, through the rings *C C*, an alternating current of twenty-five cycles per second, after spinning the armature up to 1500 r.p.m. By so doing we have converted the machine into a synchronous alternating motor, and it will fall into step with the generator and run steadily along like any other alternating motor. Its speed will be 1500 r.p.m. and the current in its armature will reverse precisely as if it were being generated therein instead of arriving from the outside. The fields in this case would have to be excited from some external source.

While the motor is running in this wise what will happen if we let down the brushes *B B* and close a circuit upon them? There are now two paths open for the alternating current sent in through *C*. One of them is via the armature windings, and against the counter e.m.f. of the field to the other collecting ring, just as before the brushes *B B* were connected. The other is through the windings to a brush *B*, and through the external circuit to the other brush, thence through another bit of the armature winding to the opposite collecting ring.

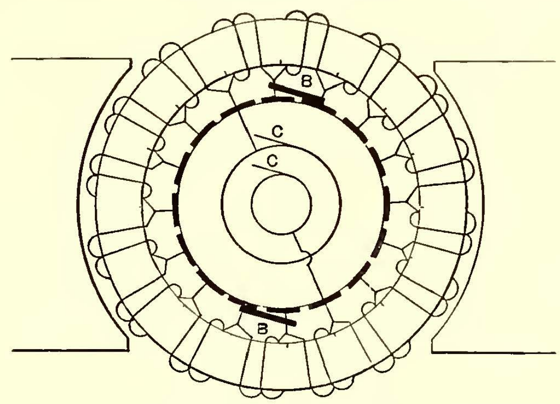


FIG. 1.—CONNECTIONS OF SINGLE PHASE ROTARY CONVERTER

Evidently the current will divide itself between these two paths, both being available. But the portion, which takes the path through *B B*, is passed through the commutator in the regular way, and emerges as continuous current in the external circuit just as if it were generated in the armature itself. For the alternating impulses sent into the armature are timed with respect to the position of the windings just as if they were generated there and are kept in this relation by the fact that the armature is kept in synchronism by its action as a motor. The energy required merely to keep up this rotation is very small, and as in other motors the counter e.m.f. automatically keeps the motor current down to the modest amount necessary to supply this energy. All the rest of the current which can be supplied to the machine up to the limit of endurance of the armature conductors may be taken from the commutator as continuous current. In fact, an armature used in this way will stand rather more current without overheating than could safely be generated in it. For the current which passes on to the line through the brushes *B B* is not compelled to traverse the whole of the armature windings, but only such parts of them as are between the brushes and the commutator segments to which the rings *C C* are connected. In fact, there will be a moment at which the current can pass directly from $C\ C$ to $B\ B$, and on the average the path of the commuted current is much shorter than if the same armature were used to generate it. From what precedes it at once becomes a natural inference that any continuous current dynamo can be worked as a rotary converter if properly connected. This, within limits, is true, and the first rotary converters were formed by adding collecting rings to ordinary dynamos.

We have seen, however, that every dynamo is intrinsically fitted to generate current of a particular frequency at its regular speed, and unless supplied with alternating current of that frequency the speed would have to be changed in using it as a rotary converter. In point of fact most dynamos have too few poles to be thus converted unless at a much higher speed or lower frequency than is desirable.

FIGS. 2 AND 3.—THREE PHASE AND QUARTER PHASE CONNECTIONS

So far we have dealt only with the converter for single phase current, which is used only to a very limited extent. Single phase synchronous motors are not self-starting, so there would be trouble in getting such a rotary converter up to speed, and, besides, there are excellent reasons for using in preference the polyphase systems for power transmission work.

The polyphase rotary converters operate on precisely the principles just explained and differ only in their connections. The machine shown in Fig. 1 could be converted into a three-phase rotary converter by applying three collecting rings and connecting them to commutator segments as nearly as possible 120 deg. apart. It would operate in just the same way as before, but would be able to start itself like any other three-phase synchronous motor running light. Similarly we could make a quarter phase converter by tapping the winding at four points 90 deg. apart and applying four collecting rings to be connected to the four wires of the quarter phase system. Both these forms, the connections of which are shown, diagrammatically, in Figs. 2 and 3, give shorter average paths for the commuted current than the single phase form, and hence on the whole give rather better outputs.

Fig. 4 shows a fine specimen of the typical modern rotary converter. It is a three-phase machine of 900 k.w. capacity, designed to operate on a twenty-five cycle circuit.

Thus far we have said nothing about the question of voltage in rotary converters. The voltage applied can obviously be varied in almost any way, but it is equally obvious that if the commutator is designed for, say, 500 volts it will give trouble as in an ordinary generator, if forced much above that point. In fact, the commutator of a rotary converter is designed like that of any other machine for a particular voltage, and since the current sent into the armature should be the same as that which could be generated in it, for any given continuous voltage the alternating pressure applied should be that which the machine would give if run as an alternating generator. This is considerably less than the continuous current voltage, since the mean effective voltage by which alternating current is rated is not the crest of the wave which, however, is the voltage, approximately, coinciding with that of the continuous current given by the same machine. Now in a single phase rotary converter the alternating current leads are taken out 180 deg. apart, and in a quarter phase there are two pairs of wires separated by the same amount so that in these cases, if the machine gave a sine wave, the effective alternating voltage would be $\frac{1}{\sqrt{2}}$ times the corresponding continuous voltage, *i. e.*, about seven-tenths as great. In the three-phase form the corresponding alternating voltage is still further reduced by the fact that while the continuous current brushes are 180 deg. apart the alternating leads are only 120 deg. apart. The ratio in this case is $\frac{\sqrt{3}}{2\sqrt{2}}$, that is, about six-tenths.

Hence, if one wishes to derive from a rotary converter 500 volts. for railway service the applied alternating voltage will have to be about 300 to 350 volts. This, of course, means that in transmitting power for this purpose, step-down transformers must always be used. The exact ratio between the alternating and continuous pressures is subject to some slight variations due to the alternating wave shape and various minor causes, and one cannot in any way change either voltage without affecting the other. This is sometimes an inconvenience, for it makes the continuous current voltage subject to any inductive disturbances on the alternating side of the line.

Since the voltage at the commutator is not generated by the armature directly, it is not directly affected by the field strength as in ordinary dynamos, hence compound winding does not affect a rotary converter in the ordinary sense. Indirectly, however, it can be made to serve a useful purpose by reacting upon the alternating side of the line, and thus varying the applied voltage very materially. It is a well-known fact that the voltage at the motor end of a line driving a synchronous alternating motor can be varied within wide limits by changing the field strength of the motor, and this holds true of the rotary converter which, as we have seen, acts as a motor.

Another curious feature of the machine is the fact that the polarity of the continuous current derived from it depends on the way the alternating current is flowing when the brushes are put in circuit. If they catch a positive impulse the current is in one direction, if a negative impulse, in the other. As they are, however, so they stay, and it is not a difficult matter to get the polarity right.

In their general behavior, rotary converters are strikingly like the best continuous current generators. They operate beautifully in parallel on either side or both sides, spark very little, show very little armature reaction, stand overloads well and really leave little to be desired in point of efficient and smooth operation. Their efficiency is in fact rather higher than if they were used as generators, for the reasons already pointed out, and their use gives a thoroughly practical method of deriving continuous from alternating currents. Only in rare cases is their chief weakness—the complete interdependence of the two circuits—of any moment. Occasionally, when the transmission circuit is very long and must be kept clear of complicated line reactions, or when the frequency used is inconveniently high or low, it is best to fall back on the motor generator. Rotary converters can be built for any frequency, but a large machine for high frequency forces an extreme multipolar construction to keep down the peripheral speed, and this means a very complicated commutator. On the other hand a very low frequency would compel a bipolar construction when a multipolar machine would be cheaper and better. Under ordinary conditions the rotary converter is at its best at from twenty to forty cycles per second.

When the motor generator is used it takes some such form as is shown in Fig. 5, which is a 500 k.w. machine, designed for use on a transmission circuit eighty miles long. Such a combined unit is a few per cent less efficient than a rotary converter and somewhat more costly, but counting in the cost and loss of efficiency in the transformers needed to supply low voltage to the latter, the difference is less than would be at first supposed.

Having thus looked over the general properties of the rotary converter we may pass to the conditions attending its economical use for railway purposes. In its relation to the working line it must be considered merely as a continuous current generator. So far as it is concerned with the trolley line proper, a sub-station with rotary converters is precisely the same thing as an independent generating station, with the same arrangements for feeding the trolley line and the same relation to the general conditions of operation. By employing such a sub-station one merely substitutes current delivered over high voltage feeders from a distant point for current generated on the spot. In general the use of rotary transformers is for one of two purposes—to utilize water power situated at a point distant from the railway line, or to feed a long line from a single steam-driven station. These are two entirely distinct propositions so far as the economics of the matter is concerned.

The first involves the comparative cost of water power and steam power delivered at a given point, the second the relative cost of steam power generated in stations of different sizes and with different load factors. The margin for profit is generally greater in the former case than in the latter, and instances of the successful use of rotary converters are in the former correspondingly more numerous.

There are at present numerous examples of railways driven by transmitted water power through the agency of rotary converters. The first instance of this kind was the Portland, Ore., road, which for the past four or five years has been operated by a thirteen-mile transmission from the falls of the Willamette. Then there are the two great plants of this kind at Buffalo and at Minneapolis and a considerable list of smaller installations. It is not too much to say that all of these have been successful and economical, for they have substituted comparatively cheap water power for rather dear steam power. The question here is merely the general problem of electrical power transmission from waterfalls.

A fine example of this use of a rotary converter station is shown in a long road of the interurban class between Barre and Montpelier, Vt. It is in a region where steam coal is quite dear owing to long transportation by rail. A water power quite off the line of the road but already developed for lighting and power purposes was available, and a transmission line was put in carrying current at 6000 volts about sixteen miles to the sub-station near the middle point of the road. Here was installed the set of reducing transformers and the 150 k.w. quarter phase rotary converter. This is operated in conjunction with a storage battery of moderate capacity to steady the voltage and render the load factor more uniform. In this connection it should be noted that while the steadying influence of the battery is less important here than in a steam-driven station, on the other hand, with cheap water power the loss of energy in the battery is not a serious matter, and with the battery to help on the peaks of the load the capacity of the transmission plant can be materially reduced and the efficiency raised enough to partly compensate for the loss in the battery. This plant has been in operation only a few weeks, but is working admirably and furnishes a fine typical example of the proper and legitimate use of both the storage battery and the rotary converter. It is one of the very few rotary converter plants installed in New England, by far the greater part of such work having been done in the West.

When we come to the other case—the distribution of power from a central steam-driven generating station to sub-stations scattered over a city or along an extended railway line, the conditions are very different. Here there is no chance for wholesale saving in the cost of power, but there is the opportunity for substituting one large station for several of less capacity and dispensing with a very large amount of feeder copper. Ordinarily, when large amounts of power must be furnished to outlying districts feeder copper is installed to meet the growing demand until finally the amount becomes very burdensome and then a new station is built. As an alternative a sub-station with rotary converters and a high voltage feeding line may be installed. In the case of a long interurban line the feeder copper is a burden from the very start, and the question of separate stations versus transmission to sub-stations is at once pertinent. The advantages of this procedure may be very material. In the first place, all the power generation is done in a single large station, which can be located at the most advantageous point along the line, so that one gains the saving always found in working on a large scale. Second, by this concentration the central station gains in having a load factor somewhat better than any one of several separate stations could have, while the load factor of a rotary transformer station can never lead to any gross inefficiency.

All this is very nice, but there are a few other things to be remembered. The cost of the rotary converters, transformers, line and generator and station capacity to operate

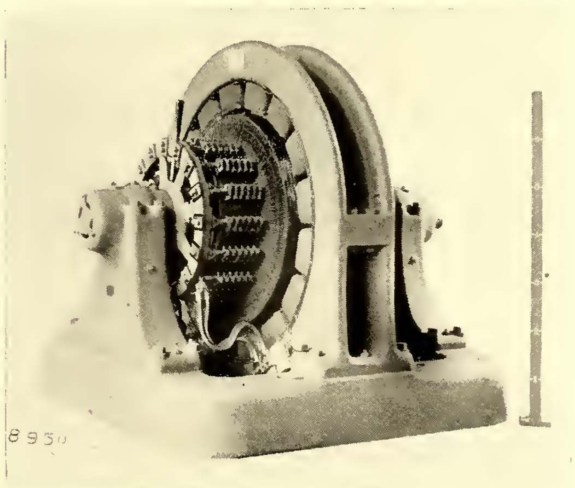


FIG. 4.—900 K.W. ROTARY CONVERTER

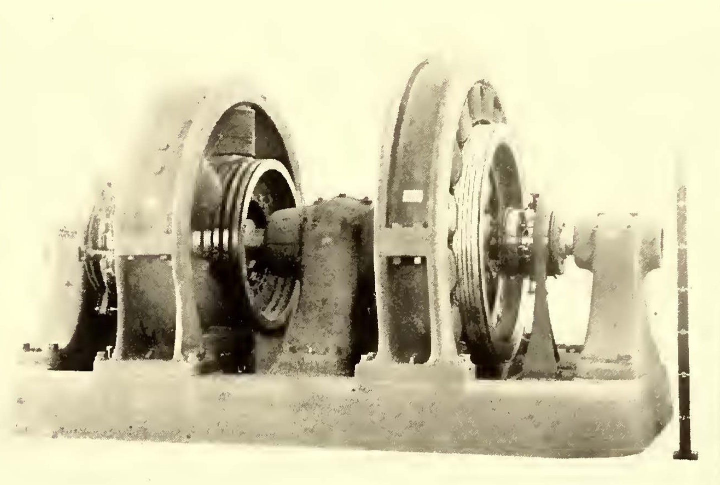


FIG. 5.—500 K.W. MOTOR GENERATOR

the sub-station system will generally be greater than the cost of separate stations—much greater if these stations are few in number and of fairly large capacity. Usually, too, the total labor account will be increased rather than diminished, since there will always have to be at least a small force at each sub-station and added force at the main station, besides the care of the transmission line, an item which it is by no means safe to neglect.

And finally it must not be forgotten that for every k.w. delivered from the terminals of the rotary converters at least $1\frac{1}{4}$ k.w. must be generated at the central station, and usually more than this. In other words, one cannot reasonably expect to get from the transmission system—line, transformers and rotary converter—an all-day efficiency higher than about 80 per cent, and it will oftener be 75 per cent than 80. If one were working under conditions of maximum economy 80 per cent could certainly be surpassed, but railway work does not furnish these conditions.

The cost of the transmission plant and depreciation thereon add still other charges against the system, and the upshot of the matter is that unless the central station can generate power fully 30 per cent cheaper than it can be generated in several separate stations, distribution to rotary converter stations will not pay. Let us now proceed to investigate the chances of meeting this condition.

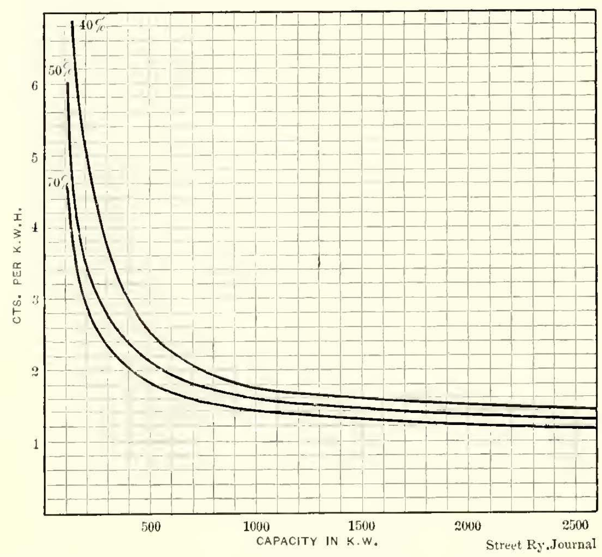


FIG. 6.—DIAGRAM SHOWING COST IN CENTS OF K. W. HOURS

The first thing to be looked into is the variation of the cost of power with the size of the generating station and with the load factor. This is of course a variable in each case depending on the relative costs of fuel, labor, etc., but under particular assumptions as to these items for any special locality, the variation we are seeking can be readily deduced. The curves of Fig. 6 give a typical case, and the relation between the different values indicated will not vary materially within the limits usually found in practice.

Fig. 6 shows the approximate cost of power in cents per k.w.h. for stations of 100 to 2500 k.w. capacity, working at load factors of 40, 50 and 70 per cent. The latter figure is only reached in large city plants operating a great many cars. Fifty per cent is a common load factor for well-handled systems of moderate size, and 40 per cent is by no means rare. The curves are based on coal at three dollars per ton and steam and electric plants of average character, neither exceptionally good nor unusually bad. The absolute costs are of course only approximations, but are well borne out by the results reached in practice. They include interest and depreciation, two important items generally left out of the published costs of power, and hence appear high to the uninitiated.

Bearing in mind the fact that there is generally no difficulty in getting a good load factor in plants of 1000 k.w. or more, let us look over these curves with relation to the use of rotary converter stations. From 1000 k.w. upward the cost of power falls very slowly indeed. We have just seen that to justify the use of rotary converters a central generating must generate power much more cheaply than several independent stations, since to make up for losses in transmission and extra cost of plant one must count on producing at least 1 1-3 k.w. for each k.w. delivered from the converter stations. It is therefore apparent that with sub-stations as large as 1000 k.w. there is small chance for economy in using sub-stations, unless the total output is very great indeed. The central plant would have to run considerably over 10,000 k.w. before it could pay to employ sub-stations of that size on street railway service. It is conceivable that if one were operating a long interurban road with heavy traffic and at high speed such an arrangement might pay in virtue of improved load factor, but even in this case the long distances of transmission would tend to more than offset the gain. Data from actual plants tend to show, too, that above a few thousand k.w. capactiy there is practically no material decrease in cost of power. There is strong reason to believe, therefore, that it can seldom or never pay to operate a large urban system from a single plant with rotary converter sub-stations. In fact such a scheme of operation should be turned down on the score of putting too many eggs in one basket if for no other reason. It may readily happen, however, that at some remote point of such a system a sub-station may be profitably utilized, employing perhaps rotary converters of a type that can be utilized later as generators when it becomes desirable in the growth of traffic to erect an independent station or to link several stations together by a transmission system.

When the total output required must be divided into scattered units of only a few hundred k.w. each, the advantages of transmission become more important. If for example one is operating a considerable interurban line requiring, say a total capacity of 1000 k.w., and the question arises between two 500 k.w. stations and a 1000 k.w. station with a 500 k.w. sub-station, considerable discrimination is required. At 70 per cent load factor in a 1000 k.w. station the cost per Fig. 6 will be about 1.4 ct. per k.w. h. In a 500 k.w. plant at the same load factor the cost would be about 1.8 ct. This in itself is too small a margin to justify rotary converters. If, however, the 500 k.w. plant cannot be assured of a load factor higher than 50 per cent the cost will be say 2.15 cts., while the larger plant remains at 70 per cent, thus shifting the balance to the other side of the ledger. The question of economy, therefore, hinges under such conditions on the relative load factor of the whole system and of its parts. Few data are available on this particular item, since nearly all plants aggregating 1000 k.w. or even several times as much are operated from a single station. In the few systems operated from several power stations the load factor does not vary greatly between station and station, but the stations are mostly so large that little variation would be expected. With an aggregate power as low at 1000 k.w. the use of sub-stations is evidently on debatable ground. On the other hand with an aggregate power of 500 k.w. such as might exist on an interurban line, the curves make it very evident that transmission to a sub-station would pay.

In general one may safely say that unless a line requires for independent stations in the neighborhood of 500 k.w. each, there is a strong probability that transmission from a single station will pay. With outputs above that point sub-station work will very often be found to be uneconomical. The dividing line between the two cases appears to lie under ordinary conditions somewhere between 250 and 500 k.w. for each station, where only two stations are concerned. It must not be supposed, however, that one can settle the case once for all by installing a number of small sub-stations, for with extreme sub-division one comes at once into competition with boosting and other modifications of ordinary feeding systems.

Under present conditions the rotary converter finds its most important use in the utilization of water power for railway purposes and in this field its importance must not be lightly estimated. In some interurban work it is likely to find a legitimate and important use even when operated from a central steam plant. In heavy city and suburban work its value is, to say the least, very problematical so far as general distribution is concerned, although it is not unlikely to prove a useful adjunct. Its chief weakness is the fact that, like other moving machinery, it requires attention, and furthermore it cannot be applied without a very material loss of energy. Skilfully used, however, it is a most valuable addition to the resources of modern engineering.

ELECTRIC RAILWAY MOTORS

BY GEO. T. HANCHETT

X.—General Data and Dimensions.

The preceding articles while descriptive of modern practice in electric railway motors, have to a certain extent reviewed development, and compared the most modern development with some of the much used and older forms. It is interesting to note which way general practice has tended.

With regard to motor cases there is no question but that the preferred form is the iron-clad four-pole machine, all the poles being salient. The consequent pole machine unless very carefully designed is certain to produce sparking troubles at the commutator, due to the fact that the consequent poles do not afford the same intensity of field at their tips as do the salient ones. Moreover, a consequent pole machine is essentially long in its vertical dimensions. It does not divide conveniently excepting on a line parallel with its field windings. Abroad, a diagonal division has been tried, thus turning the motor in such a position that its shortest dimension is a vertical one. This certainly seems to be an improvement over American practice in consequent pole street railway motors, but has only been used by the home companies in one case, that of the Sperry Electric Railway Company, formerly of Cleveland, Ohio. The four-pole salient machine was first introduced by the Westinghouse Company and is now universally used in American practice.

The bearings on railway motors are receiving much more attention by modern designers. It has begun to be appreciated that the greatest wear and tear comes upon the pinion bearing and that it is desirable to make this as long and substantial as possible. Eight inches is not an uncommon length on modern 30 h.p. sizes. It seems advisable to make the pinion bearing large, even sacrificing the advantage of bearings of uniform size and interchangeable bearing shells.

While the iron-clad housing is a necessity in street railway work, it unquestionably confines the heat and reduces the permissible output of the motor, and on heavy traction over private rights of way or elevated railway work, where the mud and dust conditions are not severe, modern practice leaves the motor case open as much as possible. The practice of having all of the openings of the case on street railway motors closed by hinged bolts is a desirable feature and is being largely adopted.

The universal method of opening street railway motors is now to swing the lower half downward, and provide means by which the armature may be retained in either half at pleasure. This method was first introduced by the Walker Company. The Westinghouse Company quickly followed suit with its No. 30 machine, and within the past year the General Electric Company has conceded the general superiority of the practice in the G. E. 52 machine.

The pole pieces on the larger sizer of modern motors are now being constructed of laminated plates. These plates are bolted together in a bunch and then drilled and counter sunk with holes parallel to the laminæ and secured to the casing by long bolts. The object of this has been to increase the efficiency of the machine. Within the past year strenuous efforts have been made by modern designers to increase the efficiency of the railway motor. This has been a most difficult task, for in spite of all efforts it has stuck very persistently at about 85 per cent. Some of the most recent results, however, are surprisingly good. The efficiency has been brought up in some cases, so the makers allege, as high as 92 per cent, a figure closely approaching generator efficiency.

The preferred armature winding is now on the straight out plan. The reduction of dead wire on the armature circuit combined with the ease of inserting the coils is too great an advantage to be overlooked. The chief objection that has been urged against the straight out winding is that it produces an excessively long armature, but the fact that it is generally adopted in railway practice has effectively demonstrated that the objection is not a valid one, for in no case of dynamo or motor design is a short armature more desirable than in a street railway motor.

The toothed armature undoubtedly owes its present popularity largely to the street railway motor. Its magnetic efficiency and its ability to withstand severe service was so well demonstrated in this field that it has been widely adopted elsewhere. Modern practice in street railway armatures seems to tend to reducing the armature diameter and the number of slots and increasing the number of conductors per slot. A most marked illustration of this policy appears in the G. E. 800 and G. E. 52 motors. The first motor has 105 slots and 6 wires per slot. The second, which is the more modern type, has 29 slots and 24 wires per slot. Railway motors have to be repaired so frequently that this is a great advantage, as it adds to the ease of winding, besides it makes the teeth on the armature much broader and enables it to withstand the severe abuse which they would receive if the bearings were neglected and the armature allowed to strike against the pole pieces.

The universal winding used for street railway motors is the series or wave winding, employing two brushes on the quarter, although if desirable four brushes could be used for the sake of greater conductivity. By this winding the number of brushes is reduced, their position is conveniently arranged underneath the lid on the commutator, the speed of the motor is one-half that which would obtain with a parallel winding with the same number of conductors and the two circuit winding is not effected by the unbalancing which might occur by the decentralization of the armature. All of these are very important advantages in railway motor design.

The popular gearing is the single reduction spur gear, although great results are predicted for the gearless motor in heavy sizes. It may also be added that the worm gear

DIMENSIONS, WEIGHTS, ETC., OF PRINCIPAL TYPES OF RAILWAY MOTORS.

Designation.		General Data.														Weight, Lbs.			Dimensions, Inches.									
No.	Name of Motor.	Service.	H. P.	Maker.	Speed at Full Load.	Reduction Ratio.	Gearing. Pin.	Gearing. Gear.	No. of Poles.	No. of Field Coils.	Total Field Turns.	Slots in Armature.	Conductors per Slot.	Commutator Bars.	No. of Bands.	Complete with Gears.	Armature Complete.	Gears and Casing.	Commutator Bearing. ×		Pinion Bearing. ×		Diameter of Armature.	Length of Armature.	Field wire B. & S.	Armature wire B. & S.	Remarks.
1	S. R. G. 30	St. Railway	15	Thomson-Houston	----	4.78	14	67	2	2	206	64	32	64	--	2,275	484	300	2	2¾	3⅜	5½	14½	8⅝	------	------	Ring armature, 16 turns per section.
2	W. P. 30	St. Railway	15	Thomson-Houston	----	4.78	14	67	2	1	139	64	16	64	None.	1,975	665	325	----	----	----	----	19⅝	7 7-16	------	------	Ring armature, toothed armature retained in lower half of frame.
3	W. P. 50	St. Railway	25	Thomson-Houston	----	4.78	14	67	2	1	102	64	9, 12 or 13	64	None.	3,280	925	347	2¾	3 1-32	2¾	6 1-16	19⅝	11 1-16	No. 4	.34 × .04	Ring armature, toothed, wound with flat ribbon
4	S. R. F. 30	St. Railway	15	Thomson-Houston	----	4.78	14	67	2	2	320	Smooth Body	10	64	--	2,260	335	360	3 33-64	3 1-32	3 33-64	6 1-16	9¾	9	------	------	Smooth body drum.
5	G. E. 800	St. Railway	25	General Electric Co.	----	4.78	14	67	4	2	203	105	6 + 8	105	--	1,800	635	235	2½	4½	2½	6	16	8	------	------	Eickmeyer drum, armature retained in lower half of frame.
6	G. E. 1000	St. Railway	35	General Electric Co.	500	3.94	17	67	4	4	143.5	93	8	93	--	2,185	578	285	2⅝	6⅜	3	8	14	13⅛	------	------	Eickmeyer drum, armature retained in upper half of frame.
7	G. E. 1200	Interurban	38	General Electric Co.	----	3.53	17	60	4	2	198	105	8	105	--	2,975	963	294	3¼	6	3¼	8	16	13	.....	------	Eickmeyer drum, armature retained in lower half of frame.
8	G. E. 2000	Interurban	138	General Electric Co.	----	3.18	17	54	4	2	84	141	2	141	--	4,650	1,450	355	3¼	6	3¼	8	18½	13¼	------	------	Eickmeyer drum, armature retained in lower half of frame.
9	G. E. 51	Interurban	82	General Electric Co.	----	1.74	31	54	4	4	56	37	12	111	--	3,875	953	338	3	5¾	3¼	8¼	16	10.5	------	------	Straight out winding, armature retained in upper half of frame.
10	G. E. 52	St. Railway	27	General Electric Co.	----	4.78	14	67	4	4	155.5	29	24	87	--	1,725	357	265	2½	6⅜	2¾	7¾	11	9	------	------	Straight out winding, armature retained in upper half of frame.
11	G. E. 57	Tr'ction He'vy	52	General Electric Co.	----	3.72	18	67	4	4	110	33	18	99	--	2 972	704	340	2⅞	6⅜	3¼	8¾	14	12	.....	------	Straight out winding, armature retained in upper half of frame.
12	No. 3	St. Railway	20-25-30	Westinghouse Elec. & Mfg. Co.	300	3.45	18	62	4	4	----	95	----	95	22	2,800	----	----	1¾	4 11-16	2½	5½	11⅝	15	------	No. 11	Rectangular formed coils.
13	No. 12	St. Railway	25-30	Westinghouse Elec. & Mfg. Co.	525-715	4.86	14	68	4	4	----	47	----	93	13	----	----	----	2	5¾	2½	6	----	----	------	------	
14	No. 12 A	St. Railway	25-30	Westinghouse Elec. & Mfg. Co.	510-550 685	4.86	14	68	4	4	----	47	----	93	14	2,270	360	350	2½	6	2½	6	11⅝	8⅛	------	------	One coil cut out.
15	No. 38 B	Interurban	50	Westinghouse Elec. & Mfg. Co.	520	2.42 3.56 4.86	24 18 14	50 64 68	4	4	----	45	----	135	6	2,340	525	325	2¾	6	2¾	6	13⅞	----	------	------	Three coils per slot, no dead coil.
16	First Walker Motor	St. Railway	25	Walker Mfg. Co.	375	3.65	----	----	4	4	167	101	6	101	----	----	----	----	----	----	----	----	15	13	No. 8 B. W. G	No. 10	Rectangular formed coils.
17	No. 3 N.	Narrow Gage	25	Walker Co.	600	4.78	14	67	4	4	144	55	16	109	3	2,079	405	292	----	----	----	----	12¾	14⅝	.180" diam	.09" diam	Eickmeyer winding.
18	No. 2 Special	Narrow Gage	20	Walker Co.	400	5.41	17	92	4	4	125	48	30	143	----	1,800	----	----	----	----	----	----	15	13¾	.180" diam	.08" diam	Eickmeyer winding.
19	3 S	St. Railway	25	Walker Co.	600	4.78	14	67	4	4	154	95	8	95	4	2,165	410	308	2½	5½	2½	5½	12¾	9¼	165" diam	.102" diam	Straight out winding.
20	4 A	St. Railway	30	Walker Co.	550	4.78	14	67	4	4	161	95	8	95	5	2,250	----	----	2½	5½	2½	5½	12¾	9¼	.180" diam	.102" diam	Straight out winding.
21	No. 10	Suburban	50	Walker Co.	525	3.90	19	74	4	4	109½	95	6	95	5	3,040	750	414	2¾	6	2¾	6	15	10	No. 2	No. 7	Straight out winding.
22	No. 15	Interurban	75	Walker Co.	580	3.29	17	56	4	2	135	57	8	227	3	4,450	1,050	490	3	6	3	8½	18	8⅝	No. 0	.042 × .6	Straight out winding.
23	No. 20	Interurban	125	Walker Co.	660	3.375	16	54	4	2	90	63	4	125	----	4,700	----	----	3¼	6¼	3¼	8	18	13	No. 000	.072 × .7	Straight out winding.
24	No. 25	Interurban	200	Walker Co.	750	4.4	15	66	4	4	65	73	6	218	10	5,530	1,395	495	3½	6½	3½	9	19	13½	B. W. G. No. 0000	.045 × .6	Straight out winding.
25	Gearless	St. Railway	20	Short Elec. Ry. Co.	110	----	----	----	6	3	264	48	16	184	----	2,300	----	----	----	----	----	----	21	14⅜	.165" diam	.09 × .13	Hand wound ring.
26	Short S. R. G.	St. Railway	20	Short Elec. Ry. Co.	550	5	----	----	4	8	----	48	30	144	----	2,220	----	----	----	----	----	----	21¾	5⅜	......	.063 × .100	Hand wound ring.
27	Oerlikon	St. Railway	20	Oerlikon Mac. Wks.	400	4.2	----	----	4	4	----	----	----	----	----	2,424	----	----	----	----	----	----	----	----	------	------	
28	Oerlikon	St. Railway	15	Oerlikon Mac. Wks.	----	5	----	----	4	4	----	----	----	----	----	2,050	----	----	----	----	----	----	----	----	......	------	
29	Oerlikon	St. Railway	10	Oerlikon Mac. Wks.	450	5	----	----	4	4	----	----	----	----	----	1,764	----	----	----	----	----	----	----	----	------	------	
30	S. R. G.	St. Railway	30	Edison Gen. El. Co.	----	4.78	14	67	4	2	----	----	----	----	----	2,270	----	----	----	----	----	----	----	----	------	------	
31	S. R. G.	St. Railway	15	Edison Gen. El. Co.	----	4.78	14	67	4	2	----	----	----	----	----	1,600	----	----	----	----	----	----	----	----	------	------	

has never received a fair trial in this country, and that it possesses a great many advantages which are by no means insignificant. The worm gear permits the use of a motor of high speed and efficiency, which incidentally involves very much reduced weight, and further the motor connected by worm gearing need not be mounted rigidly on the axle but can be completely spring suspended at a long distance therefrom. Still another advantage obtains in the fact that a motor so geared becomes an effective brake on the wheels unless supplied with current. The wheels cannot turn the motor, for the worm gear is not a reversible combination unless the pitch of the worm is very high. The fact that many of the old Sprague double reduction motors are now being used on many street railways and are preferred by many managers of some of the early single reduction types such as the W. P. 50 and Westinghouse No. 3, gives ample notice that a light motor would be well received, even at the expense of a lower efficiency in the gearing. It is further to be added that the worm gear is noiseless.

In the days of exposed gears, sprung shafts were of such frequent occurrence that considerable attention has been devoted to making the shaft of a railway motor very stiff. Its diameter is now considerably larger than in motors of equal capacity used for other purposes.

RAIL BONDS

In probably no other branch of electric railway construction has greater progress been made, since the early days of railroading, than in that of connecting the rails electrically for the return circuit. The original method was to use a small galvanized iron wire riveted to the web of the rail. This arrangement was copied largely from the practice of the steam railroad companies in bonding their rails for the electric block signal system, and the bonds were hardly, if any, larger than used for that purpose. It was thought that the earth could be used mainly for the return circuit, and efforts were made to secure good connections with the earth by buried plates, rods and other means. Modern practice, on the contrary, tends to confine the return current to the rails as much as possible, and to make the carrying capacity of the connection round the rail joints as good as that of the rails themselves, supplementing the carrying capacity of the rails where there are large currents by the use of return feeders, either overhead or underground. Galvanized iron is no longer looked upon as a desirable material for bonds, and in nearly all of the modern bonds its place is taken by copper.

The connection between the rail bond and the rail itself is a most important consideration. Where copper is used for the bond, local electric action will take place between the two dissimilar metals, copper and steel, unless moisture is excluded, so that all modern bonds provide for an absolutely water tight joint at this point. Again the electrical carrying capacity of copper is, approximately, from six to seven times of that of the steel of the rail, so that to prevent undue heating and loss in energy at the junction of the two metals, the area of the steel in contact with the bond should be six or seven times that of the cross section of the bond itself.

Another point learned from the experience of early days is, that too much care can hardly be taken to have the surface of the bond hole in the rail bright and free from rust. If the rails are drilled or punched for bonding some time before the bonds are placed in position, it is always advisable to have them reamed out and cleaned before inserting the bond. For this purpose a special jig and ratchet is probably better than an ordinary hand reamer, so that there will be certainty of securing an absolutely smooth surface and centrally reamed hole. It is also then advisable to clean the holes with soap and water or some similar solution, to be sure there is no grease on the surface of the steel, and the bond terminals themselves should be thoroughly cleaned and polished, so that polished copper will come in contact with the polished surface of the rail. Some engineers prefer drilled holes to punched holes, considering that a more perfect orifice is secured in this way.

Another point upon which practice differs is in regard to the location of the bond. It can be attached to the rail in three positions, viz.: to the web, to the base, and underneath the head. If the connection is made to the web, a long bond can be used to span the angle plate, or a short bond can be placed under the angle plate. The advantages of a long bond are, of course, that the bond is not subject to as great vibrations as if only a short distance is spanned; its disadvantage lies in the additional amount of copper required. On suburban roads where exposed track is used, there is an additional disadvantage in placing the bond outside the angle plate, owing to the liability of its loss through theft, the amount of copper contained in a bond being sufficient to tempt the unscrupulous. The principal objection brought against attaching bonds to the base of the rail are their interference with the paving, and to their location under the head of the rail where the terminals project through the head that the upper ends of the bonds are subject to vehicular wear.

There is a large class of rail bonds at present on the market, and it is the purpose of this article to illustrate and describe the mechanical features of these bonds. So many

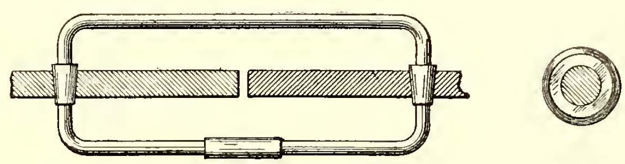


FIG. 1.—WEST END BOND

improvements have been made recently that it is thought that a description of the latest types of bonds manufactured by the companies mentioned will be of value.

Fig. 1 illustrates the West End bond manufactured by the A. & J. M. Anderson Manufacturing Company of Boston. It is designed to go round the angle plates and each end of the wire, which is commonly a No. 00 and tinned, is provided with a tapering steel bushing through which the wire passes. Holes are drilled in the rail web to receive these bushings, and they are then forcibly driven in. By reason of their tapering form these bushings are compressed as they enter the hole, and the wire which passes through them is in turn compressed. Soft steel bushings are used because it is possible to drive them in more forcibly than if copper bushings or the wire itself without the bushings were used. The wire is usually about 80 ins. in length, and the ends are joined together by means of a tinned copper slotted sleeve, 4 ins. in length, into which the ends are inserted and sweated. In Boston two of these bonds are used at each joint. The use of steel against steel in the contact, made by mechanical means, is for the purpose of having no electrolytic action at this point.

Fig. 2 is the Johnston bond made for A. Langstaff Johnston by the John A. Roebling's Sons Company. It is in five parts, the bond proper and four brass nuts. The bond is in the form of a copper rod with its two ends bent at right angles. On each of these two ends is cut a screw thread. Two nuts work upon this screw thread, one a flat nut and the other a conical nut of the same slope as the slope of the bored-out hole in the rail. The conical diameter of the nut is such that when introduced in the rail and tightened by the other nut the two ends cannot be brought quite together; in this way the contact is of a very rigid character. After the nuts are screwed tightly up so that their flanges come against the web of the rail, giving a large area of

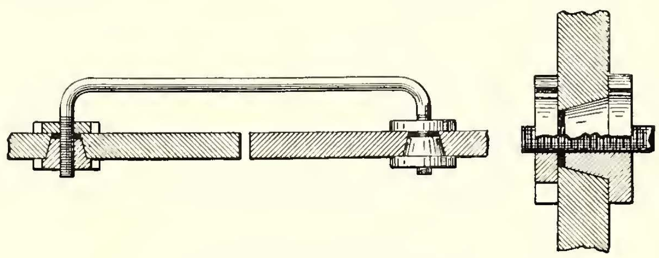


FIG. 2.—JOHNSTON BOND

contact, the protruding end of the copper rod is slightly upset, so that the outside nut cannot become loose. The joints may be then soldered, but in any case should be suitably covered with a coat of insulating paint.

Fig. 3 shows the Bryan bond manufactured by James Bryan & Co. of Pittsburgh. The bond wires, which are two in number and which can be of any size, are clasped at the rail between a washer of steel, which is directly under the bolt head, and one of copper, which is separated from the web only by a thin corrugated plate of copper. After the nuts are placed in position the steel bolt shown is screwed up tight. The immense pressure put upon the bolt presses out the corrugations of the thin copper washer, making good contact with the rail, which has been previously polished. The ratio of steel area at point of contact to the area of the bond wire is 1 to 9.46. One special advantage claimed for this bond is its great adaptability to cross bonding, as the rail bonds and the cross bonds can be made of continuous wire.

Fig. 4 illustrates the Columbia bond of the John A. Roebling's Sons Company of Trenton, N. J. It consists of three parts, two copper thimbles and a connecting rod. On each end of the copper rod is a truncated cone head with a fillet at the base. The inside of the thimble is tapered to fit the head of the bond, while the outside is slightly tapered on the opposite side. In applying the bond the cone-shaped heads are placed in the holes in the rails from the one side

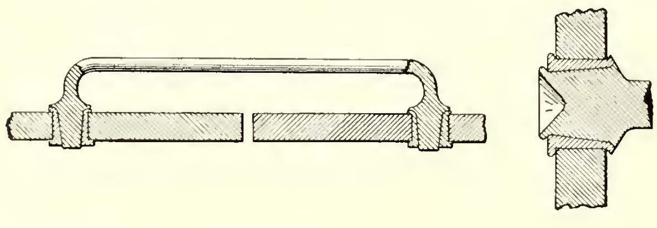


FIG. 4.—COLUMBIA BOND

and the thimbles are slipped over them from the other. A portable hand press is then applied and the wedge-shape head of the bond is forced into the thimble so that being of the same metal they become practically one, while the copper of the thimble fills up any irregularities of the web hole. The process of pressing in is claimed to be superior to that of driving in by hammer, as it admits of more uniform work, and as the bond is wedged both ways it cannot become loose. The contact with the rail, owing to the greater cross section of the bond at the web, is seven times the section of the wire.

Fig. 5 shows another type of bond in which an ordinary wire is used for a connector, but is held in place by a bonding cap. This is of steel slotted, with conical ends, and fits snugly over the ends of the bonding rail. The hole in the rail is 1-32 ins. smaller than the outside diameter of the cap. The latter is driven into place by a hammer, and the crimp extending the full length of the cap allows the shell to compress firmly over the wire and into the rail. The

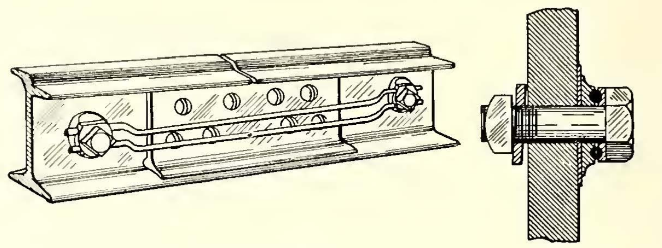


FIG. 3.—BRYAN BOND

cap is manufactured by the Ohio Brass Company of Mansfield.

Fig. 6 illustrates the solid American rail bond, manufactured by the American Electrical Works of Providence, R. I. The connector is a piece of ordinary wire held in place in the web of the rail by two bushings of copper. The outside bushing slips freely into the rail, the hole of which is tapering. The inside bushing, which is slipped over the end of the rail bond after the latter is placed through the outside bushing, is then driven into place by a sledge and follower.

Fig. 7 shows a flexible bond of somewhat the same type, supplied by the same manufacturers. The connector is a stranded wire with American terminals. The latter use a bushing similar to the outside bushing of Fig. 6, but the end is spread by driving in a special wedge, as shown.

Fig. 8 illustrates the "protected" rail bond of the Forest City Electric Company. This bond is designed to go under the angle plate. The conductor portion of the bond is made up of a closed loop of flattened copper wire in greater or less number, according to the size of the bond desired, and the copper terminals are then cast upon the wires. This produces, of course, an excellent electrical and mechanical union, which has been termed a cast weld joint. The bonds are then reheated and the terminals drop-forged to size and finish. The terminals are pressed into the rail holes by what is termed a bond welder. This is in reality a powerful press which spreads the copper of

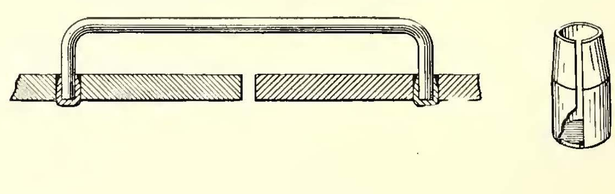


FIG. 5.—OHIO BRASS CO.'S BOND

the terminals until it completely fills the hole and spreads the head over, increasing the area of contact. This method of contact fastening is claimed to be superior to any riveting method, in that inefficient workmen cannot introduce any elements of weakness in the bonds or connections.

Fig. 9 illustrates the "Harrington ball" bond, using the same character of bond and terminals as that illustrated in Fig. 8, but employing a different method of connecting the terminals to the rail. The terminal is cored out before being slipped into the bond hole. A small steel ball, slightly larger in diameter than the core, is then forced into the hole by sledge and follower. This expands the terminals, forcing the copper closely inside the bond hole in the rail web. The ball is forced all the way through, making good contact between the copper and the steel at every point. In case the ball should slip through too easily a second ball, slightly larger in diameter, is driven through. The bond is supplied by the Harrington Rail Bonding Company, and is made under the W. R. Cock's patent.

Fig. 10 shows the "Harrington diagonal" bond, also supplied by the Harrington Rail Bonding Company, and designed to be inserted at the junction of the web and base of the rail, as shown. It is intended for bonding outside the angle plate, and made up of four copper wires rolled into a conical terminal about three-quarters of an inch in diameter at its thickest end, where it is driven in by sledge and follower. The bond is set at an acute angle, and its position through the thickest part of the rail gives it a much broader area of contact than if it was driven through the web of the rail. Another advantage of a long socket is that it is held very rigidly in place and cannot work loose. The bond itself is long enough to span the angle plate. Less paving has also to be removed if the rails are drilled in this position than if a horizontal hole through the web of the rail was drilled, the amount being figured at about 66 per cent less. For drilling, the manufacturers supply a special tool by which several holes can be drilled at the same time. The Harrington Rail Bonding Company is also selling agent for the bonds shown in Fig. 4, but made with flat terminals to go under the angle plate.

Fig. 11 illustrates the Chicago or Crown rail bond, manufactured by the Washburn & Moen Manufacturing Company. This bond is in three parts, the bond proper and two steel drift pins. The terminals of the bond are thimble shaped, and are passed through a hole in the rail, into which they should fit closely. The end is then expanded slightly with a tapering punch driven into the hole in the terminal. This serves to secure the bond in the rail, while the drift pin is driven home. The latter is 1-16 in. larger than the hole in the end of the bond into which it is driven, hence the terminal is expanded and the contact between the iron and copper is so intimate that corrosion or electrolytic action cannot occur. The end of the tubular terminal is then pounded over to provide additional surface of contact. This bond is made in several forms; one long enough to span the angle plate, the other to be placed underneath the latter. In the former case a solid bond is usually used. For a protected bond under the angle plate, stranded copper with solid terminals is employed. (Fig. 12.) The manufacturers have a special method of connecting the stranded wires with the terminals without the use of solder and by which it is impossible to tell definitely where the exact union is made. The terminal hole is not a perfect cone, but of the form shown in the engraving, this having been found in the opinion of the manufac-

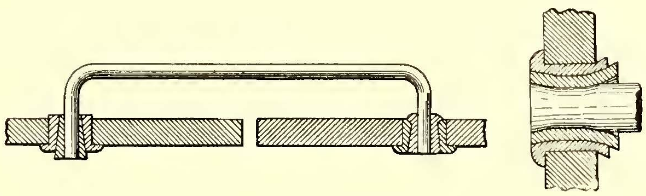


FIG. 6.—AMERICAN SOLID BOND

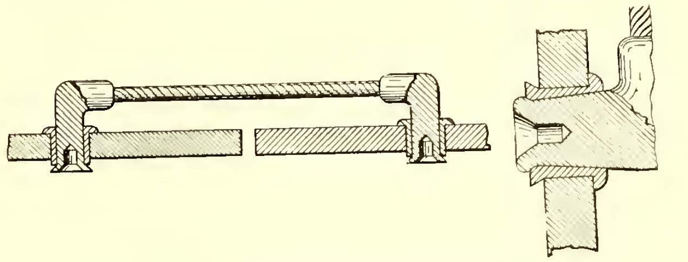


FIG. 7.—AMERICAN FLEXIBLE BOND

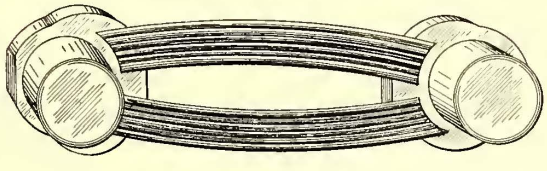


FIG. 8.—FOREST CITY BOND

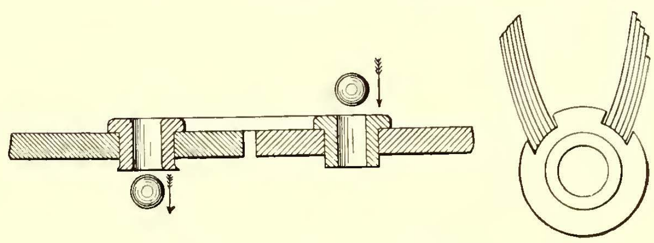


FIG. 9.—HARRINGTON BALL BOND

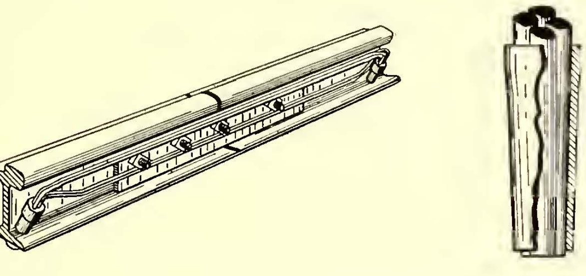


FIG. 10.—HARRINGTON DIAGONAL BOND

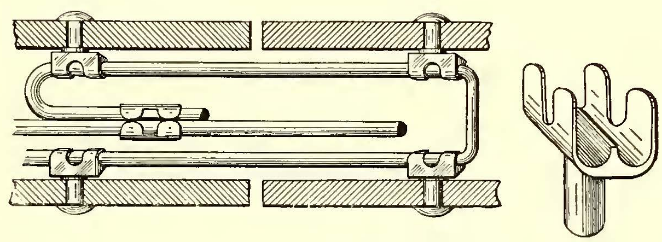


FIG. 13.—GRAUTEN BOND

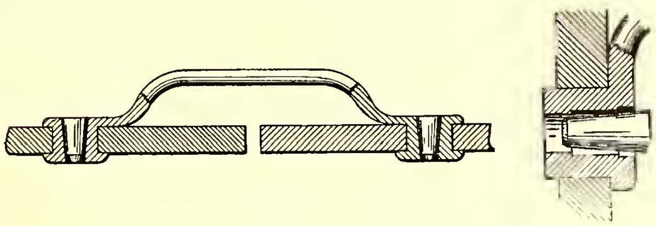


FIG. 11.—CHICAGO OR CROWN BOND.

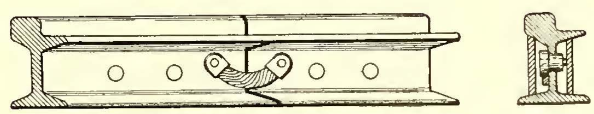


FIG. 12.—CROWN PROTECTED BOND

turers more desirable. From this form of this aperture these terminals take the name of "crown" terminal.

Fig. 13 illustrates the Grauten rail bond of the H. W. Johns Manufacturing Company of New York. It is a simple and convenient form of bond, in that ordinary wire is employed, so that it permits the use on the spot of bonds of any length, from the shortest to the longest, and of any carrying capacity both for bridging joints and cross connections. As sold, only the terminals of the bonds are furnished. These consist of a single casting of composition metal, rich in copper, with a machine finished shank for riveting in the holes of the rails, and one or more grooves

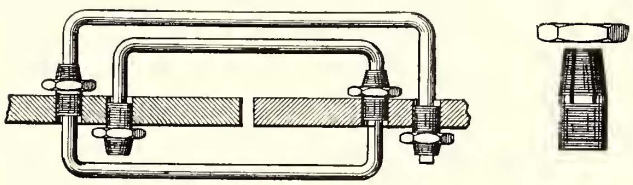


FIG. 14.—STERN & SILVERMAN BOND

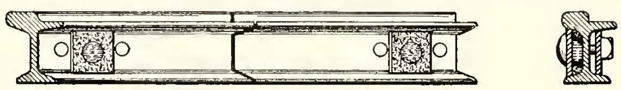


FIG. 15.—BROWN PLASTIC BOND

for the reception of the connecting wires, which constitute the bond proper. As many of these terminals are attached to the rails as are required for the necessary contact surface. The wire is then placed in the terminals, the lips of which are bent over and the connection soldered. The stock dimensions of the hub run from 9-16 in. to 3-4 in., and the shanks are cut at one end to facilitate riveting. If desired, the connecting wire can be carried the length of the rail or across to the opposite rail. The bond furnishes a method of utilizing both new and old trolley wire in odd lengths. Lately the demand has been for grooves adapted for No. 00 B. & S. gage, in preference to No. 0 B. & S., which was at first universally employed. By using the double connector or terminal and multiplying the number of attachments to the rails, it is apparent that great

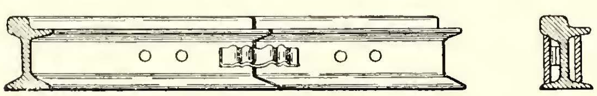


FIG. 17.—PAYNE WELDED BOND

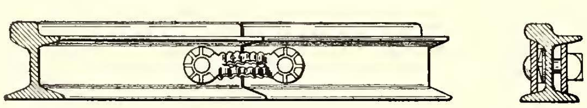


FIG. 19.—SYRACUSE BOND

flexibility in rail bonding and ample capacity are obtainable.

Fig. 14 illustrates a bonding chuck manufactured by Stern & Silverman of Philadelphia, and with which an ordinary copper wire is used as connector. The chuck is bored to fit the bond hole in the rail and one end of the chuck is screwed into the rail. The other end tapers, and is slotted to fit the bond rail, which is slipped through the chuck. The nut is then screwed up, binding the surfaces closely together, after which the joints are coated with insulating paint. This bonding chuck is of steel and allows the lacing of the bonding wire, if desired, as shown in the engraving.

Fig. 15 illustrates a method of bonding in which the angle plates are depended upon for connecting the rails, the device being a method of connecting the rails with the plates. The bonds are composed of two parts, a plastic or putty compound of good conductivity, which makes contact between the rail and the angle plate, and a flexible cork washer to hold the plastic compound in position as near the end of the rail as possible. The current then passes through the bond to the channel plate, then through the second bond from the plate to the next rail. Contact spots, about 2 ins. in diameter, on both rails and plates are cleaned of soil and rust and treated with an alloy which silvers the surface and prevents them from rusting. Usually

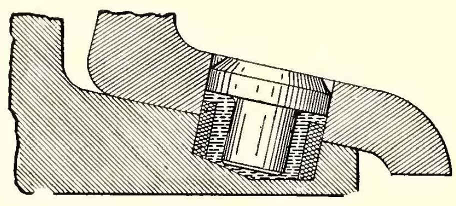


FIG. 16.—BROWN BOND FOR OLD RAILS

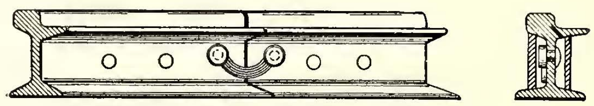


FIG. 18.—ATKINSON BOND

the plastic bonds are installed by the same gang which puts on the angle plates. For cleaning the rails a portable hand power emery or carborundum wheel, with flexible shaft, is usually used. This is usually leased or purchased from the bond manufacturers. After the joint is completed the outer angle plate is usually marked with white paint to indicate the presence of the bond. The material is the invention of Harold P. Brown of New York, and has been in use on some roads for over three years without change or deterioration.

Fig. 16 illustrates a somewhat different method of using the same material for rebonding old T or girder rails. On the end of each rail a hole five-eighths in. to seven-eighths in. in diameter is bored diagonally through the bottom of the angle plate and into but not through the base of the

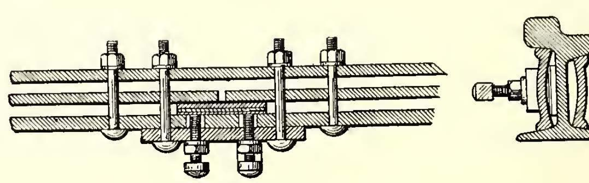


FIG. 20.—AJAX BOND

rail. The drill has a point with a very obtuse angle, and as it penetrates the lower surface of the plate it carries down a burr into the surface of the rail. As the hole progresses a part of this burr is carried into a part of the rust between the two steel surfaces, forming a telescope hole, which is perfectly smooth on the inside. The drill is wet with a solution of soda and water, instead of oil, to prevent the trouble which follows the use of an insulating fluid on a metal contact surface, and the drill chips are removed with a permanent magnet. The hole is then amalgamated with the solid alloy, and then partly filled with the plastic alloy, all of which forms a conducting path of low resistance between the rail and angle plate. An amalgamated copper plug, T shaped, seals the hole and completes the circuit between the rail and angle plate, by dipping into the plastic alloy. The plug is then locked in place by a burr made by a blunt chisel.

Fig. 17 shows the Payne welded bond, which is simply a corrugated strip of copper with flat terminals welded under the rail. The bond can be placed in any position, either on the web, on the base or under the head, and has the advantage, of course, of using only a small amount of copper with the same conductivity, and of being of but one piece. The rail is manufactured by the Payne Welded Bond Company, of New York.

Fig. 18 illustrates the horse shoe rail bond, manufactured by J. M. Atkinson & Company, of Chicago. This bond is designed to go under the angle plate, and is made in the form shown, of a horse shoe, or in a double horse-shoe form, in which the terminals are connected by two sets of conductors. The bond terminals are expanded in the rail holes by pressure applied by a screw and ratchet-clamp.

Fig. 19 illustrates the Syracuse bond, manufactured by the Central City Brass & Manufacturing Company, of Syracuse, N. Y. This bond is made in both short and long lengths for use around the angle plate or underneath it; the engraving shows the latter position. The characteristic of the bond is the use of broad, flat terminals, which can be brazed to the rail. The plates are made a part of the wire, and their contact surfaces are ground down true on a surface girder. They are cleaned with soldered salts, and then dipped in melted solder, the superfluous metal being allowed to run down and settle on the surface. The bond is then placed around the bond hole in the web of the rail, which has previously been faced off, the clean metal being treated with some soldering salts and the bond bolted in place until the washer is flattened out. The soldering process is accomplished by a gasoline torch, the effect of which is the melting of the solder on the plate. This is accomplished by the springing action on the part of the lock washer, which draws the bond plate into closer action with the rail and squeezes out the superfluous solder around the outer edges. When the bond is used under the fish plate the bolts are not used, but instead a clamping device, which is taken off after the bonds are brazed to the rail, is employed.

Fig. 20 shows the Ajax bond, supplied by the Ajax Metal Company, of Philadelphia. This bond consists of copper strips, which are placed under the fish plate and are pressed against the side of the rail by screws, as shown. Before being placed in position, the faces of the rail web are amalgamated, as are also the faces of the copper strips, making a good metallic contact. The screws are fitted with nuts so that there is adjustable means of renewing contact. The special advantages claimed for this bond are the provision for expansion and contraction of the rail, and the fact that the bond is uniform in character.

I am frank to say that my opinion is simply this—that municipal interference with street railways and their vested interests must be fought with facts, and not with charges; and it seems to me most ill-advised on the part of this association to take as its main ground against municipalities operating street railways, that the officers of the municipalities are not to be trusted by the people. It seems to me that we are bound to meet this question with information and facts; and therefore I suggested, and the association passed, a resolution that the secretary be instructed to procure the facts as regards the operation of street railways by municipalities.—From address at the St. Louis Convention, 1896.

NEW POWER PLANT AT AKRON, OHIO

Early in 1896 there was consummated a consolidation of the street railway and electric lighting interests in the city of Akron, Ohio, by which the Akron Street Railway & Illuminating Company succeeded to the business of the Akron Street Railway Company and the Akron General Electric Company. Both companies were possessed of power plants, which, although considered models at the time of their construction, were far behind the engineering practice of the day. Owing to the increased demand

BOILER ROOM, AKRON

upon their respective stations both companies were contemplating the installation of additional units. Almost the first problem, therefore, which confronted the management of the new company was the advisability of maintaining two stations and placing the necessary additional units in each or of consolidating them in a new plant, using such of the old apparatus as might be suitable and making up the balance of the power required with new and larger units. This question was one which required considerable deliberation by the management, and it was some time before a decision was reached.

After due consideration it was decided to erect an entirely new station upon the site of the old street railway power house, as this site was within three blocks of the center of the city and possessed of a great many advantages over other properties owned by the company.

The construction promised to be exceedingly difficult owing to the necessity of continuous operation of the old plant until the new one was ready for service.

Figs. 1 and 2 show the station as it will appear when completed. The soil at the site was all "made ground" to the depth of about 20 ft. and this necessitated careful consideration of design and considerable additional expense of construction. To the east lay the tracks of the old terminal yard of the C. T. & V. R. R., as shown in Fig. 2. These tracks were some 24 ft. above the grade line of the proposed building, and were supported upon an embankment, the base of which extended far in upon the company's property, while confined within the walls of a stone conduit, which lay diagonally across the site selected for the engine room, ran an old mill race. The presence of this embankment necessitated the construction of an extensive retaining wall which is also utilized as a foundation for the east building wall. Owing to the continuous movement of trains through the railroad yards it became necessary to construct the heavy wall in sections. Large dimension sandstone laid in cement mortar was used for this purpose.

The character of the soil and the presence of the conduit mentioned above necessitated the placing of a heavy concrete footing, covering the entire space to be occupied by the building. This footing or sub-foundation was built of crushed limestone, torpedo sand and Portland cement, and is 4 ft. in depth. The top is finished and forms the basement floor.

The building when completed will cover an area of about 21,000 sq. ft. and will be divided into an engine room 50 ft. x 240 ft. and a boiler room 44 ft. x 208 ft. The construction throughout will be practically fireproof, being of steel frame with brick blanket walls. The foundation walls are of large dimension sand stone laid in cement mortar, and rest upon the concrete sub-foundation before mentioned. The steel columns which support the roof trusses are also designed to carry the girders for the traveling crane.

The main floor in engine room is constructed of 1¾-in. matched flooring, finished over with a ⅞-in. hard maple floor, laid diagonal to the first, the whole being supported upon steel beams which are in turn supported upon columns extending to the sub-foundation. The roof construction consists of steel trusses supported upon the main columns, while mounted upon these are steel purlins which carry 1¾-in. yellow pine roof sheeting covered with green factory slate. Star pattern ventilators are placed on the roof over the boiler room, and the windows throughout the building are extra large in order that an abundance of light and ventilation may be had.

The construction of the first section of the new building, which consisted of an engine and boiler room, each 96 ft. in length, a brick chimney with a 72-in. flue and 130 ft. high, with the stack of the old plant, required the removal of all the walls of the old boiler house and the reconstruction of the retaining wall along the tracks. This necessitated supporting the roof of the old boiler house on cribbing until the roof of the new building could be placed in position.

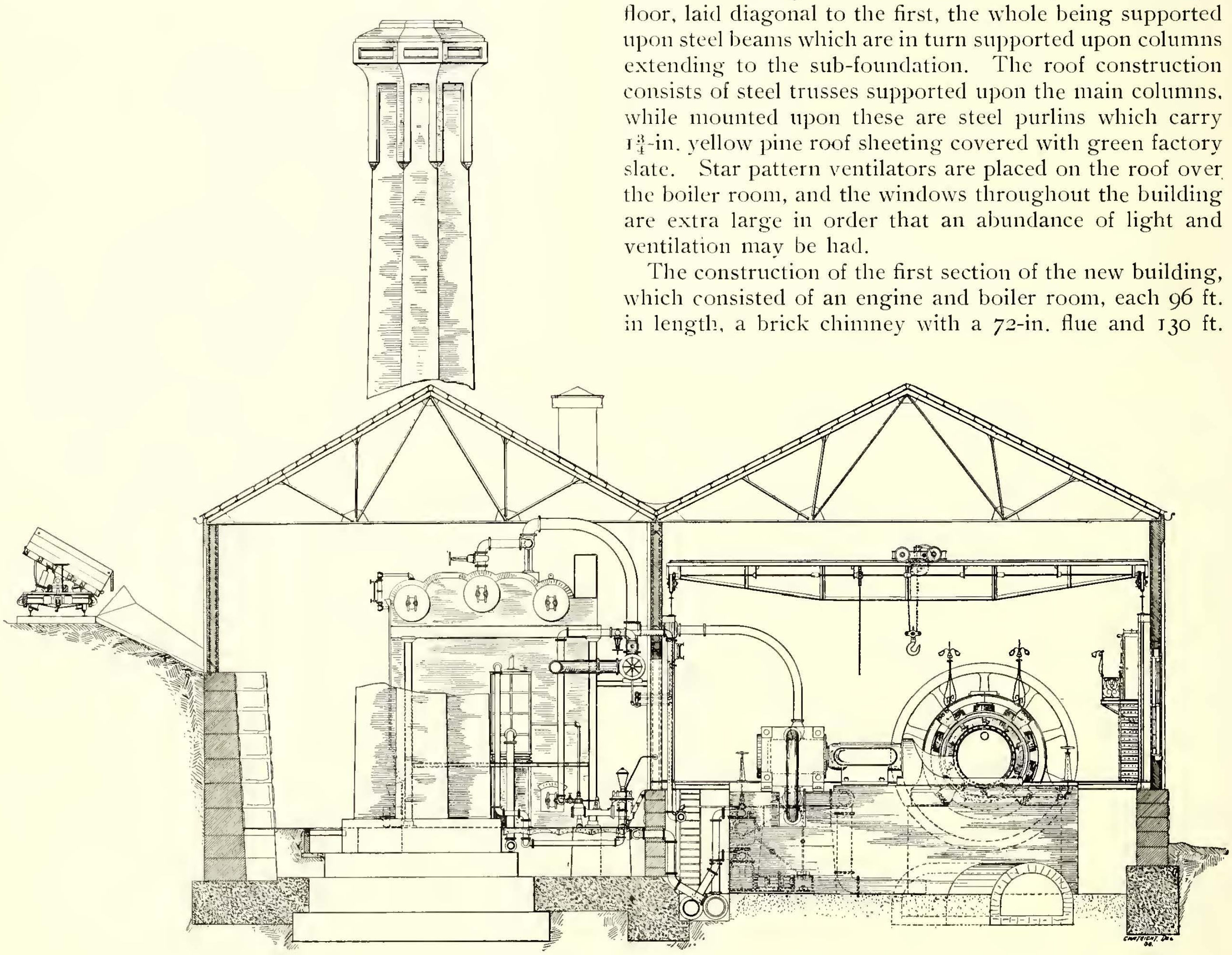


FIG. 1.—SECTION OF POWER STATION, AKRON

As the rear walls of the old tubular boilers came in line with the division wall of the new building it became necessary to support the roof trusses upon false work until a portion of the new station could be put in shape to operate and thus relieve the old boilers so they may be removed. As but a section of the building was being erected the ends of both engine and boiler rooms were filled with wooden bulkheads.

The foundations for all pieces of apparatus, excepting the electrical apparatus in the lighting department, are constructed of concrete, faced up with four layers of brick and resting upon large sub-foundation. The cement used in this work was Sandusky Portland. The belted electrical apparatus has no other foundation than the main floor, this being constructed sufficiently strong to admit of placing apparatus of this type at any point.

Located in the boiler room at present are four batteries of Stirling water tube boilers having a capacity of 2200 h.p., and carrying a steam pressure of 125 lbs. per sq. in. Two of these batteries are new and have a capacity of 600 h.p. each, while the other two are boilers which were removed from the old lighting station and after having been remodeled were installed in the space occupied by the tubular boilers in the old plant. Each of these batteries has a capacity of 500 h.p.

All the boilers are equipped with American underfeed stokers, and extending the full length of the boiler room is an air duct which is supplied with air under pressure from electrically-driven fans and in turn supplies through ducts leading to each stoker the necessary air for forced draft. Located between the side walls of two of the boiler settings and directly in the rear of the stack is the pump room, which contains Laidlaw-Dunn-Gordon duplex independent driven piston pumps, which supply the water to the feed water heater. This heater is of the Cochrane feed water heater and purifier type and is rated at 2000 h.p. From this heater the water flows into two Epping-Carpenter pumps which supply the water to the boilers. The main steam header is located between the rear boiler walls and the division wall between the engine and boiler rooms, rests upon expansion rolls which are supported upon beams the ends of which are attached to these walls. This header is 20 ins. in diameter and is built of extra heavy wrought iron pipe, fitted with cast iron flanges, and is of the screwed and peened class of construction. The fittings are all of extra heavy cast iron, and all bolts are of steel. All the pipe, fittings and valves used throughout the plant were furnished by the Crane Company. The main steam header is divided into sections which are connected by copper bends. The separators are of the horizontal Cochrane type.

In the engine room there is at present installed a Hamilton Corliss cross-compound condensing engine with cylinders 20 ins. and 40 ins. x 48 ins. stroke directly connected to a 400-k.w. Westinghouse railway generator. This engine exhausts into a Deane independent driven jet condenser which is placed in the basement between the foundation of the high and low pressure engines. A duplicate of this unit will be installed in the near future which will give the company, in its railway department, about 1600 h.p., including one engine in the old plant which has been connected to the new piping system and can be used in emergency cases.

In the lighting department there are at present four Armington and Sims cross-compound condensing engines, with cylinders 16½ ins. and 25 ins. x 15 ins. stroke, belted to the lighting apparatus, which consists of three arc machines of 125 lights capacity each, two 110-volt direct current dynamos of about 500 lights capacity each, two alternators with a capacity of about 7000 lights and a 200-k.w. 500-volt power generator. Each engine exhausts into an independent driven jet condenser of the M. T. Davidson type. These condensers are placed in the basement but have the valve stems of the regulating valves extended above the main floor at a point which enables the engineer to manipulate them without leaving the throttle of the engine.

The belts are all of double dynamo belting and are 14 ins. wide. The switchboard is of black enameled slate. It is mounted upon a balcony overlooking the engine room

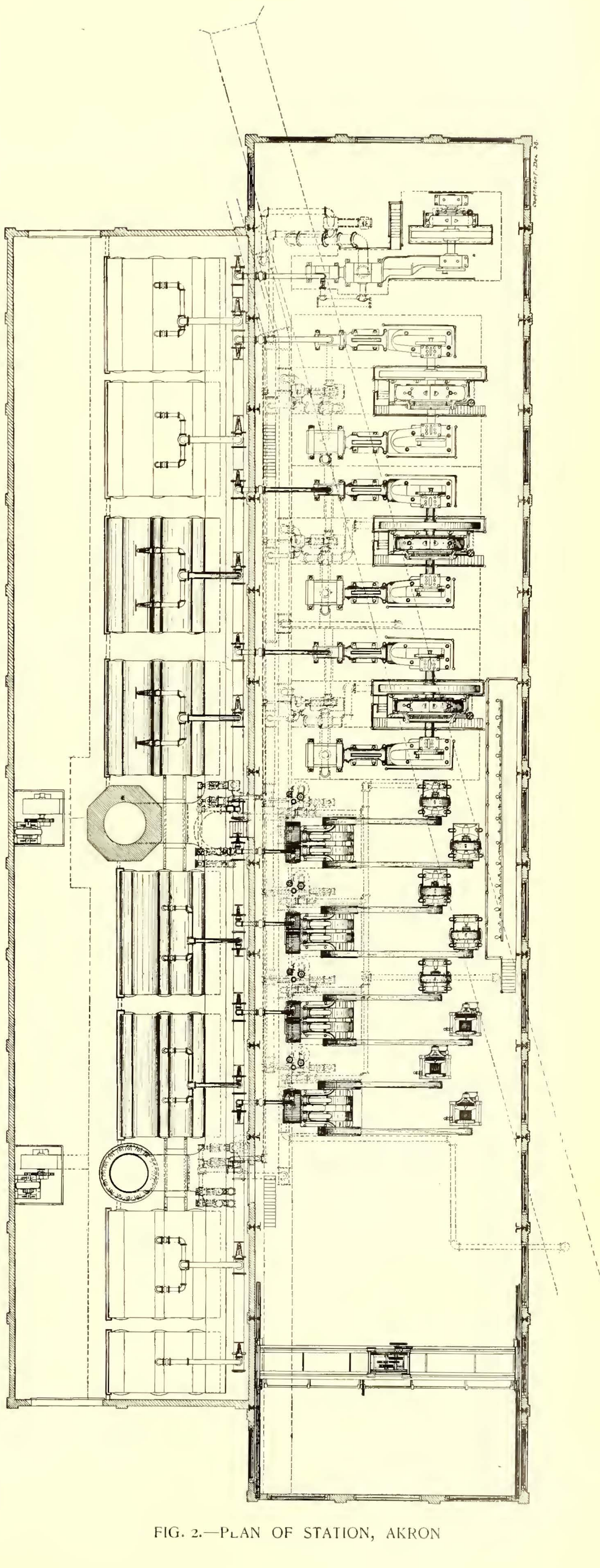


FIG. 2.—Plan of Station, Akron

and is provided with the highest grade of instruments and everything necessary to successful operation.

Water for the condensing and boiler feed purposes is obtained from the mill race which flows through the property, but as this water is very filthy, owing to its having passed through a great many manufacturing plants, such as machine shops, cabinet shops, flouring mills, varnish works, etc., it was necessary to provide a system of purification. An intake crib was constructed which removed a part of the mineral sediment and all the floating oil; from this crib the water is admitted to a settling reservoir constructed of brick. The reservoir is divided into two compartments and is so connected to the intake crib and the supply main to the building that either compartment can be cut off to admit of cleaning. The water is taken from this settling reservoir into the building through an 18-in. cast iron main, and after being used in the condensers is delivered into the hot well consisting of a 20-in. cast iron pipe extending the full length of the building.

A specially designed fitting is provided for the pump suction from the hot well by means of which the water is always taken from the center of the pipe. After passing through this process and through the Cochrane feed water heater and purifier, the water is in a very good condition to enter the boilers. When completed the station is expected to contain about 6000 h.p. in engines. Of this 2200 h.p. will be for railway uses and 3800 h.p. for lighting.

The company supplies power to all the cars of the Akron, Bedford & Cleveland Railway in and out of Akron, in addition to its regular business.

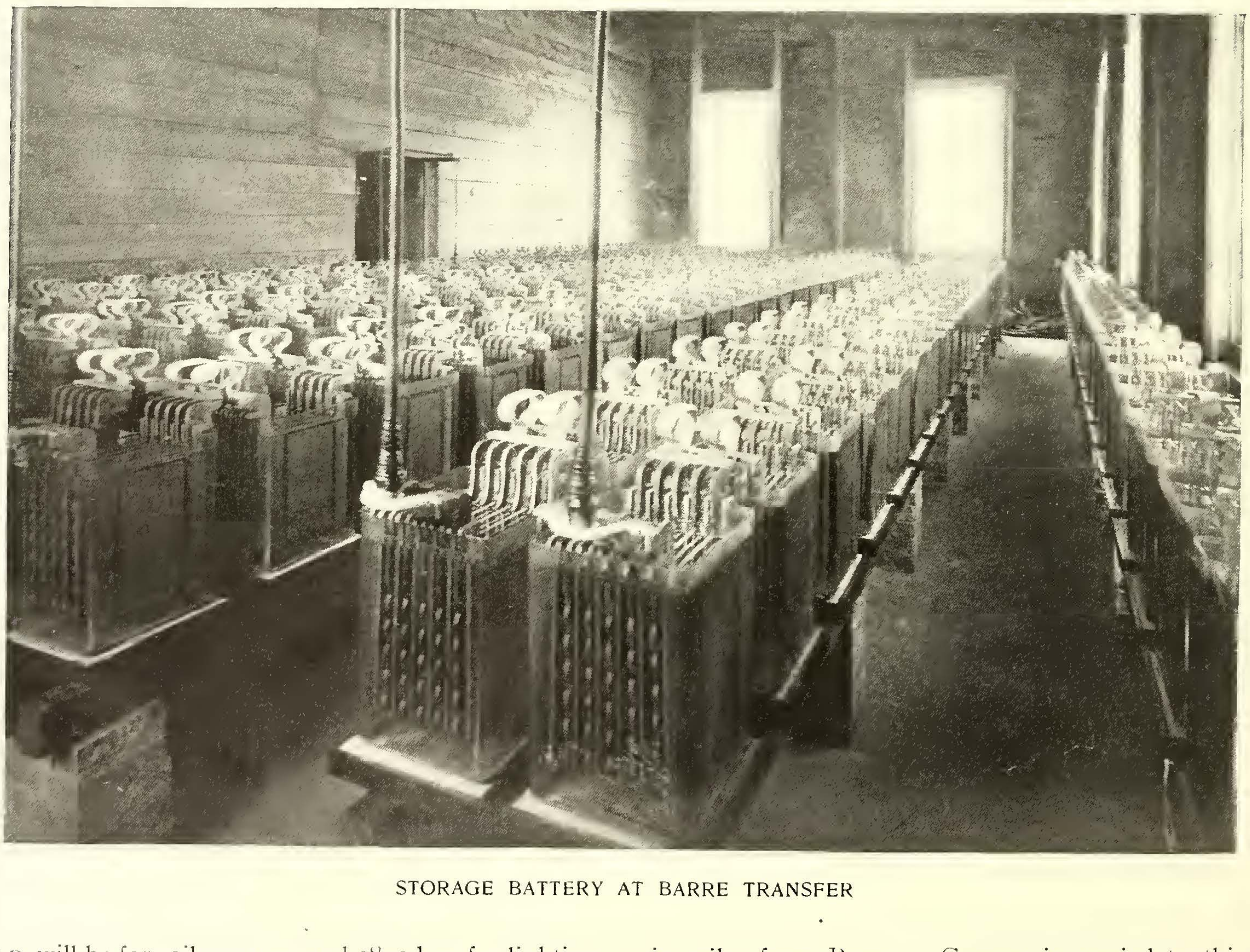
No expense has been spared to make this a first-class plant and all the materials and apparatus are of the highest grade. Much credit is due Charles A. Chapman, consulting engineer, of Chicago, for the able manner in which he designed and carried out the construction of this station under such trying conditions.

LONG DISTANCE TRANSMISSION POWER PLANT, MONTPELIER, VT., WITH BATTERY AUXILIARY

The Barre-Montpelier Traction & Power Company, of Montpelier, Vt., has just completed an installation at Barre Transfer, three miles from Montpelier, Vt., which presents a number of very interesting features. This plant is particularly notable as being the first railway plant in the United States operated exclusively from rotary converters with storage battery auxiliaries.

Power is furnished by a dam in the Winooski River at Middlesex, Vt., which gives an average of something over 2000 h.p. throughout the year. At this point a generating plant was installed and started up in April, 1896, embracing three 750-h.p. turbines which drive two 150-k.w. Westinghouse three-phase alternators which furnish current for a great deal of work in the immediate vicinity as well as supplying power for the railroad service. The Barre-Montpelier Traction & Power Company also operates a line nine miles long, running between the two cities, over which it runs five cars which cover the mileage in about forty-five minutes running time.

The sub-station just inaugurated, containing the battery and the rotary converter with which it operates, is located at Barre Transfer three miles from Montpelier and six miles from Barre. Current is carried to this point from the plant at Middlesex, where it is generated as three-phase alternating current at 2200 volts with 7200 alternations per minute. From the generators the current is carried to two step-up oil insulated transformers of 150 k.w. capacity each, raising the potential from 2200 to 6300 volts. At this latter voltage the current is carried from the plant to the car house, a distance of eight miles from the step-up converters to the step-down transformers. The run is made with three No. 6 rubber-covered wires, run-



STORAGE BATTERY AT BARRE TRANSFER

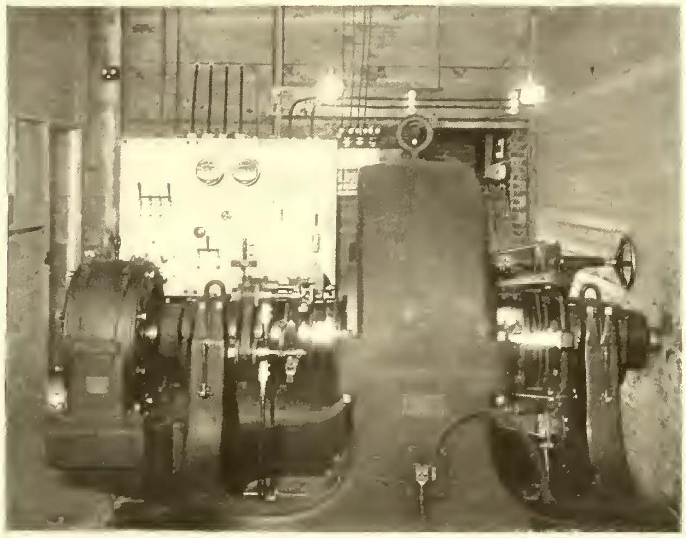
ning on double petticoat glass insulators and protected at both ends with Wirt's non-arcing 2000-volt lightning arresters, there being three in each phase. The high-tension line is also fused with high-tension fuses after entering the transformer house at the car house. The two-phase side is fused between the oil transformers and the switchboard with aluminum fuses.

The step-down transformers at the car house convert the potential from three-phase to 480 volts two-phase current. The connections from this service to the rotary converter are made on the combined switchboard for the rotary and storage battery. This board is of white marble and presents a very neat appearance.

The rotary converter, which was built by the Westinghouse Electric & Manufacturing Company, as shown on this page, is of 160-k.w. capacity, generating on the direct current end 550 volts, and is arranged to be started by a 25-h.p. synchronous motor. The rotary was designed specially to operate under the conditions of this service in connection with the battery. The direct current end is compounded to suit the working voltage of the battery under the widely fluctuating loads so that the battery will take up the fluctuations without the aid of a booster or other auxiliary apparatus, thus making the operation of the plant exceedingly simple.

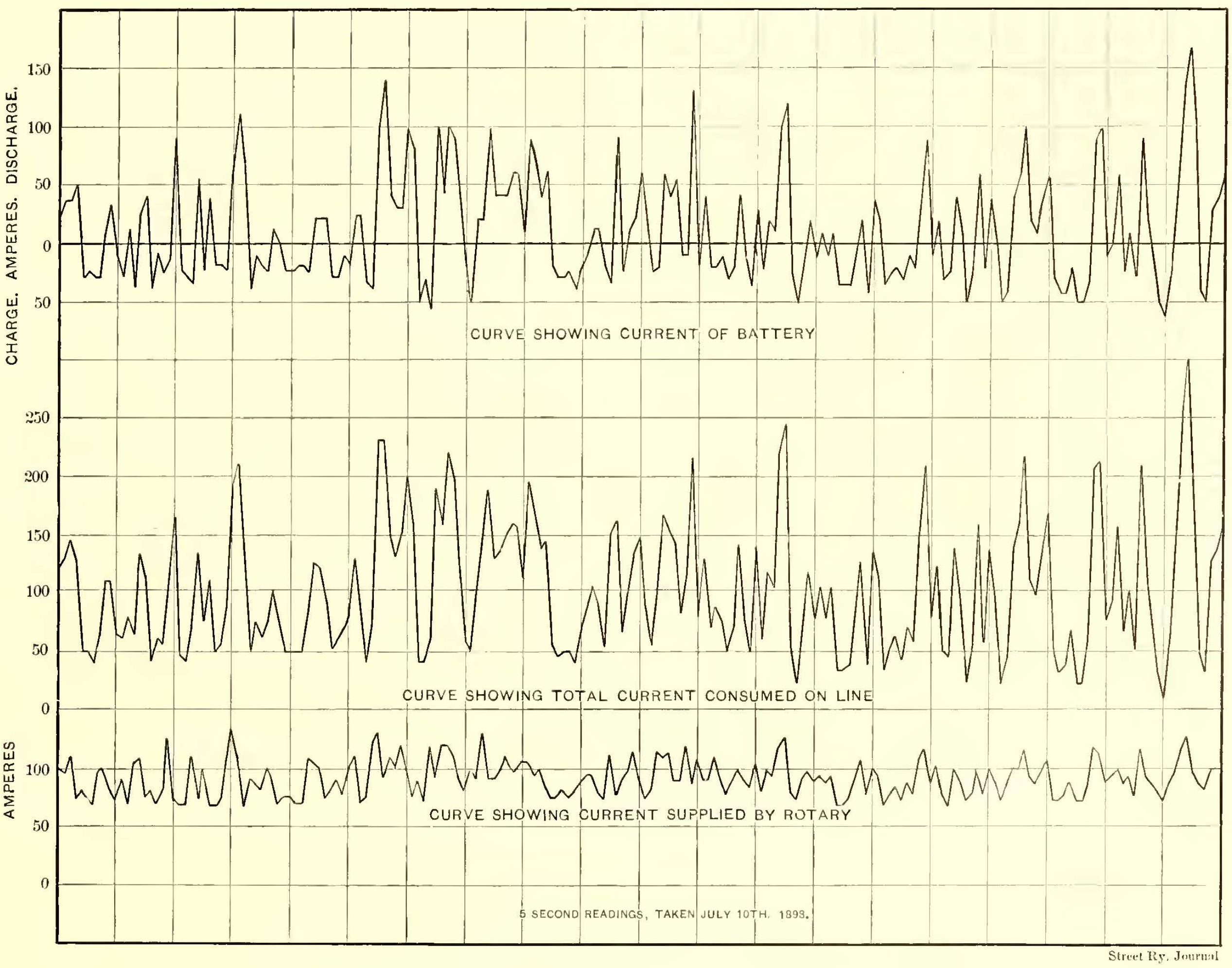
The battery, which consists of 248 cells of type 11-F chloride accumulators, supplied by the Electric Storage Battery Company, is connected in multiple with the rotary converter, the two being connected directly across the trolley line. The entire length of the line is operated with no further provision for feeders than the single No. 00 trolley wire.

The battery, as will be noted by reference to the curves given herewith, takes practically all the fluctuations in load, so that the rotary runs at nearly a constant load inde-



ROTARY CONVERTER

pendent of the service on the line. The 248 cells of the battery are located in a small room partitioned off at the end of the car barn, in a single tier on wooden racks. Each cell consists of fifteen plates, 10½ ins. sq., suspended in a glass jar, which in turn is supported by a tray filled with sand, which rests upon four single petticoat glass insulators.



CURVES SHOWING REGULATING EFFECT OF STORAGE BATTERIES

TRAMWAY SYSTEM OF BRISBANE, AUSTRALIA

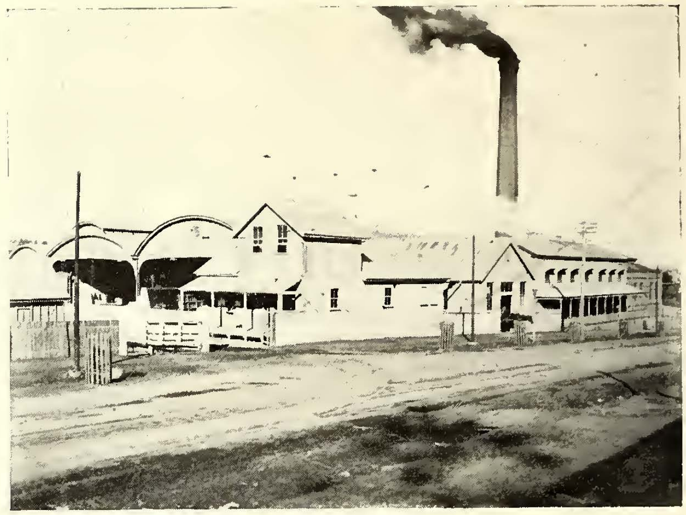
BY S. HERBERT BROWN

Brisbane, the capital city of Queensland, is situated on the Brisbane River and about twenty miles from its mouth. It lies in latitude 27 deg. 28 min. South. Its climate conditions are semi-tropical, the average maximum and minimum temperature being 77° and 55°. It is divided into two parts, North and South, which are connected by a bridge over the Brisbane River. The population of the city, including suburbs, is 100,000. The old horse system which had been in existence for thirteen and operated fifteen miles of single track was neither a financial success or popular with the public. Owing to length of line and many gradients, horse cars were not inducive to successful operation, and with suburbs scattered, and many at considerable distance from existing tram cars, traveling to and from the city was slow and irksome.

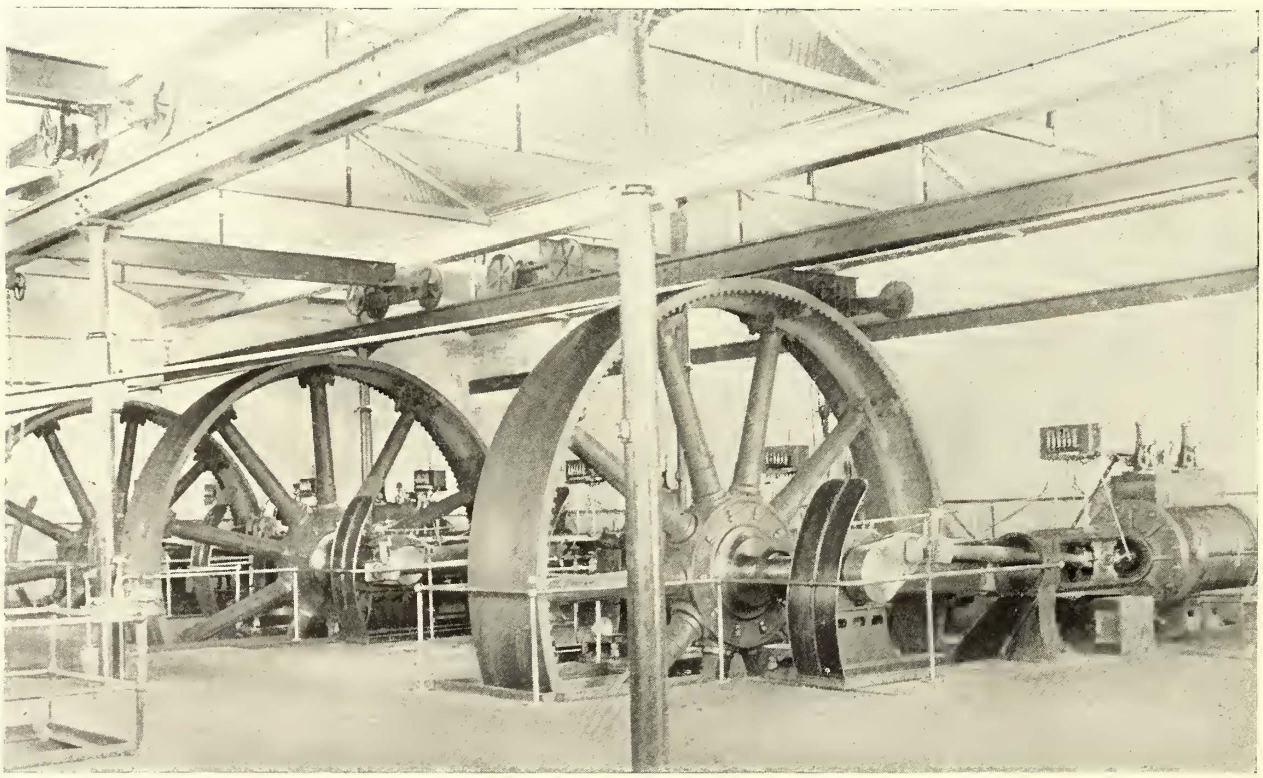
This company was the first in Australia to supersede horse by electric traction, and at present has the largest electric road in the country. The promoters are English capitalists interested in similar systems in other countries. In acquiring the rights of the old company they had, by consent of the City Council and several Divisional Boards and a special Act of Parliament, the right to adopt electricity as a motive power. The franchise is for twenty-five years, at the expiration of which the city has the option of purchase of the system.

Since its inauguration the increase of traffic has been doubled, and its general success augurs well for the future. The adoption of electric traction followed by the increased speed, cleanliness of cars and the marked improvement in appearance and manners of employees had a marked effect on public approval, and the terms in which the system is spoken of by visitors has attracted the attention of Australian tramway men and its progress and success is watched with interest. The reader who remembers the conservatism displayed toward electric trams in the United States a few years back can readily understand the feelings with which many regarded the adoption of electric trams in Brisbane.

J. S. Badger, formerly of the General Electric Company, of Schenectady, N.Y., was the constructing engineer, and to his large experience has been due, in a great measure, the success with which the construction work was carried on. Mr. Badger is now chief engineer and manager of the company.



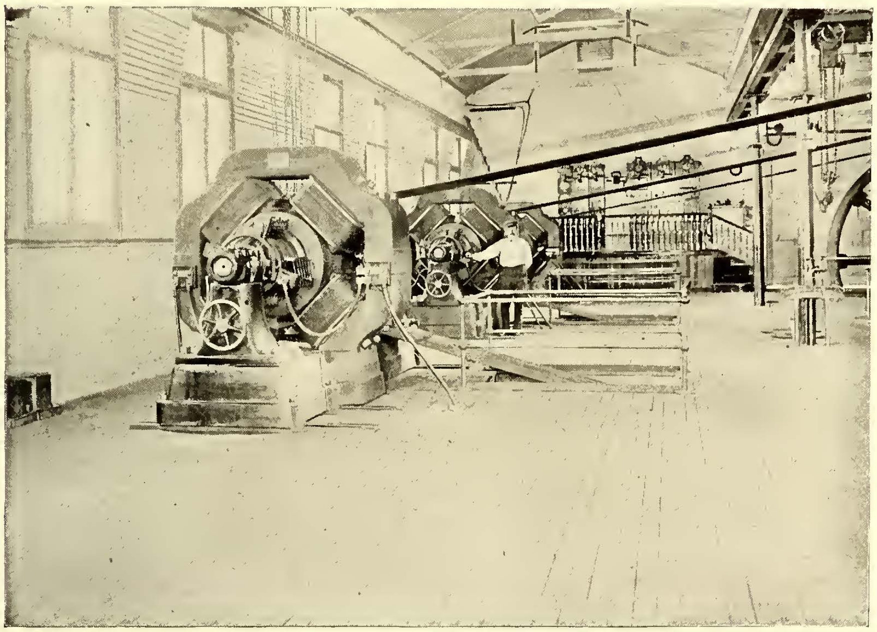
EXTERIOR OF POWER STATION



INTERIOR OF POWER STATION

There are now $25\frac{1}{2}$ miles of electrically equipped tramway lines in operation. The seven suburbs which the cars traverse are New Farm, Breakfast Creek, Ithaca, Bulimba and Exhibition on the north side, and Logan Road and West End on the south side. The New Farm and Breakfast Creek routes starting from the north side connect with the Logan Road and West End lines respectively on the south side. The distance from New Farm to Logan Road is $5\frac{1}{2}$ miles and from Breakfast Creek to West End $3\frac{1}{2}$ miles. The

Ithaca line, consisting of 4 miles and 2½ chains of single track, starts at the corner of Queen and George Streets and passing through George and Roma Streets branches here for Ithaca via Caxton Street or Red Hill and makes the loop return by the above named streets to the terminus. This is perhaps the most popular line of all, embracing as it does the hills west of the city and giving the public a cool ride and beautiful views of the city and surrounding country. The Bulimba and Exhibition routes terminate at Brunswick Street and passengers are transferred to New Farm and Breakfast Creek cars. When the work of wood-paving is completed permitting ordinary traffic and more new cars are built it is intended to alternate the Ithaca cars with these two routes.



GENERATORS AND SWITCHBOARD

Several other extensions are projected, but the present lines will be completely equipped first and the system thoroughly organized. The extension to Hamilton has been decided favorably, conditioned upon permission being granted for further extension to Queensland Turf Club race-course, and if the Hamilton Divisional Board desire it there will probably be little trouble in obtaining the necessary construction order.

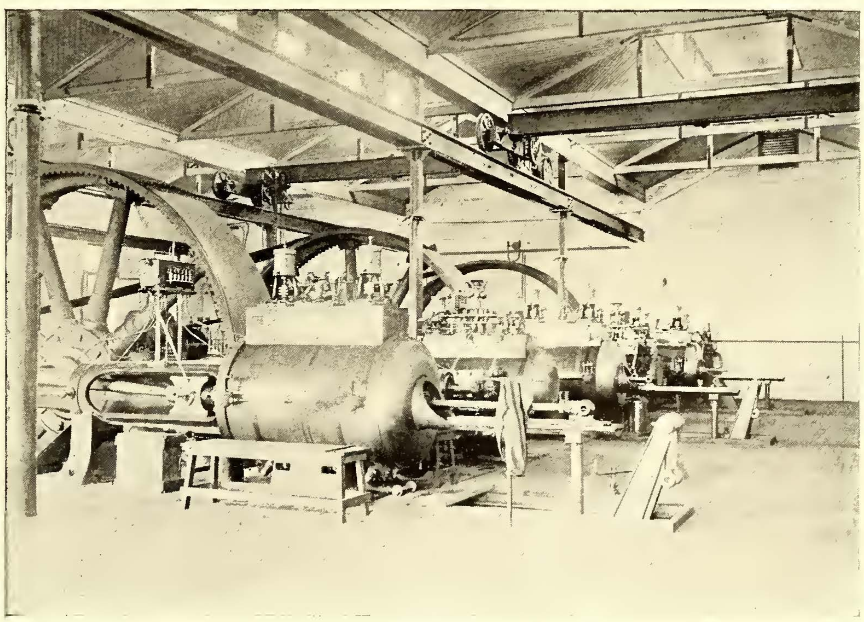
Another extension which has been approved and which only awaits the same mark of consent is from the Exhibition to Brisbane Hospital. Arrangements are also pending with the Ithaca Council for an extension of an existing line along Latrobe Terrace, and the company will complete this providing the council agrees to maintain the road. The directors contend that the provisions of the act under which the company is compelled to maintain the roadway between tracks and 9 ins. each side was intended for application to old horse car system and not to the existing scheme.

The headway of cars varies from six to twelve minutes except in Queen Street, through which all lines traverse, and here the headway is about two minutes. The speed varies from six to ten miles per hour in the city to fifteen miles per hour in the suburbs.

The system of fares is as follows: Passengers are carried from city to terminus of line for threepence or six cents if paid at one time, otherwise a penny or two cents is required for each section, the average length of section being three-quarters of a mile. No transfers are given and the tickets are punched denoting the number of the section paid for, and must be shown when demanded by conductor. The general office, power station and car house are located at Countess Street on grounds leased from the Government railway and adjoins their yards. The office is a plain wood building while the car house and other buildings are built of iron pillars with sheet iron roofs and sides. The car house at Countess Street is the largest and will house forty cars. A section at Logan Road holds eighteen. In both pits extend the whole length of shed and are lighted with electric light. In the repair shop, which on account of distance from manufacturers will form an important feature of works, the latest machinery will be installed and all repair work will be done by the company.

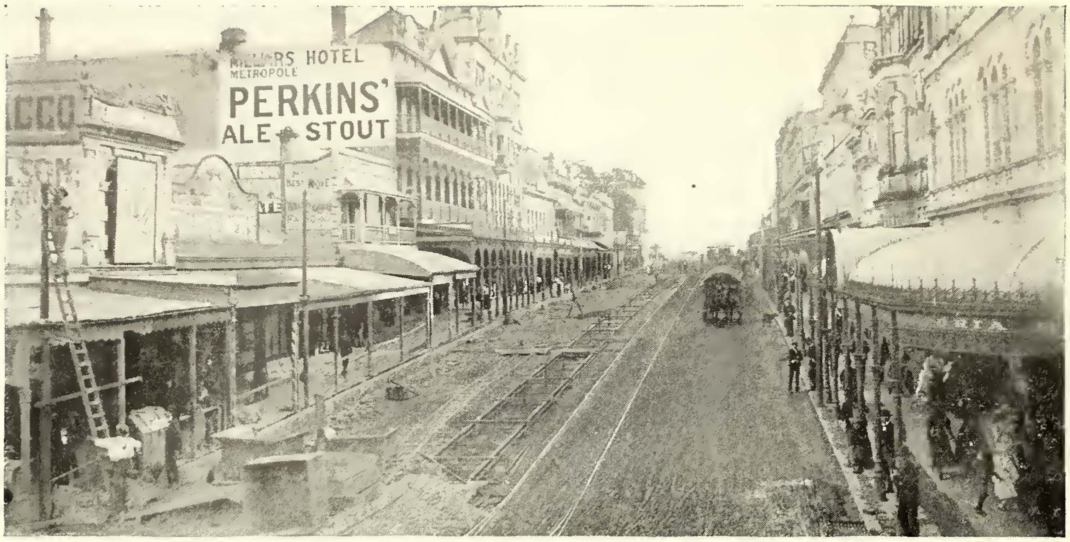
The power station, which is located centrally to all lines, is a one-story brick building with ample cellar capacity. It measures 92 ft. x 129 ft. and is divided into engine and boiler rooms. The condensers and all supply and exhaust pipes are in the cellar and are easily accessible. The dimensions of the engine room are 92 ft. x 70 ft. and of the boiler room 78 ft. x 59 ft.

The engine room is well lighted and ventilated; three overhead cranes, each of four tons capacity, run the entire length of the room. It contains at present three 450 h.p. cross-compound condensing engines manufactured by Robey & Sons, Lincoln, England, and sufficient room has been allowed for another unit in view of further extensions. The dimensions of the engine cylinders are 18 ins. and 30 ins. x 40 ins. stroke. They make 86 r.p.m. at a pressure of 150 lbs. and both cylinders are steam jacketed. The Richardson-Rowland patent trip valve gear is employed. The fly wheels are 17 ft. in diameter and weigh twenty-six tons. The rims are 37 ins. broad and over them run leather belts to the generators.



REAR VIEW OF ENGINES

The electrical equipment consists of three General Electric multipolar railway generators of 400 h.p. each. The switchboard is situated at one end of room, and is placed on a raised platform in a conspicuous position. It is of slate, covered with black lacquer and contains three generators, three feed and one main generator panel. The instruments are the General Electric Company standard type.



LAYING TRACK ON CONCRETE BED

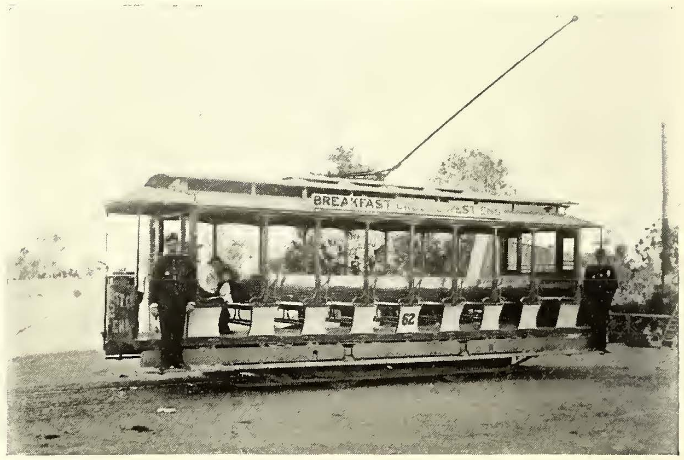
The boiler room is 18 ft. lower than that of engine room and contains 1200 h.p. of Babcock & Wilcox boilers in three batteries of two boilers each. The working pressure of boilers is 150 lbs. Additional space is reserved for three more batteries. The chimney is 150 ft. high, with a 7-ft. flue. Two duplex Worthington feed pumps 9 ins. x 5¼ ins. x 10 ins. stroke are installed.

Water is obtained from the city mains and nine iron tanks with a capacity of 18,000 gallons are placed just back of boiler room. All feed water is passed through a Railton & Campbell filter. Coal is delivered from railway trucks into bunkers immediately back of boiler room.

The water tower for cooling condensing water is a wooden tower 17 ft. x 17 ft. and 31 ft. high. It contains rows of wooden slats placed 2 ins. apart in two tiers. Under these are four fans worked by a 25 h.p. motor. The hot water pumped to the top of tower passes through a distributing trough and is allowed to percolate between the rows of slats, and after being further cooled by fans passes into the reservoir below.

The rolling stock is mounted on thirty-eight Peckham "extra-strong" cantilever trucks and three Brill trucks, all supplied with General Electric 800 motors. The car bodies which have been built in the company's shops present an exceedingly handsome appearance. They are of three types—the open, the combination open and closed, and closed cars. The latter were made by splicing two 16-ft. cars, and are expected to give several years' service. The other types in length measure 29 ft. and 29 ft., and are made from Queensland woods, principally spotted gum, mottled and yellow pine, yellowwood and cedar. The climate of Brisbane, which corresponds somewhat to that of southern California, makes the combination car the most serviceable. The illustrations show these three types of cars. A street sprinkler and metal and tool car are under course of construction.

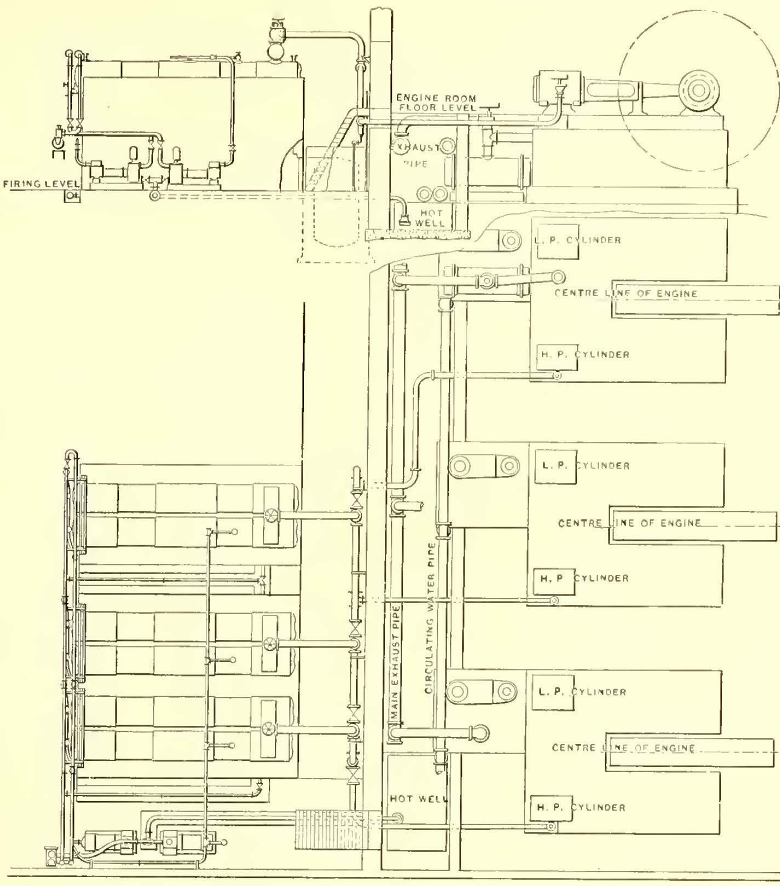
STANDARD COMBINATION CAR

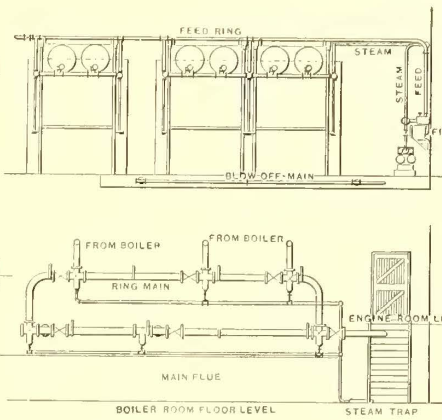


STANDARD OPEN CAR

STANDARD CLOSED CAR

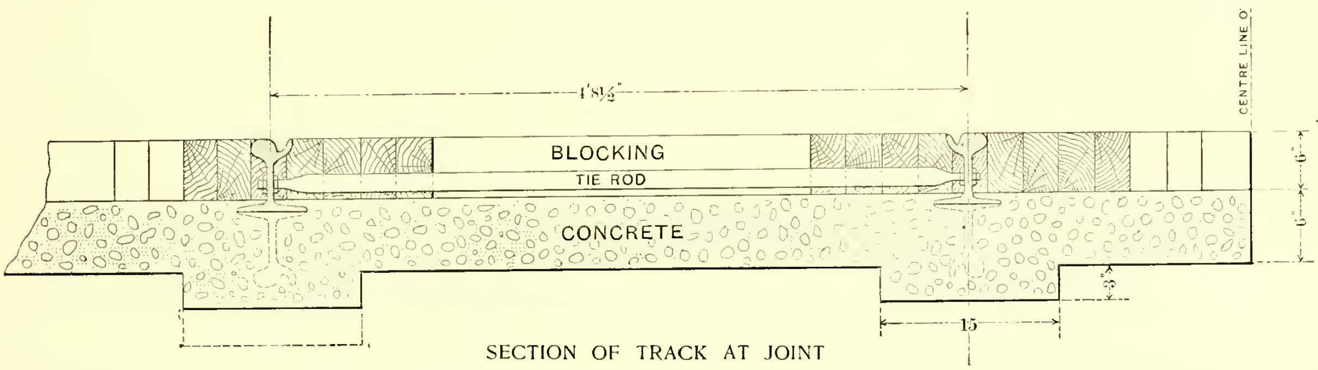
The track is of a substantial character, laid with ordinary 6-in. grooved girder rails, weighing 81, 77 and 55 lbs. per yard. The lighter rails are only used on suburban lines and are the best of the old rails, while in the city and all





PLAN AND SECTION OF POWER STATION

extensions the 81-lb. rails are used. The gage is 4 ft. 8½ ins. The rails are spiked to iron-bark ties 9 ft. x 4 ins. x 8½ ins., spaced 2 ft. 6 ins. apart, center to center, with



SECTION OF TRACK AT JOINT

angle fishplates, 2 ft. x 4 ins. x ¾ in. Tie bars are used every 10 ft.

The method of track construction where the streets are wood blocked is shown on this page. Ties are used, the rails resting on a concrete foundation, and under the ends of adjoining rails a 3-ft. length of inverted rail is bolted, making a very firm joint. There are several curves of 40-ft. radius, and with a 7-ft. wheel base it was not long before both flanges and treads were much worn, and to mitigate the trouble a looser gage was allowed with a guard bolted to the outside of the rail. The bonding consists of two No. 0000 bonds 2 ft. 6 ins. in length, of the Chicago type, and the track is cross-connected every fifth rail.

Span wire construction is adopted throughout. The poles used in North Brisbane are of steel, furnished by Morris, Tasker & Co., while in South Brisbane and all suburbs iron-bark poles are used. All are set in concrete comprised of five parts ashes and three sand and one cement. For the trolley a double wire of No. 0 gage and No. 4 solid steel for span wire is used.

The overhead line material is supplied by the General Electric Company, and a double insulation is used throughout.

BUREAU OF INFORMATION AT BOSTON

One of the important departments of the convention will be the Bureau of Information arranged for by the committee on transportation and information. This will be in charge of Robert H. Derrah, of the Boston Elevated Railway Company, whose knowledge gained in preparing the Derrah's Street Railway Guide to Eastern Massachusetts, will be found especially useful. A space containing some 240 sq. ft. has been reserved for the information booth, and this will be handsomely fitted up with rugs and furniture, with writing materials, etc., for delegates and street railway men. In the booth will be a library of guide books, not only of Boston, but of Concord, Lexington, Plymouth and other places which many of the delegates will wish to visit. There will also be a case containing folders of all the railroad companies, with maps of Boston and surrounding cities. A special telephone will be put in this booth, in addition to that in the main building, so that if any delegate wishes information which cannot be furnished by those in the booth they will soon be able to supply the want. This is the first time in the history of the association that anything of the kind has been provided, and it is believed that the Bureau of Information will prove one of the valuable features of the Boston convention.

The Catskill Electric Railway Company, of Catskill, N. Y., has recently been granted permission to increase its capital stock from $30,000 to $400,000, and work on the road will be commenced at the first possible moment. L. E. Robert, of 290 Halsey Street, Brooklyn, is president of the road.

BRADFORD ELECTRIC TRAMWAYS

The Bolton road tramway, of the city of Bradford, England, was recently put in operation, and its success will do much to advance the status of the trolley system in Yorkshire, as well as throughout England.

The tramway system in Bradford comprises about fifteen miles of streets and twenty-one miles of track which have been using steam and animal power. Thirty-five engines, forty-eight cars and 143 horses have been required for the service, and the total number of car-miles run per annum has amounted to 447,826. The percentage of expenses to receipts on these steam-horse lines has been heavy, and last year stood at 92.04, the expenses per car-mile being 13d. These expenses, however, have not prevented the company paying a substantial dividend, last year's return to the shareholders of the owners, the Bradford Tramways & Omnibus Company, being 6 per cent. The system which has just been completed, however, forms no part of the lines operated by that company. . The lease with the city under which the Bradford Tramways & Omnibus Company operates expires in four years, and there is no reason to doubt that the company will then transfer the whole of its system to the municipality. In the meantime the corporation has resolved to construct new lines to be operated electrically, and the tramway, that has just been equipped, forms the first portion of what will eventually be a system of considerable magnitude. The city has a population of 235,000 and owns its own gas, water and electric light plants, markets, slaughtering houses, cemeteries and parks, and has ten free libraries, an art gallery and a museum. To these must now be added electric trams. The total cost of the construction has been between £60,000 and £70,000, and the work has been carried out under the superintendence of the city surveyor, J. H. Cox.

The total length of the route is 1 mile 1501 yards, the steepest grade being 1 in $15\frac{1}{2}$, the total rise from one end of the line being 322 ft., which gives an average grade of 1 in $30\frac{1}{2}$. Girder rails weighing 105 lbs. per yard have been used throughout. Between the rails and about 18 ins. on each side of the rails the track is paved with granite blocks. Each rail joint is bonded with Chicago crown flexible bonds $5\frac{1}{4}$ ins. long. In addition there are cross bonds between the rails at intervals of every 120 ft.

THE OPENING TRIP IN BRADFORD

SINGLE BRACKET CONSTRUCTION

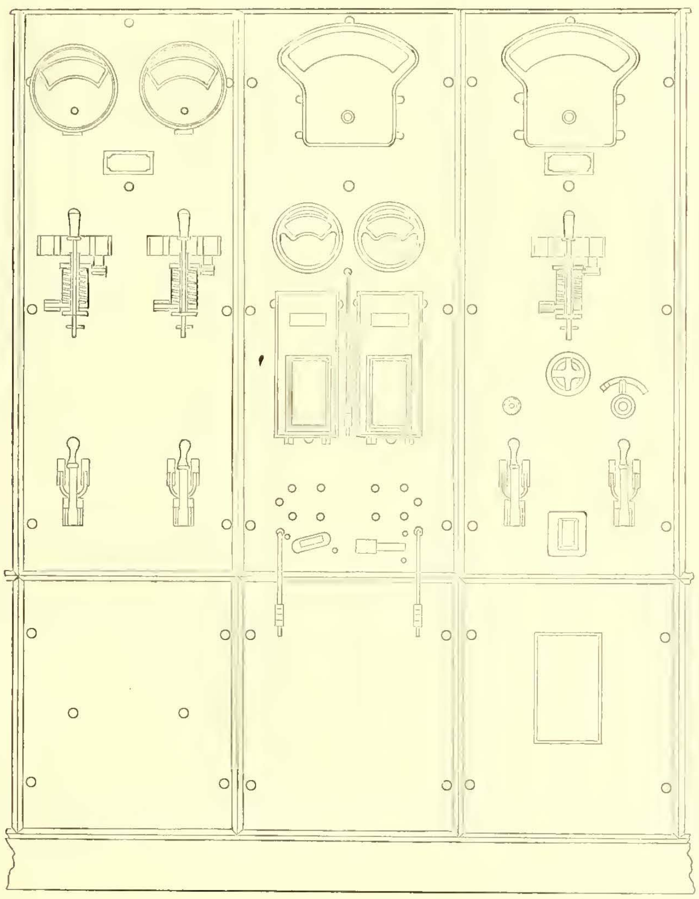
DOUBLE BRACKET CONSTRUCTION

The poles supporting the trolley wire are of the single and double-arm bracket type. The illustrations give typical examples of the poles at the side of the street, and others placed in the center of the roadway. They are 25 ft. above the surface of the ground, and are built up of wrought lap welded steel in three sections; each pole is provided with cast-iron ornamental finials and collars and an ornamental cast-iron base bearing the city coat of arms. The line work is of the most excellent description, the trolley wire being remarkably well suspended. The wire is of hard-drawn copper, .325 ins. in diameter, and is divided into the usual half-mile sections by means of sectional insulators. The feeder switch pillar, from which the adjoining sections of line may be controlled, is at most points placed above ground, and consists of a cast-iron case with water-tight hinged door. It is furnished with six plug switches, test terminals, and lightning arrester, the switches being mounted on marble bases. Two of the switches are for connecting and disconnecting the feeders, the remaining four making connection to the trolley wire.

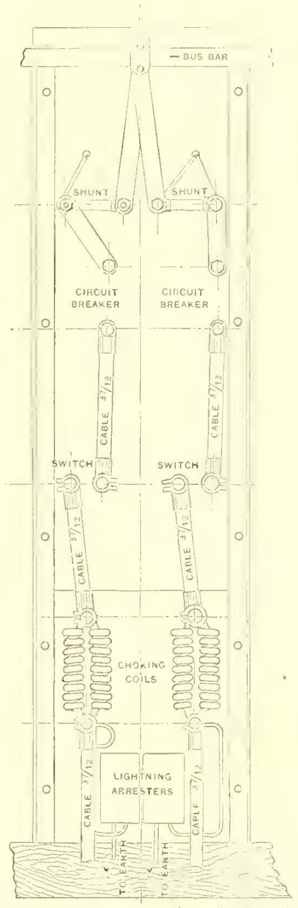
The rolling stock on the system at this moment comprises seven cars, which are elegant specimens of car building. The bodies have been built by the Brush Electrical Engineering Company, and are mounted on the well-known Peckham cantilever extension trucks; the length of wheel base is 6 ft., and the gage 4 ft. Each car is furnished with two Westinghouse motors, supported by the Westinghouse system of side suspension. The motors are geared to the wheels by single reduction gearing, which is completely enclosed. Series parallel controllers are provided, one at each end of the car, and there are the usual main and emergency switches and lightning arresters.

The trolley is of the swiveling arm type, and is the latest form of Dawson trolley supplied by Mr. Blackwell. The arm is mounted on a cast-steel base, and the vertical movement is controlled by two sets of side springs. The average running pressure of the trolley is 16 lbs. The trolley head is completely insulated from the trolley pole, the wheel being of the well-known "West-End" type. It ought to be mentioned that the cars are built to carry outside passengers, the full complement of passengers being fifty-one—twenty-two inside and twenty-nine outside. The cars are lighted with ten incandescent lamps each.

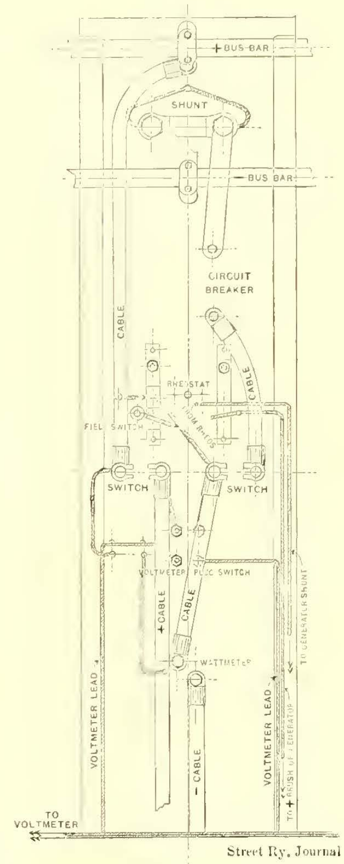
The current for the line is supplied from the local lighting station in Valley Road. A view of the switchboard erected at this point is given on this page. It is of black marble, and has a most handsome appearance. It stands some 4 ft. away from the side wall, thus giving ample room for examination. There are feeder panels, generator panels, and the usual panel devoted to carrying out tests in accordance with the Board of Trade rules. Each panel has the usual measuring instruments and a Cutter automatic circuit breaker.



FRONT OF MAIN, FEEDER AND GENERATOR PANELS



BACK OF FEEDER PANEL



BACK OF GENERATOR PANEL

All line work, poles, trucks and switchboards were supplied by R. W. Blackwell, of London, the motors by the Westinghouse Electric Company. The technical details given above are from London "Electrical Review."

VISIT OF BELGIAN ENGINEERS TO ENGLAND

A party of members of the Ghent Society of Engineers, numbering about forty, led by the president, A. Debeil, Inspecteur Génáral des Ponts et des Chaussées, Brussels; MM. Wyhowski, Ingenieur Conseil, Brussels, vice-president, and Victor Van Lint, Inspecteur du Service des Eaux, Brussels, the secretary of the society, recently visited London and inspected various places of interest. Arriving on Aug. 13, they were met by Philip Dawson, who is a member of the society; Mr. Fernie, the London representative of the STREET RAILWAY JOURNAL, and Mr. Binyou, of R. W. Blackwell & Company, who had arranged an interesting programme for their visit. The following two days, during which the party remained in London, were devoted to visiting the principal points of interest.

ELECTRIC TRACTION IN ENGLAND

The anomalous condition of the tramway system in England, by which cities of the first class in that country have about the same miles of track as cities of the third class in America, and by which the horses still continue to furnish almost without exception the only motive power for most of the street railways, continues to attract increased attention there. That the cities of England are notoriously lacking in transit facilities is being recognized by a greater number of the citizens of that country, and, as one writer in the "London Daily Mail" recently said, "So far as city transportation is concerned, the country is about the same now as when the Lord made it." Much attention has been attracted to this subject recently by an able series of letters in the "London Daily Mail," by E. F. Vesey-Knox, M. P. for the city of Londonderry. This gentleman first points out the fact that during the past six years the American electric industry for traction purposes has equaled in yearly value that of the trade of Great Britain with China, a trade for the retention of which England has spent vast sums of money in the maintenance of its Eastern Squadron, and is now almost prepared to declare war against Russia. He calls attention to the fact that most of the equipment of the existing electric roads in England is of American manufacture, and that all English manufacturers have seemingly neglected this important branch of the industry. He attributes the lack of trolley roads in England, and the consequent neglect of the electric railway manufacturing industry in that country, partly to the notorious Tramways Act of 1870, and partly to the unreasonable prejudice existing against overhead trolley wires. This opposition seems to be based entirely upon æsthetic grounds, but Mr. Knox shows that this prejudice is unreasonable, by drawing a striking comparison between the appearance of the ordinary English street, with its illuminated advertisements, the lack of uniformity in its buildings, etc., with the more tasteful streets of continental cities such as Brussels, Berlin, Basle and others where the overhead lines are in use. His express purpose is to arouse popular enthusiasm and direct public thought to the advantages of the speed, convenience and cheap transit afforded by electric railways. He considers the Tramways Act of 1870 an abomination, and Light Railways Act of 1896 a great step in the right direction "although its powers might be extended." He believes in affording every help and encouragement to companies to engage in electric railway construction, "as they surely show more enterprise in meeting popular requirements." This opposition to trolley wires encountered in England is not surprising when we remember the vehement protests in many cities in America to their introduction, before their advantages were understood, and will depart as rapidly as the few lines for which rights have been secured are put into operation.

MIDDLESBOROUGH, STOCKTON & THORNABY ELECTRIC TRAMWAYS

This road has recently been built by the British Thomson-Houston Company for the Imperial Tramways Company, Limited. The system employs alternate current distribution at 2500 volts and one sub-station.

The inspectors of the Board of Trade, Sir Francis Marindin and Major Cardew, R. E., having finished their survey, the former of the line and the latter of the power stations, and expressed their approval and satisfaction at the admirable way the whole undertaking had been carried out, this important electric tramway is now open to the public.

The system used is the overhead trolley. The cars hold sixty persons outside and inside and cost £800 apiece. The entire cost of the system so far exceeds £200,000. The charge for the route of 6½ miles is only 3d., and special trains for workmen will be run at 1d. for the whole distance. Middlesborough and the adjacent towns rejoice now in one of the most complete and best equipped tramways in the United Kingdom.

IMPORTANT TRAMWAY CHANGES IN MARSEILLES

The Compagnie Générale Française des Tramways, of Paris, which owns and operates electric tramways in Havre and Nancy, has decided to convert the present horse tramway system in Marseilles to electric power. The tramways in that city have a length of about 100 k.m. of track, to which will be added about the same amount of new track. The power station has a capacity of 7500 h.p. and will be designed so as to be capable of being increased to 10,000 h.p.

For the first time in Europe the principle of tri-phase distribution at the high potential of 5500 volts will be applied to railway service. There will be six sub-stations located throughout the system. The current will be taken by means of the trolley and carried on the roof on the Blackwell system.

The engines in the power station will have a capacity of 1500 h.p. under normal conditions, but capable of working up to 1800 h.p., and will be directly coupled to alternators of 1000 k.w. mounted on the shaft. The alternators will be six meters in diameter.

The engines will be of the cross-compound type, condensing, with semi-tubular boilers of 200 square meters of heating surface each. The consumption of coal will be 1 kg. 200 of heat per k.w. The tri-phase current at 5500 volts is transmitted to the sub-stations, where by transformers it is reduced to 550 volts before being supplied to the trolley.

The switchboard will be from 20 to 25 meters in length. The feeders will be in duplicate, in view of possible additions to traffic and as a measure of security. The entire installation of steam and electric plant will be installed by the Société Alsacienne de Constructions Mecaniques, of Belfort, France.

The rail will be of the Vignole type, with a groove 44 mm. in depth, and a base of 150 mm. It will weigh 50 kg. per m. The joints will be very substantial, and will be formed of two angle plates 75 cm. in length, connected by six 25 mm. bolts. The type of rail adopted has been specially designed by M. Thonet, chief engineer of the Compagnie Générale Française des Tramways, and will be rolled by the French Steel Works. The rails will be bonded with "crown" bonds, placed under the angle plate, also supplied by R. W. Blackwell.

The track construction will rest directly on a base of asphalt and sand, the rails being supported on steel ties, spaced two meters between centers. A short section of the track will be laid with old rails, with Falk cast weld joints. Of these latter there will be about 12,000 to be cast.

The rolling stock will consist of 400 motor cars and 250 trail cars, and the total cost of the entire installation is estimated at 20,000,000 francs. It will be one of the most important tramways in Europe. The uniform fare of 0.10 francs for all distances will be charged, and it is thought that the number of passengers, which to-day is 30,000,000 per year, will be doubled. The electric system will be put in operation about Jan. 1, 1900, and work will be commenced shortly.

STEAM RAILROAD CONVERSION NEAR LOCKPORT

The most recent application of electricity to the steam railroad, superseding, with faster schedule, the steam locomotive and steam schedule, was made Monday, Aug. 15, on the branch line of the Erie Railroad which runs from Tonawanda to Lockport, N. Y., feeding into the main line of that road. The service is of a mixed type, the passenger traffic being carried on by trolley cars and the freight service by electric locomotives.

The operating company is the Buffalo & Lockport Railway Company, of which W. Caryl Ely, first vice-president of the American Street Railway Association, is president, and Burt Van Horn, general manager of the Buffalo & Niagara Electric Railway Company, is manager. C. K. Marshall, superintendent of the Buffalo & Niagara Falls Electric Railway Company, will also be superintendent of the new company.

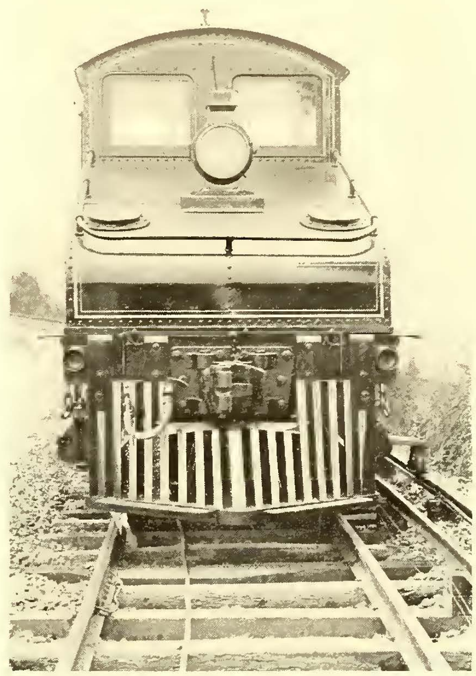
The Buffalo & Lockport Railway Company was organized in April, 1898, for the purpose of connecting the cities of Buffalo and Lockport, N. Y., by means of a first-class, high speed electric railway. It has acquired by purchase the road formerly owned by the Lock City Electric Railroad Company, consisting of five and one-half miles of first-class single track running through the principal streets of the city of Lockport, with its equipment for local business. It has also acquired by a ninety-nine year lease the Lockport Branch of the Erie Railroad from Lockport to North Tonawanda, N. Y., consisting of 13½ miles of single track from Lockport to North Tonawanda, with side tracks and switches at way stations and terminals. This road, when a part of the system of the New York, Lake Erie & Western Railroad, was operated by four steam locomotives. The schedule gave about eight trains per day between the principal stations, and a much less number to the less important places. Passengers went through from Lockport to North Tonawanda, from which point they reached Buffalo or Niagara Falls as the case might be.

The Buffalo & Lockport Railway Company has also acquired by purchase the roads formerly owned by the Buffalo, Kenmore & Tonawanda Railway Company, and by the Buffalo, Elmwood Avenue & North Tonawanda Railway Company, consisting of 7½ miles of single track between Buffalo and North Tonawanda, and one mile of single track within the city of Buffalo. By these tracks it makes connections with the tracks of the Buffalo Railway in the latter city. The total length of tracks owned or leased by the company is twenty-nine miles.

By traffic contracts with the Buffalo Railway Company and Buffalo & North Tonawanda Electric Railway this company thus provides a through line from all parts of Lockport to all parts of Buffalo, and also between Lockport and Niagara Falls. It will do all the freight, mail and express business of the Erie Railroad between Lockport and North Tonawanda, and will in many ways become a component part of the Erie system. The cars and trains between Buffalo and Lockport run direct to the main station of the Erie Railroad at North Tonawanda, and the sight of the steam and electric systems side by side at this point and doing business through the same train yard is a novel one.

Work was commenced May 17, 1898, and, as stated, the road was opened for traffic Aug. 15, 1898. It is already doing a heavy business.

Power is obtained from the Niagara Falls Power Company by tapping its long distance transmission line between Buffalo and Niagara Falls at a point between the Falls power house and the station of the Buffalo & Niagara Falls Electric Railway at Tonawanda. It is carried at a pressure of 10,500 volts alternating current over the No. 0000 bare copper wires on triple petticoated insulators set on cedar poles, to the rotary converter sub-station located in a new power house at the Lockport terminal of the old Erie branch. Here it is led into six 150-k.w. static transformers of the air-blast type, similar in construction and operation to those installed in the Niagara Street power house of the Buffalo Street Railway. In these the pressure is reduced to 350 volts, and at this pressure the current passes to two rotary converters, where it is converted into continuous current at 500 volts. The rotary converters are standard General Electric six pole k.w. 500 revolution machines. The switchboard is of the standard panel type, and consists of one high tension panel for the



SIDE AND END VIEWS OF LOCOMOTIVE

high potential transmission, two low tension panels for the alternating current side of the rotaries, two "K" direct current railway panels for the direct current sides of the rotaries, and two transformer panels. The air blast for the transformers is furnished by a blower built by the Buffalo Forge Company and driven by a $1\frac{1}{2}$-k.w. motor.

The switches for the high tension current are of the quick-break type, each blade being separated from its next neighbor by a marble barrier. The blades are pulled open by means of a hooked stick, the hook being inserted in an eye let into the end of the blade. The fuses on the high potential circuits are of the expulsion type, in which the fuse is held between two springs, so that at the moment of fusing, the two ends, between which the arc would ordinarily spring, are instantaneously pulled apart. Each of the direct current panels is, of course, equipped with a "K" circuit breaker.

The line is protected by GE lightning arresters of the short-gap type, so successfully employed in the high-voltage transmissions in the West, as well as on the Niagara transmission circuits. The lightning arresters are placed on the wall of the sub-station, where the high potential transmission wires enter the building.

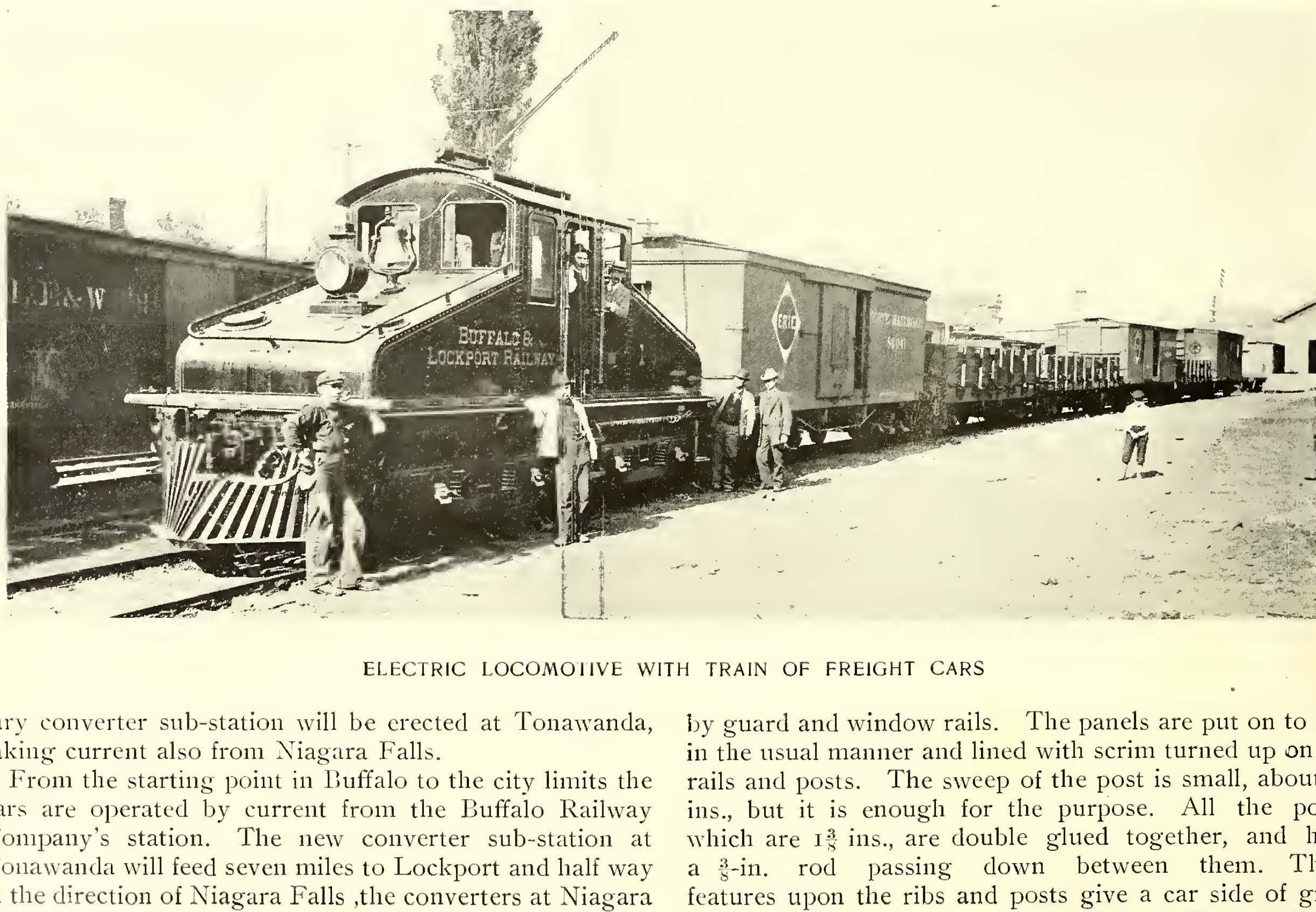
As soon as their present plant is completed another rotary converter sub-station will be erected at Tonawanda, taking current also from Niagara Falls.

From the starting point in Buffalo to the city limits the cars are operated by current from the Buffalo Railway Company's station. The new converter sub-station at Tonawanda will feed seven miles to Lockport and half way in the direction of Niagara Falls ,the converters at Niagara Falls feeding half way back to Tonawanda. The arrangement will be such that the Buffalo & Lockport Railway system can give current to or take it from the system of the Buffalo & Niagara Falls Electric Railway. The Lockport converter station will then feed back seven miles to Lockport, and supply current also to the city lines in Lockport itself.

The new rolling stock consists of two 36-ton electric locomotives, supplied by the General Electric Company, for freight service, and ten electric motor cars mounted on eight wheels and built by the J. G. Brill Company, of Philadelphia for passenger service.

The theory of handling the passenger service has been entirely changed from that in force with steam traction. Instead of long intervals between trains the cars are run on half-hour headway. This requires five cars to operate the twenty-five miles between Lockport and Buffalo. The speed is high. Over their own right of way the cars ran on their first trip at the rate of fifty miles per hour, including stops. The running time from Lockport to Tonawanda is twenty-six minutes; to Buffalo, one hour and fifteen minutes. In this trip thirty-three minutes are spent in the city of Buffalo in a distance of six miles, where the speed has to be kept low to conform to city ordinances. Even with this drawback, however, it is expected that in the near future the running time between Buffalo and Lockport will be reduced to one hour.

The following are the leading constructive features of the passenger and smoking combination cars: They are 31 ft. 8 ins. long over the end panels, and with platforms 4 ft. 6 ins. long, measure 42 ft. 4 ins. over the buffers. The latter are of the Brill angle iron pattern. The width of the car at the sills is 7 ft. $8\frac{1}{2}$ ins., and the width over all 8 ft. The sides of this car are to some extent a combination of steam and electric road practice. They are trussed upward, and have truss rods below very much as in the ordinary steam car side. In paneling, street car practice has been adopted with the usual longitudinal panels protected by guard and window rails. The panels are put on to ribs in the usual manner and lined with scrim turned up on the rails and posts. The sweep of the post is small, about $1\frac{3}{4}$ ins., but it is enough for the purpose. All the posts, which are $1\frac{3}{8}$ ins., are double glued together, and have a $\frac{3}{8}$-in. rod passing down between them. These features upon the ribs and posts give a car side of great strength, and at the same time it is very light, stiff and durable. The roof is of the regular street car type, with trolley board in the center. The height over the trolley board is 12 ft. The height to the under side of the sill is 35 ins., and in order to enable a single step to be used easily the platforms are dropped 10 ins. below the floor of the car. This, with a $14\frac{1}{2}$-in. rider, enables the step to be brought within 18 ins. of the ground. The platforms are enclosed by a round-end vestibule. These vestibules have openings on the diagonally opposite corners of the cars. Hinged doors, which fold back against the vestibules, completely enclose the platforms when so desired. Folding gates are also provided. These turn back against the outside of the vestibule.



ELECTRIC LOCOMOTIVE WITH TRAIN OF FREIGHT CARS

The car is divided into two compartments, one of which, seating twelve persons, is used for smokers. This is 9 ft. 2 ins. long, and has six reversible back seats. This compartment is separated from the remainder of the car by a partition having glass windows on each side of the sliding door; in the other compartment there are fourteen reversible back seats. All the seats have spring cushions, Hale & Kilburn patented, and covered with woven cane. The aisles are fitted with grooved hard wood floor boards. The floor under the seats is left smooth.

The head linings are of birch veneers decorated; the inside finish of the car is cherry with chipped glass beveled edges in the ventilators. The windows are extra large, and have an upper stationary sash in addition to the lower one, which drops. The cars will be fitted with electric heaters, a small one under each seat, and also push buttons.

All the cars of the road are mounted on Perfect trucks (Brill No. 27). By their use a wheel with a 2½-in. tread and a ¾-in. flange suitable for city streets can be used. It must be understood that these cars are also to be run on T rails at a speed that will enable them to average forty-five or fifty miles per hour, and the motors are speeded up to fifty-five miles per hour. Electric brakes are provided upon coach axle, there being four motors per car. The discs for them are cast upon the wheels themselves, which are double plate. From these features it will be seen that the cars are designed to completely serve the purpose of a steam train, maintaining the high speed between stations. With the advantage of a light weight the average rate will probably be much greater than could be obtained with a locomotive.

The baggage and passenger combination cars present another new and interesting type of car adapted to high speed service. They have a passenger compartment, with a seating capacity of twenty-eight and a baggage compartment 11 ft. 10 ins. long. The car body is 31 ft. 8 ins. long over the end panels, 7 ft. 8 ins. wide at the sills, and 8 ft. wide at the widest point. The platforms are 4 ft. 6 ins. long. The total length over the angle iron buffers is 37 ft. 10 ins. This length provides ample seating capacity, while the baggage compartment has space for all the baggage likely to be presented at any one time.

Plated sills with a very stiff floor frame make the body of the car light, strong and very stiff. At each end there is a round end vestibule closed on one side. The doors of the vestibule are at the diagonally opposite corners. They are double, and fold back against the vestibule wall. The openings are also closed by Brill gates, which fold outside, as shown. The complete housing of the motorman is in direct line with the closed cab of the engineer, who is in the best condition to exercise all his faculties when best protected from the weather.

The baggage compartment has two 4-ft. sliding doors on each side of the car. The partition between the bag-

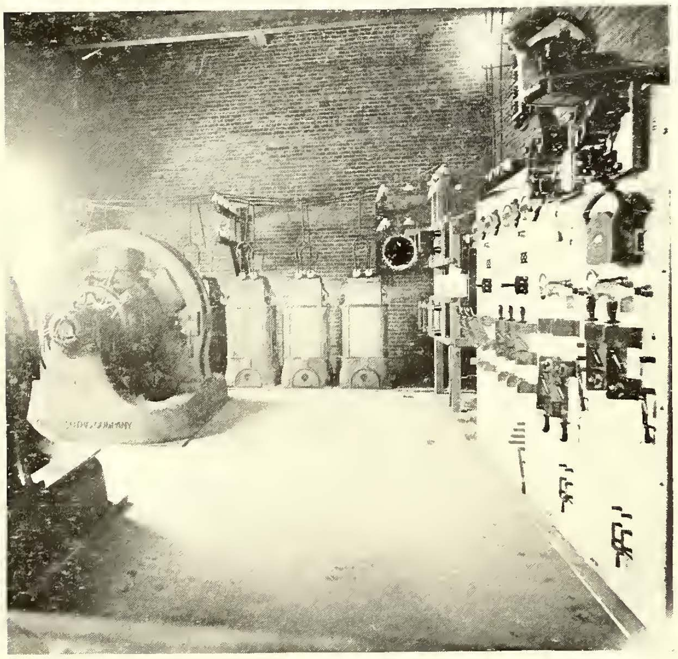
PASSENGER CAR

COMBINATION PASSENGER AND BAGGAGE CAR

gage and passenger compartments has a sliding door. The windows in this partition are fitted with curtains. The end doors of the cars are both double, and slide. The partition is of cherry, which is the inside finish of the passenger compartment. The seats are similar to those in the smoking compartment cars, just described.

Each car is equipped with four GE 57 (52 h.p.)motors, and B8 controllers, and electric brakes are employed. The equipment is similar to that on the new cars used on the long distance lines of the North Jersey Street Railway Company, of Newark, N. J. The weight of each car loaded is from twenty to twenty-five tons.

The two locomotives have been built for the purpose of handling the freight business of the road exclusively. The road being a feeder to the main Erie system, the freight traffic is considerable. To haul it, therefore, powerful locomotives were necessary, and in them the General Elec-



INTERIOR OF TRANSFORMER SUB-STATION

tric Company has incorporated such improvements as the actual operation of its locomotives on the Baltimore & Ohio Railroad and the Hoboken Shore Road has dictated.

The design follows closely that of the locomotives just mentioned, two sloping shields being placed one on each side of a central cab, the whole carried on two swiveled trucks. The cab frame is made of 1¾ in. x 1¾ in. angles, covered with a sheathing of ⅛-in. iron.

The platform, or main frame, is built up of 8-in. channels, running the entire length of the platform, and securely riveted to cross plates at the ends directly over the center truck bearings. Heavy oak buffer beams, to which are attached the draw heads and pilots, are secured to the ends of the platform. The trucks have swing bolsters, supported by elliptical springs, and the truck frames are built up of forged and rolled iron securely bolted and riveted together, the pedestals being made of cast steel. The truck proper rests on coil springs, supported by equalizing bars. The wheels are 36 ins. in diameter, with steel rims and iron centers.

The locomotives are each equipped with four GE 55 motors. The draw bar pull at full speed is approximately 3400 lbs., handling a 340-ton train at about fifteen miles per hour. The motors are rated each at about 160 h.p. As the maximum speed required is quite low, two motors are at all times connected in series.

The controller is of the K-24 type, with cut-out wiring modified to fit the special requirements of the equipment in regard to speed. Outside of the resistance points only two combinations of the motors are possible, the first throwing all four motors in series, and the second or running position, placing motors No. 1 and No. 3 in series and the pair in multiple with motors No. 2 and No. 4, similarly connected.

The locomotives are equipped with pneumatically controlled trolleys. With this arrangement it is no longer necessary for the engineer or helper to leave the cab to replace the wheel on the wire or reverse the trolley. This is effected by a handle conveniently placed over the engineer's head. The downward motion is obtained by admission of air to a cylinder, the piston of which in moving compresses the spring holding the pole in place when running. The upward motion is accomplished by the spring and the movement sideways by hand, both pole and handle being on a swivel plate. The views of the locomotive on page 535 were taken while it was being tested at Schenectady. Here, for convenience, the current was taken from a third rail, and this explains the absence of a trolley pole.

The balance of the equipment consists of air-brakes, air whistle bell, air blast sanding device, air pump, magnetic circuit breaker, magnetic switch, lightning arrester, electric lights, etc.

The following are some of the dimensions:

Length over all	32 ft.
Height of cab over rails	12 "
Distance between centers of trucks	13 "
Wheel base (one truck)	6 "
Gage	4 ft. 8½ in.
Diameter of wheels	36 in.
Complete weight of locomotive	36 tons

The locomotives have already been subjected to several severe tests. They are specified to be capable of hauling trains of 300 tons weight, exclusive of the locomotive, which, estimating the average car at thirty tons, would mean a train of ten cars. The locomotives have already proved themselves equal to hauling as many as twenty-eight loaded freight cars at the specified speed of fifteen miles an hour.

The transformation of this line from steam to an electrically operated road marks an important step in the employment of current on the steam road. If, in its operation, it successfully attains the results expected, it will conclusively prove that electricity can be economically applied to the operation of branches and feeders of steam trunk line systems. It would be too much to expect an immediate conversion of these latter main lines from steam operation to operation by electricity, but with electric locomotives and motor cars profitably carrying on both freight and passenger traffic on their feeders, the entering wedge will be driven still further and the ultimate result will be by so much nearer of attainment.

Considerable satisfaction has been expressed by the citizens of Lockport at the change in motive power, and great credit is due Messrs. Caryl Ely and Van Horn for the initiative which has brought about the successful installation of electricity on this road.

CHANGE IN BOSTON PROGRAMME

At the moment of going to press the announcement is made of a slight change in the programme of the Accountants' Convention. R. Lancaster Williams, treasurer of the Richmond Traction Company, of Richmond, Va., will lead the informal discussion instead of S. H. Bennett, of Atlanta, as announced on page 509.

DOUBLE TRUCK CARS IN NEW YORK

The drawing on the accompanying inset shows plan, longitudinal section and side and end elevation and details of the standard type of double truck closed car adopted by the Metropolitan Street Railway Company, of New York City, as built by the J. G. Brill Company. Of this type the company has several hundred in operation and several hundred in course of construction. The car is 28 ft. long over end panels and 36 ft. over dashers. The width of the car at sills over panels is 6 ft. 6 ins. and at belt rails is 7 ft. 6 ins. with 6 in. sweep of post. There are on each side ten windows, which are provided with Stephenson metal sash stiles; the sash are glazed with Chances' English "26 oz." glass. The car has pantasote curtains on the inside, mounted on Hartshorn rollers and Acme fixtures, and there are lazy tong gates at each opening of platform. Each end of the car is fitted with Sterling brakes, Millen patent. The sides and hoods are fitted with Millen patent reversible signs controlled by beveled gear and operated from the interior of the car or underneath the hood. The interior finish is in selected silver white ash, and is entirely free from specks, streaks or dark spots. The seats are longitudinal, of three-ply veneer covered with the Broadway standard pattern of wilton carpet. The car has maple veneer ceilings, and is without any striping or decoration. The car is fitted with Sterling No. 1 register of the Broadway pattern, and also Sterling rod ringing devices. The car has Brill's patented angle iron bumper and the Broadway standard draw bar, Brill's patented ratchet brake handle and patented alarm gong and Sterling sand box.

The side posts are of 2-in. ash, and the floors are covered with diamond pattern of mats. The doors are of the twin operating type. For stiffening the side framing of these cars the Brill Company has incorporated in their construction three systems of trussing, the regular underrunning truss rods to hold up the center of the car, the horizontal truss planks of 1¾ ins. thick along each side and underneath the seats, and gained at every post and halfed into the corner posts, so as to strengthen the ends and centers. In addition to these two systems of trusses there is an overhanging truss rod to prevent the ends sagging, and there is also a flat bar of iron 1¼ in. x ¼ in. with rounded ends, which is let into every post and held in position by small castings and screws; the rounded ends are then passed through the end corner posts with sunken washers on the outside. The object of this is to further strengthen the sides and prevent the opening of any joints at the belt rail. The cars are painted a standard color, striping and lettering, and are mounted on Brill Eureka Maximum Traction pivotal trucks. These trucks have a 4-ft. wheel base with 30-in. driving wheel and 20-in. trail wheels, and are of the New York Car Wheel Company's make. The brakes are so arranged that the power is applied to the wheels in accordance with the amount of weight set on them. The boxes are of the Brill dust and oil tight type, and the side frames are steel castings without bolts, nuts and rivets, except for the cross pieces.

The value of the maximum traction truck is particularly well illustrated in the service of the Metropolitan Street Railway Company. The two prime requisites are ample propulsive power with two motors to a car and a low car body. The truck used brings the body down to the lowest point, and while securing an exceedingly steady motion to the car body, provides all the adhesion necessary for rapid acceleration and high speed; at the same time ample space is provided for the motor. The trucks are also, it is claimed, soft on the rails, giving much less wear to the roadbed than a much heavier body on four wheels. A particularly useful feature is the fact that the braking power is so arranged as to be in proportion to the amount of weight on the wheels, a feature which prevents the wheels from skidding. This is a particularly desirable feature, as the Millen brake, or the brake employed, has exceptional power and rapidity of action, and by this feature of the brake rigging the full power of the brake can be obtained without danger.

POWER CONSUMPTION IN RAPID TRANSIT SERVICE

BY A. H. ARMSTRONG

The August issue of the STREET RAILWAY JOURNAL contains an article by Mr. Carus-Wilson giving some views of the comparative efficiency of different methods of train acceleration. The article is intended as a criticism of a paper on the same subject appearing in the June issue of the JOURNAL, but Mr. Carus-Wilson evidently does not clearly understand the basis upon which the paper was written; that is, the consideration of only the actual energy output of the motive power.

Energy values throughout are net; that is, no account is taken of losses occurring in whatever motive power may be used and its method of control. Thus the problem as worked out was a purely mechanical one, and while many electrical terms were used in bringing out the various points, yet the results were not limited in any way to electric motors as a source of power. Thus the introduction into the discussion, by Mr. Carus-Wilson, of the losses occurring in the series parallel control of electric motors during the accelerating of a train is entirely outside the scope of the paper and the results which he derives therefrom, even if they were not misleading, could in no way be taken as pertinent to the original paper.

For instance, the June paper, far from advocating the constant rate of acceleration as requiring the least energy expenditure, adopted this method as being the only one applying to different motive powers in general. If the electric motor were adopted as the motive power to discuss, a due amount of acceleration upon the motor curve would have proven much more efficient than the constant accelerating rate, both in regard to energy input and also motor capacity.

If, further, the discussion of motor control had been taken up, the series parallel method of control would not have been limited to motors having $I^2 R$ losses only, as is done in Mr. Carus-Wilson's remarks, but due consideration would have been paid to the excessive core loss and gear loss resulting from constant speed running.

By leaving out these light load losses Mr. Carus-Wilson has made out a very fair case, but if all the losses occurring in the practical operation of a train by electric motors had been discussed, it would have been found that not only is the coasting method of train acceleration more efficient in energy expenditure, but in input energy as well. This comparison I have brought out more fully in a paper presented before the American Institute of Electrical Engineers, taking up also the effect of series parallel control upon the train input.

The remarks made concerning an increase of 30 per cent in motor capacity for acceleration with coasting are obviously untrue, being based upon $I^2 R$ losses alone and neglecting entirely the core loss.

In conclusion it may be pointed out that in general the method of acceleration permitting the minimum speed at which brakes are applied requires the least energy input, other conditions being equal.

RECENT ELECTRIC CONSTRUCTION OF THE NEW YORK, NEW HAVEN & HARTFORD RAILROAD COMPANY

BY N. H. HEFT

About a year ago I described in the columns of the STREET RAILWAY JOURNAL the electric railway installation made by the New York, New Haven & Hartford Railroad Company between Hartford and New Britain, and at Nantasket Beach. At that time the third rail method of conducting the current to the car had been in use by us only a short time, and its practical value was to a certain extent undefined. During the last year, however, we have had no reason to alter our opinion as to the merits of electric traction by the third rail, and to its economy over steam traction under certain conditions, and, although certain changes have been made in minor details in the system employed, it remains practically the same as a year ago. The changes made have been principally in the rolling stock, as will be described later.

The additions to the electric railway equipment of the New York, New Haven & Hartford Railroad Company, which have been made since July 1, 1897, have been:

1. An extension of the Hartford and New Britain third rail system from New Britain to Bristol and extending through Cooks, Plainville and Forestville, a distance of 8.8 miles. The track equipped is part of the old New England Railroad, now the Highland Division of the New Haven system. The service between Bristol and Hartford is conducted by three regular trains, which run half hourly between New Britain and Hartford, and hourly between New Britain and Bristol. The construction between New Britain and Bristol is the third rail, the same as that between Hartford and New Britain, and passenger cars only are run. The electric cars are confined to one track, and the steam cars to the other track of what was formerly a double track steam line.

2. The electric equipment of the connecting spur, two and one-half miles in length, between New Britain and Berlin. No steam trains are used on this line except freight trains, and occasionally the electric motor cars haul freight cars. The third rail system is in use.

3. An extension of the Nantasket Beach system from East Weymouth to Braintree, a distance of 4.4 miles. This is a double track road, both tracks being equipped with the same third rail system employed on the Nantasket Beach line. The same rolling stock is also used.

4. The Stamford to New Canaan branch, length eight miles. This is a single track road, formerly operated by steam power, and has its southern terminus at the main line station at Stamford. The grade for three miles is 91 ft. to the mile. The former service was supplied by one train, which connected with all the main line trains stopping at Stamford, and this same service is now given by an electric train consisting of one motor car and usually a trail car. On Sunday afternoon, however, two trains are in service. The schedule on Sunday is hourly from 8 A. M. to 1 P. M.; then half-hourly to 8 P. M.; then hourly to 10:30 P. M. This line comprises the most important electric extension made by the New Haven system during the last year, and I will therefore discuss its novel features.

The motor cars are of the combination passenger and baggage type, as shown in Fig. 1. They were built by the Jackson & Sharp Company, of Wilmington, Del., and have 30-ft. bodies divided into a 10-ft. baggage and 20-ft. passenger compartment. The former is equipped with a folding seat, which can be used for smokers, or can be folded up. The regular passenger compartment is equipped with Hale & Kiburn walkover seats, upholstered in rattan, and has a total seating capacity for twenty-eight passengers. The interior finish is in mahogany. The cars are equipped with 4 ft. 6 in. vestibules. The motor cars are fitted with Christensen independent air pumps, engineers' valve and tank and Westinghouse jam cylinders and triple valves.

FIG. 1.—TRAIN OF ELECTRIC CARS AT STAMFORD STATION, N. Y., N. H. & H. R.R. CO.

The trail cars, which were also built by the Jackson & Sharp Company, are 37 ft. long over all, with 3-ft. platforms. They are fitted with ten reversible and two permanent benches, are finished in ash and cherry, and are fitted with duck curtains, which can be drawn down below the seat.

The motor cars are mounted on a new type of truck, built by the Baldwin Locomotive Works, and known as the Heft Electric truck. The main points considered in the design of this truck were (*a*) simplicity of arrangement, and (*b*) facility in inspecting or removing motors. The truck has a steel frame throughout. The transom has a side play of 2½ ins. at each end. A spring plank, which supports it, is arched in the center to allow plenty of room for the suspension bars which carry the third rail shoe, which is attached to the truck. There are no outside brake beams to interfere with easy access to the motors, and the brake rods are so arranged that slack in the brake rigging can be taken up not only at the end of the rod, but also with a turn buckle placed at the center of the rod. The pilot brace is so arranged that it can be lifted up by the removal of a bolt, allowing an inspector to get at the motor boxes or motors readily.

The entire upper half of the truck can be removed very quickly from the lower part, including the wheels and axles, motors, side suspension bars. All that is re-

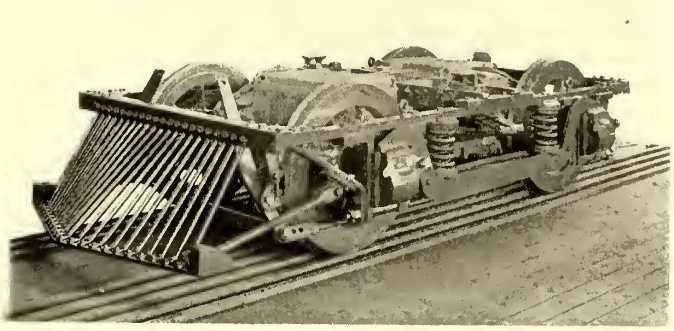


FIG. 2.—FRONT END VIEW OF TRUCK

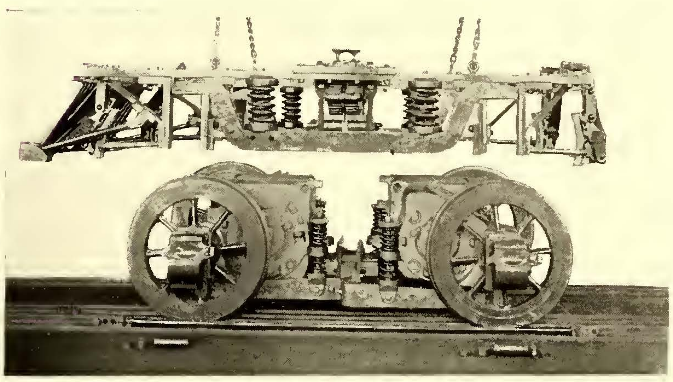


FIG. 4.—TRUCK WITH UPPER HALF RAISED

quired is to remove four thimble bolts under the pedestals, take out the cotter pins connecting the brake rods to the brake levers, and disconnect the motor cables. The motor connections are made through a junction box, so that they can be disconnected as quickly as disconnecting a hose cable.

The motor spring suspension is entirely separate from the car spring system, the motors being suspended on separate side bars, as shown in Fig. 4. This enables the traffic manager to graduate the system of springs supporting the car body to any extent desired, making a very easy riding car. The front of the motor casing is fitted with lugs above and below the transom bar, so that in case of a break in the motor suspension bar the motors will be caught on the transom, thus preventing derailment. The connection of the axles by the side bars, carrying the motors, are independent of the upper part of the truck, and will keep the axles in parallel after the upper part has been raised, as shown in Fig. 4. The work of changing the motors is then an easy task, and one which two men can do in fifteen minutes at the most with a proper hoist.

Hollow, open hearth, steel axles are used for greater strength. These axles have a diameter of 8 in. at the gear wheel fit, 6½ in. at the wheel fit, 6½ in. at the motor box fit, and have journals 5½ in. x 9 in. The diameter of the hole in the axle is 1½ in. The wheels are of the Vauclain composite type, with wrought iron centers and steel tires.

The motors used are of the new G. E. "55" type, known as the New York, New Haven & Hartford Railroad motor, rated at about 175 h.p. each. The ratio of gearing is 2.47 to 1, which gives a car speed of about twenty-three miles per hour when ascending the 1.2 per cent maximum grade, or forty miles per hour on level track.

The overhead trolley construction is used, bracket construction being employed for the greated part throughout

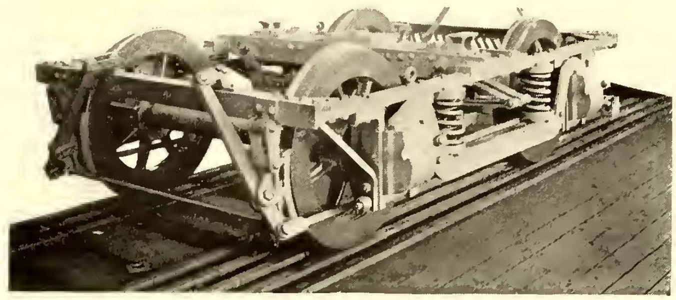


FIG. 3.—REAR END VIEW OF TRUCK

the line, except at the Stamford terminal, where span wires are employed. The trolley was adopted in place of the third rail on this section to make it possible to operate the cars on the ordinary street railway of the Stamford Street Railway Company, whose tracks are used for a short dis-

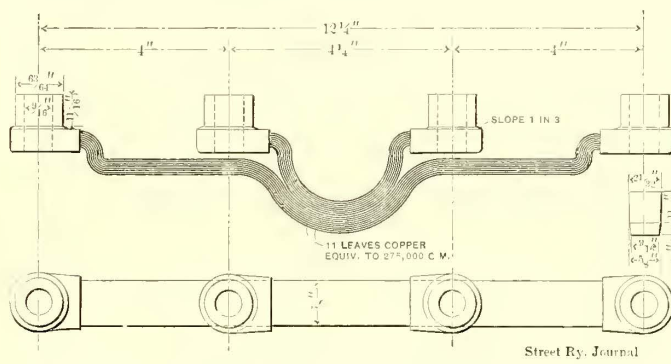


FIG. 5.—PLAN AND SIDE ELEVATION OF BOND

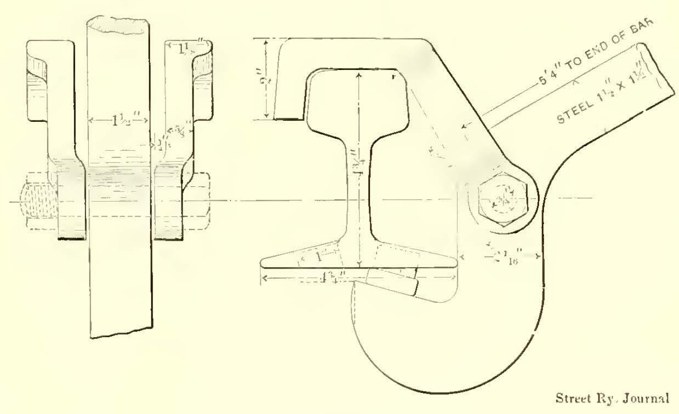


FIG. 6.—BONDING TOOL

tance in Stamford in making a loop between the eastbound and westbound stations of the New Canaan Branch, and also to make it possible for the Stamford cars to operate on the New Canaan Branch if necessary. The trolley wheel is similar to that employed on the overhead section of the Nantasket Beach road, and has a flat tread with straight flanges. No difficulty has been experienced in keeping the trolley on the wire, and in descending the grade from New Canaan to Stamford, where the speed of the cars frequently reaches fifty miles an hour, no attention is paid to the trolleys. The trolley wire is No. 000

and No. 0000, with long soldered ears and flexible brackets. No overhead frogs are used in the line, and at the turnout at Springdale a separate trolley wire is employed and the trolley is shifted from one wire to the other as the siding is made. With a little practice the employees have learned to do this without stopping the car.

Great care has been exercised to secure a return circuit of low conductivity, and each joint is bonded with two bonds, each having a section of 275,000 c.m. The type of bond used is similar to that employed by the New York, New Haven & Hartford Railroad Company elsewhere, and is shown in Fig. 5. It consists of a leaf bond with "crown terminals," and is applied underneath the base of the rail, to which it is attached by means of the tool shown in Fig. 6, which forces the drift pin of the size shown through the aperture in the bond terminal, after which the bond head, which is countersunk, is set by hammer around the edge of the drift pin to prevent the latter from working loose.

The poles are of octagonal yellow pine, 8 in. at top and 10 in. at the butt, and 30 ft. to 33 ft. long.

Near the Stamford terminus of the road the electric line runs parallel with the steam railroad line for a distance of about two miles, but no interference has been noticed here of the electric railway return circuit with the electric block signal system used on the main line. To guard against any possible danger from this source the two crossovers between the electric railway tracks and the steam railroad tracks are insulated at the joints.

Each train carries three employees—a motorman, a conductor and a brakeman, the latter being necessary on account of the large amount of baggage carried.

Power is taken from the Stamford power station, in which are two Green single, non-condensing engines 22 ins. x 36 ins., each district connected to a 300-k.w. General Electric generator. Return tubular boilers are employed, and sparks are used as fuel.

CONVERSION OF THE EDINBURGH HORSE TRAMWAY SYSTEM INTO CABLE TRACTION*

BY W. N. COLAM

In 1890 the cable system in Edinburgh was in its infancy, as the second line built had only been opened to the public in the month of February of that year, and the first line in January, 1888. The information available at that time as to the operating costs was not reliable, because the lines had not been at work long enough to ascertain how far the working costs would be increased after the lines and machinery had been in use for some years. This can now be given without any dubiety from the regular balance sheets for the last 10½ years up to the date when the Corporation of Edinburgh bought up the lines at a price which yielded a profit over the original cost of construction of about 30 per cent.

The conditions under which these lines have been compelled to operate cannot be considered conducive to the best financial results for either receipts or expenditure, for the following among other reasons:

(1) The maximum speed was limited to six miles per hour when the system was inaugurated, mainly because it was something new, and has not since been raised because in the hilly district perhaps slow speed is not so noticeable.

(2) No Sunday traffic on tramways has been permitted.

(3) The routes are most exceptionally hilly.

(4) The ends of the routes are not built over, and lead nowhere in particular.

(5) The engines are high-pressure non-condensing, working at low pressure of steam.

(6) There are no economizer means of utilizing the gases nor feed-water heaters.

(7) The whole managerial department was in London, which necessitated heavy traveling expenses.

Notwithstanding the unfair limitation in speed and other drawbacks, the results have been eminently satisfactory, as will be seen from the following statement (Table No. 1) made from a comparison of results in 1890 with the last year of the company's working in 1896:

TABLE No. 1.

YEAR.	Motive Power.	Maintenance.	Total.	Car Miles.	Passengers.
1890	£1279	£2219	£3498	222,822	2,582,620
1896	1180	2710	3890	376,725	3,715,989
Increase, per cent	----	22.12	11.23	69.06	43.88
Decrease, per cent	7.74	----	----	------	------

NOTE.—The Motive Power includes wages, coals, oil tar, waste, water and engine room requirements. Maintenance is for road, cars and plant.

The tabulated results of No. 1 must be somewhat puzzling to the uninitiated in cable haulage, because, when analyzed, they show that although the mileage has been increased 69.06 per cent, and the number of passengers carried increased 43.88 per cent, the cost of motive power, instead of being greater, happened to be less. The reduction in cost of motive power has been due to improvements and a slight reduction in the price of coal, and the reason for no increase is that the loads up and down balanced on an average. These figures once more prove that cable haulage is able to enormously increase its car service, and so provide for the future without appreciable increase in its working expenses.

It will be observed from the returns that, whereas the number of passengers only increased 43.88 per cent, the car mileage increased 69.06 per cent. This is most important to note, because it points to a factor peculiar to cable haulage. It is directly in the interests of the management to improve the service of cars beyond even the requirements of the public, because, beyond the wages of the drivers and conductors, very little extra is incurred in placing each additional car on the line.

Even more satisfactory results than are shown in Table No. 1 were recorded on one of the cable lines during a week of greatly augmented traffic, and the author now presents these figures, believing them to show the most unique results for the conditions of operating which have ever been obtained in tramway practice in Great Britain. The ordinary weekly working expenses given in the table was arrived at by a division of the yearly certified accounts of fifty-two weeks, and the increased cost of operating was carefully checked during the week, and was mostly due to wages and gratuities given to the men and inspectors for close attention to their duties.

TABLE No. 2.

YEAR 1893.	No. of Cars.	Mileage of Cars.	Passengers.	Tons Hauled Per Mile.	Cost Per Ton Mile in Pence.	Total Receipts.	Total Expenses.
Show week, 24th to 29th July	47	3395	112 663	7.14	.75	£468	£75
Ordinary week. Av. 4 weeks	36	2514	27,541	5.75	1.11	114	67
Increase, per cent	31	35	309	24	---	311	12
Decrease, per cent	--	----	------	---	33	---	--

Table 2 shows that with the same fares a cable tramway was able to increase its receipts 311 per cent by a rise of working expenses of 12 per cent only.

That by quickening the service of cars by 1⅛ minutes, when the traffic would warrant it, the working expenses per car mile run were reduced ¾d.

That the tons hauled per mile increased 24 per cent, and the cost of hauling a ton mile was reduced 33 per cent. This is elasticity in the right direction and the author is of opinion that local authorities and tramway companies too often make the mistake of not thoroughly arriving at sound conclusions as to the elasticity of a mode of traction in this direction when considering the initial cost of systems under scrutiny.

The last return of the company's working showed that the cost per car mile, including every charge possible, excepting depreciation and interest on capital, was 5.2 pence, notwithstanding the restriction on speed and the severe hills, etc. The receipts per car mile had only been 10.13 pence, which was just about what the *cost* per car mile run has been on the horse system of Edinburgh. The foregoing facts conclusively prove that the lines have been a great success financially, and the fact of the Corporation of Edinburgh still favoring cable should be sufficient authority for the statement that mechanically they have met with public approval.

The Corporation of Edinburgh has purchased all the tramways within the limits of the borough, and they have leased the work-

* Paper read before the Incorporated Association of Municipal and County Engineers

ing to a company for twenty-one years, the company agreeing as follows:

(1) To pay interest of 7 per cent upon the price paid by the Corporation for old lines, and the same rate of interest upon all sums of money expended by the Corporation in converting to any form of mechanical traction they choose.

They also agree to set by each year a fixed sum of money sufficient to return the capital of the lessees, and to insure the tramway lines and other works being left in a thoroughly good condition when the lease expires.

(2) To pay the cost of maintaining the tramway tracks and other works.

(3) To reduce the hours of workmen as desired by the Corporation.

(4) To pay 3 per cent upon sums expended by Corporation in reconstruction until the lines are finished.

The Corporation, by borrowing the necessary money for the purchase and construction of lines at 2½ per cent, and by getting 7 per cent from the lessees, will be able to write off the cost of the tramway system within the terms of the lease. The author thinks that the Corporation is to be congratulated upon the arrangement made, and suggests that those who advocate municipal working of tramways might consider the Edinburgh arrangement worthy of favorable reflection.

Before entering upon descriptive matter it may be of primary interest to give what the author believes to have been some of the Corporation's reasons for adopting cable haulage in preference to other mechanical powers which have found favor elsewhere.

First of all it must be stated that the original lines were self-contained and were in no measure the inducement for extending the system for the preservation of continuity.

Secondly. The overhead wire system of electricity, which was the only other system reported as being anything like a financial success, was not entertained in Edinburgh because of its interference with the amenities of the city.

Thirdly. Because the contour of the city is peculiar in being exceptionally hilly, and where so many hills exist in a city it is of paramount that the speed ascending hills shall not be less than that attainable on level portions of the routes.

Fourthly. The buildings limit line of the city is more markedly defined than in most cities.

Fifthly. The cable system in Birmingham, London and Edinburgh had placed the fact beyond a doubt that the Corporation could treat for a lessee with full knowledge of what would be an approximate working cost per car mile with the cable system, whereas by any other system which could be in any way considered no such reliable information was available, particularly from experience of operating under British Board of Trade Regulations. Further, it is within the author's knowledge that eminent electrical opinion has been given that Edinburgh is not a suitable place for electrical traction in any form.

Table 3 gives the miles of lines within these respective districts reduced to single track of tramway.

TABLE No. 3.

	Miles of Double Track.	Miles of Single Track.	Reduced to Miles of Single Track.
Edinburgh	19.004	700	38 708
Portobello	2 110	....	4.220
Leith	2.165	.170	4.500
Total	23.279	870	47.428

Throughout the system there will exist nearly all conditions of tramway operating which are to be met with in ordinary practice. For instance, the grades are as high as one in eleven, there are right angle branches, "S" junctions and compound triangular junctions to be worked. Single lines of track with passing places are not common, but at places are required. Cross traffic, where cables cross each other, have also to be dealt with. Bridges and cellars have already been crossed by the cable construction in Edinburgh, when clearances of 14 ins. only from the surfaces of the roads have been available, and lastly, an arrangement for crossing a swing bridge in the Leith District has been designed. Arrangements are made by which the traffic can be returned (or short circuited) through turn outs when the management considers it will be advisable during parts of the day to provide an augmented service of cars short of the terminus of the route, and such provision is also made for isolating a cable section where a block may occur.

The general speed of cars throughout the Edinburgh District is to be eight miles per hour, but passing round important corners and over congested crossings, the drivers of cars will not be able to acquire a higher speed than four miles per hour, and they will be able to go as much slower than four miles as may be required. Provision is being made to increase the maximum speeds when the Board of Trade may give permission. In the outlying district of Portobello it is expected that the Board of Trade will raise no objection to nine miles.

The track rails are of the usual type now common for tramways, and are 6½ ins. deep, weighing 83 lbs. to the yard.

The tests of 42 to 44 tons per square inch for tensile, 15 to 20 per cent on 8 ins. for elongation, and 40 to 45 per cent contraction, called for in the specification, was objected to by British manufacturers, but the engineers are pleased to report that the effort was made, and the tests were fully obtained, with the result that extremely hard and yet tough rails have been laid in the system.

The slot rails weigh 48 lbs. per yard, and are of a somewhat milder steel than the track rails, the tensile asked for being 39 tons to the square inch, with 15 per cent elongation and a contraction of 30 per cent. The actual amount of metal appearing on the surface of the street in these slot rails is 1 3-16 ins. Against these rails also it will be observed that the paving setts can be placed right up to the edge of the rail with any chipping, and on a square bed, which is important. The Barrow Hæmetite Steel Company carried out one contract for rails and Messrs. Dick, Kerr & Company the other.

The points and crossings are all to be made of steel, and no facing points are used excepting when they cannot be avoided, such as junctions.

Trailing points for track and slot rails will work by springs, but where facing points are required the track points are connected underground to the slot points by levers in such a manner that, whichever way they are thrown over, there is a locking apparatus introduced to fix the slot correctly with the track points. The slot points are built up of cast and spring steel. The track points are made of cast steel, and track over slot and slot over track crossings are built up from the section of these rails, but the junctions of slot and slot are made of cast steel with renewable points.

The paving setts are granite, of two qualities as far as workmanship is concerned. Inside the track the setts are 3 ins. wide x 5 ins. deep, and the average length is about 6 ins. Outside the track the setts are 6 ins. deep x 3 ins. wide. The better quality of setts are axed on top as well as square on ends and sides. The hatch covers, which are used in the track for obtaining access to the pulleys, are filled with granite setts specially dressed, and of the same size as other setts, so that in ordinary conditions they are almost imperceptible on the road surface.

In the road construction a great deal of wood has been used, and this has chiefly been of the hard Australian qualities. In some cases the wood has been laid from curb to curb, including inside the tramway track.

The standard distance between the tramway tracks is 4 ft., but where the streets are narrow this has been reduced to 3 ft. At places where the streets are exceptionally wide, the tracks have been spread apart to give a distance between of 6 ft., and electric light posts have been erected in the center. The width of the slot is specified to be in no case more than ¾ in.

The terminal pits for diverting the cables at the terminal of each route are so constructed that, regardless of whether the route ends on an incline upward or downward, the cars will proceed to the extreme end of the journey by means of the cable, and no gravitation whatever will be resorted to. This is attained by passing the cable around two large vertically placed pulleys, one behind the other, and one slightly inclined. By this means, even in a heavy snowstorm, a car could proceed through the snow to its terminus and start out again without the tracks being cleared.

Where cables terminate in the middle of a route and meet other cables, the two cables are made to lap past each other by arrangement of large pulleys placed in a pit. At these places the cables are so arranged that the operation of releasing from one cable and taking the other is performed while the car is at a state of rest, and will not require more than fifteen seconds to accomplish the change over. The operation is practically automatic The reduced maximum speeds of cables for passing round important main corners in streets is obtained by the introduction of auxiliary cables, which are worked off the axles of large pulleys kept in motion by the main cable, and the main cables are thus saved from a great deal of hard work, and their lives, consequently, will be materially lengthened.

There seems to be an idea existing that cable tramway tracks are very serious innovations for streets, because they require a tube construction beyond an ordinary tramway track. The following information will confute any such erroneous impression:

During the first twelve months of the contract there were laid in the streets of Edinburgh a trifle over twenty miles of cable track. The greatest speed attained was during six consecutive days, when an average of 220 yards per day was attained on one section of new lines.

It will be seen that the amount of finished work during twelve months averages out to a little more than 112 yards per working day, which would be considered splendid work for an ordinary horse tramway line, where the traffic is such as in Edinburgh, and where the tramway service has to be maintained. The contract for road and pit work was secured by Messrs. Dick, Kerr & Company, Limited.

The depot for the Western District is of red stone and a fine quality of brick, the former being exclusively employed for the front elevations. The buildings include engine room, boiler room, chimney 180 ft. high, pump room, built-in water tanks to hold 40,000 gals., tension room, car sheds for forty-three cars, cart sheds and stable for three horses, stores for road work, and underground stores for oils, etc., lavatories, offices, etc.

The engines are horizontal compound non-condensing, with cylinders placed side by side on separate cranks set at right angles. There are three pairs of engines attached to the one line of main shafting. Each main shaft is divided into sections which can be connected by specially arranged couplings forged on the shaft ends. Two 14 ft. 6 ins. diameter grooved pulleys are mounted in the line of shafting, so that any two of the three engines can be geared to work the two pulleys. These pulleys are made for carrying thirty-two ropes of 1⅝ ins. diameter, and they will revolve at 45 r.p.m. The power of the engines will be transmitted to the counter shaft through pulleys 30 ft. diameter. The high-pressure cylinders are 23 ins., the low-pressure cylinders are 40 ins. diameter. The stroke is 5 ft.

A premium of 5 per cent has been offered as a bonus on the contract price of the engines for every pound of water per indicated h.p. consumed per hour less than the 20 lbs specified. In like manner a deduction of 5 per cent will be made, but should the consumption per indicated h.p. reach 23 lbs., the engines may be rejected.

The engine room is provided with two cranes to lift 24 tons each. Messrs. Dick, Kerr & Company, Limited, secured the contract for this portion of the work.

The boiler house is placed immediately behind and considerably lower than the engine room. The coals taken in off the road have not far to be lifted into the bunkers over the boilers. All the pipes to and from the boilers and engines pass underneath the engine room floors without dipping, and do not appear at all in the engine room, also the low level of boilers should also reduce the chance of priming through syphoning. The boilers are cylindrical marine type, 10 ft. 6 ins. x 12 ft., with super-heater tubes on the top. The gases from the fire enter a back combustion chamber, from which they pass to the front of the boiler through tubes into the smoke box. They are returned over the top of the boiler, passing on their way around super-heater tubes into a second back chamber which directs the gases along the bottom of the boilers into the main flue.

Apparatus is provided for diverting the gases down the sides of the boilers, in case the super-heater tube should require attention when the boiler is under steam. The duty of these boilers is to evaporate not less than 9000 lbs. of water per hour at a boiler pressure of 160 lbs. There are four such boilers designed to work up to a pressure ultimately of 160 lbs. These boilers will not be worked to anything like their full capacity, and a large reserve will always be kept in hand.

The main steam piping is welded steel, and all in duplicate. The feed pipes are in copper and are duplicated. The boilers are fitted with Vicars' mechanical stokers, supplied with coal from an overhead bunker running the full length of the boiler house. Coal is taken up with ropes to the bunkers in receptacles resembling contractors' steel wagons, which are so adapted that they are suitable either for use on the body of a cart through the streets or to form the tipping body of a tramway coal truck which will travel on rails over the top of the coal bunker.

There are two heaters, arranged so that they may be used together or separately. These are of the Brown-Berryman type, and each heater is capable of passing 1600 gals. of water per hour. The pumps are in duplicate, and are 8-in. double vertical Weirs' type.

The arrangement of pipes from the pumps is to effect the following combination of feeding:

(*a*) All the boilers may be fed with hot water.
(*b*) All the boilers may be fed with cold water.
(*c*) Any number of boilers may be fed with hot or cold water.
(*d*) Any one boiler may be fed with hot and cold water.
(*e*) Any one boiler may be fed with hot or cold water.

Messrs. George Sinclair & Co. are the contractors for the work in connection with the boilers, etc.

At No. 2 depot the arrangements of boilers and machinery is much the same as at No. 1, only the boiler house is not placed exactly in the same relative position to the engine house, but has the advantage of being at the side of a railway, so that a siding has been made by which means coals can be lifted direct up into the bunkers instead of having to be brought in carts as at No. 1 depot. At this depot all the smithy, repair, general machine, carpenter's, and paint shops are placed. At both depots the cars are brought in and taken out from the main road by auxiliary cables, and they are traversed into the repair shops or ordinary sidings by traversers, also worked by auxiliary cables. The tension races are immediately at the back of the engine rooms, and under car shed floors. The pulleys on the main carriages are placed horizontally, and the tension weights are arranged vertically upon the wall of the engine room, so that the man in charge can observe at any moment the fluctuation of strains taking place upon any one line being driven from each station. From No. 1 station five cables will be driven, and the longest at present will be 24,000 ft., but these will all be capable of considerable extension. The longest cable in the system at present is 34,500 ft. The mode of driving the cables is somewhat as explained in the author's paper of 1890, but the grip pulley has the improved white metal jaw which has given great satisfaction in the London Cable Tramways. Each grip pulley can be thrown out of action without interfering with any other, by means of a coil clutch of powerful construction.

Opposite each rope drive there will be an iron drum, with a spare cable for its respective route, ready at any moment to be run into the road. At the side of the engine room an engine and drum is provided for hauling out old cables, and it is estimated that the longest cable will be taken out and a new one put in within the space of one hour.

The gripper apparatus to be placed on the cars is an important feature of the arrangements made for cabling the Edinburgh extensions. The whole machinery is inclosed with a cast-iron box standing on the platform of the car, and occupying about the same space as is taken up on the car by an electric tramway controller. The main improvements over the gripper of 1890 consists of provision by which the driver of the car standing in the front of the car can operate the gripper by his side or the one at the rear end of the car by a simple reversing of a lever. It is by this means that the driver can cross over the cable running at right angles to his path. He proceeds to a stopping point with the gripper attached to his main cable; he then by the one process lets go that cable in the front and takes it in the rear gripper and proceeds over the crossing of the cable. The operation takes only a few seconds, and should be quite safe, because there is an automatic arrangement provided for stopping the car providing the driver should be forgetful or careless. Another improvement is, that the portion of the gripper which works in the tube underground can be quickly detached from the car and dropped into the tube if anything should go wrong with it. The attachment previously used direct on to the axles of the car, was found in practice to have several drawbacks, and the new gripper is fixed to adjustable bars on the bogies, and the moving parts are inclosed so that there will be no fear of oil, etc., injuring wearing apparel.

There are 125 cars being built on the bogie principle. The bogies are very light in construction, being made of 5-16-in. pressed steel frames. The chief feature about them is that the wheels are on the axles outside the bearings, and that the wheel base is 3 ft. 9 ins. and less than the gage of 4 ft. 8½ ins. This is contrary to customary practice, but the author has tried them very severely, and finds them to answer admirably. The cars are designed to seat eighteen passengers inside and twenty-eight outside, and the only noticeable departure from ordinary practice is that the insides of the cars will be domed after the manner of railway carriages, instead of the type of roof common in tramway cars.

In concluding, I would specially invite the members, as advisers to their respective districts, to always insist upon arriving as far as possible at:

Firstly. The saving which can be effected by any particular system over the whole period in which that system is intended to operate, before allowing the initial cost to have any influence upon the minds of their committees.

Secondly. To compare (at least in a common-sense way) with existing systems the cost of repairs which are likely to result upon each individual system.

With regard to the first point, it is not generally recognized what amount of expenditure is justified in converting horse tramways to mechanical traction.

What expenditure is warrantable upon introducing a system which can even only show a saving over the old system of 1d.

per car mile run? We will take as an illustration a town system in which it is desired to have a good service of cars, such as 1000-car miles per mile of double track per day, and experience shows this is to be quickly attained with cable haulage, which fosters and can afford to foster a tramway business in a way which no other system can. One thousand car miles per mile of double track per day, with a mean car speed of six miles per hour (which is, of course, low), would require for working a day of seventeen hours, an average interval between the cars of say two minutes, ten cars thus running on the mile of street length and performing sixty-car miles per hour. This would give 365,000 car miles per mile of double track per annum, and 1d. per car mile saved would be in round figures £1,500 per mile of street per annum. That sum is sufficient to pay 5 per cent interest on a capital of £30,000 per mile of street, and yet it is only 1d. saved per car mile.

Cable haulage for such a service would be about 4d., and would probably be nearer 5d., per car mile cheaper than the present expenses for horse traction.

And yet there are people who still hesitate, and some even refuse, to consider mechanical form of traction where the initial cost is high, and therefore never discover the extraordinary results and savings which may be effected in the future by the expenditure of additional capital at the right time.

With regard to the second point the author would like to draw your attention to the class of figures which you have to guard against.

In a paper lately read before the Institution of Civil Engineers, the costs of maintenance and repairs on an electric tramway line were given to four places of decimals as follows: For the maintenance and repairs of cars, with motors and everything complete, .26725d. per car mile run.

The author ventures to say that nobody will dispute that the cost of maintenance and repairs for heavy cars, with heavy motors and electrical machinery, must in the future cost far more to maintain than the ordinary horse car, and yet it can be most conclusively shown that the average cost of maintaining a horse car only in Edinburgh during eleven years has been 51d. per car mile run, or twice the figure which is quoted for electrical maintenance.

Again, it was also stated that the cost maintenance and repairs for lines, which would include the whole of the permanent way, rails, bonding, electric poles and wires, etc., was .0088d. per car mile run. Experience shows that the average expense of maintaining the horse tracks alone in Edinburgh has been during eleven years .64d. per car mile run, or nearly seventy-three times the amounts given for maintaining electrical road and wires, etc., etc.

The author does not wish to infer that these figures are put forward to wilfully mislead, but he cannot too strongly warn those who are seeking for information, that a few such items in the cost of maintenance would make the difference between financial success and failure. The cost of maintenance can only be properly arrived at when the fullest data of working is available over an extended period of time.

The whole of the work is from the designs of the author and your vice-president, Mr. Cooper, who are superintending the carrying out of the work with assistance of their respective staffs.

The magnitude of the street railway interest is better realized when we think of the rapidity of its growth and development, when we turn back twenty-five years, that same period of which we have heard so much in the past five months from the platforms of railroad cars and elsewhere—in that twenty-five years the street railway business has increased ten-fold, and there has been a corresponding creation of value, a creation of value meaning increased comfort and happiness for the people, and increased employment for human labor.—From address at the St. Louis Convention, 1896.

The amount of heat necessary in a car to maintain a given inside temperature depends on two things: the first thing it depends upon is the amount of artificial heat which you give it; and, secondly, it depends on the number of passengers you carry. It has been known for a good many years, and it is a point that is always considered in calculating the amount of heat necessary in a room like this, for example, how many people are in the room. It is well known that the average person is capable of giving out an amount of heat in twenty-four hours which will raise 26½ pounds of water from 32 deg. F. up to 212. That means 191 British thermal units per hour. So that if you, on an average, require 10,000 British units, the total, including an average of sixteen persons in the car, would be 10,000, plus 3056, giving us the total of 13,056 British thermal units.—From paper read at the Montreal Convention, 1895.

POWER CONSUMPTION IN ELECTRIC RAILROADING *

BY S. T. DODD

The power necessary for propelling a car or train is equal to the product of the quantities: the Speed, which is a quantity, definite, measurable and easily recognized, and the Force, the effort exerted by the motive mechanism, or its equivalent, the train resistance. The latter being more obscure and less easily measured deserves a careful study.

In analyzing the train resistance four principal divisions must be noted:

(1) Grade Resistance or the effort necessary to lift a train up a certain slope. In electric railroad work this becomes a more important factor than in steam railroad work, on account of the steeper grades we encounter.

(2) Curve Resistance, or the effort necessary to propel the cars around curves upon the track. This enters in as such a small factor that I shall only note it here for the purpose of completeness and shall not refer to it again.

(3) Acceleration Resistance, or the effort necessary to carry a car of a given weight to a certain velocity in a certain time. On account of the character of the traffic in electric railroad work this becomes a more important factor than it is in steam railroad work.

(4) Frictional Resistance, or the effort necessary to propel a train at a constant velocity over a level track. This division being the most obscure shall receive our attention first.

FRICTIONAL RESISTANCE

The nature of the resistance encountered by moving trains has been discussed by steam railroad engineers for many years. I might stop here to note an advantage which we have in electric railroad work over steam railroad engineers in the measurement of this quantity. In steam railroad work, readings from a dynamometer interposed between the engine and train only give the resistance of the train itself, leaving out of account the resistances experienced by the engine, which, in many cases, amount to a very considerable proportion of the whole. While the reading of steam engine indicators is a sufficiently laborious and delicate operation on stationary engines, it is much more so when the position of the observer is on the outside of a locomotive running at twenty-five to sixty miles an hour, and even with this indicator reading, unless the efficiency of the engine is very accurately known, as it seldom is, we are unable to separate the quantity, train resistance, from the internal losses in the engine. On the other hand, the determination of this quantity in electric railway work is a very simple matter.

Fig. 1 represents the curves of torque and speed of a street

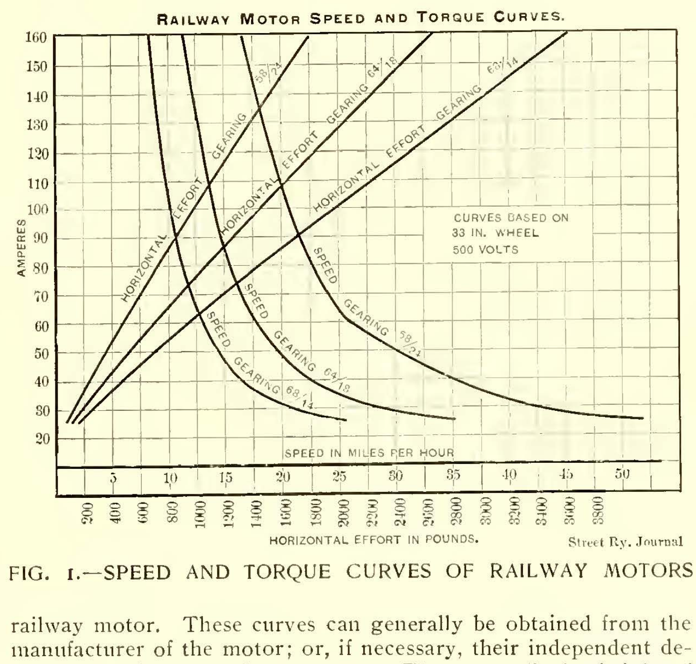


FIG. 1.—SPEED AND TORQUE CURVES OF RAILWAY MOTORS

railway motor. These curves can generally be obtained from the manufacturer of the motor; or, if necessary, their independent determination is a very simple matter. The perpendicular height of any point on either curve represents the current flowing into the motor, while the horizontal distance from the left-hand side of the sheet shows upon one curve the speed in miles per hour at a fixed voltage, and upon the other curve the horizontal effort in pounds which the motor will exert at the tread of the driving

* Paper read before the Civil Engineers' Club, Cleveland.

wheels when it is taking this amount of current. In order to determine the effort exerted by a car equipment, it is only necessary to place an ammeter in circuit with the motors, and the reading of this, by comparison with the curves of the particular motor, gives us immediately the horizontal effort exerted by the motor at that instant and, approximately, the speed. For example, suppose the motor in question is geared with twenty-four teeth in the pinion and fifty-eight teeth in the axle gear, the two curves marked "gearing 58 x 24" in Fig. 1, show that when 30 amps. are flowing into the motor it will exert a horizontal force at the rim of 33-in. driving wheel of 120 lbs., and the car will be moving at forty-two miles per hour with 500 volts at the motor terminals. If the ammeter reading is 125 amps. the same curves show that the effort exerted is 1320 lbs. and the speed is 17.5 miles per hour. I say "approximately the speed," because the speed is dependent upon and almost proportional to the voltage at the motor terminals, and as this fluctuates in electric railway work anywhere from 10 to 20 per cent, the speed cannot be determined without a simultaneous determination of the voltage. The torque exerted by the motors, however, is independent of the voltage; a certain current flowing through the coils of the motor will develop a definite pull at the armature shaft. I am aware that this statement contradicts a popular impression that a series-wound motor will take more current to drive a car at a low voltage than at a high, but it can be shown that the statement is absolutely true, and that the popular impression is the result of mistaken, or rather, misinterpreted, observations.

To return, however, to the question with which we started—how many pounds of pull does it take to move a train of a certain weight at a certain velocity? The formulæ which steam railroad engineers have developed have been, in some cases, based on hundreds of experiments; but, on account of the widely differing nature of track and train construction, the formulæ differ widely from each other, both in their form and in their final results, and without intending to criticize the older branch of railroad engineering, I wish to collect here some of the best known of these formulæ and compare them with readings which we have obtained in electric railroad work:

(1) One of the oldest formulæ with which I am familiar was proposed by D. K. Clark, and is of the form $(8+\frac{V^2}{178})\ W$, V being the speed of train in miles per hour and W the weight of train in tons of 2000 lbs. I have changed the formula from the form usually given, viz., in tons of 2240 lbs., for the sake of comparison with others.

(2) Another formula proposed by Prof. Rankine is of the form

$$\{ 5.35 + .268\ (V\text{-}10)\ \}\ (T + 2\ E),$$

T being the weight of the train behind the engine and E the weight of the engine and tender. You will note that Prof. Rankine's formula is a straight line, the resistance being proportional to the velocity above ten miles per hour, and a constant quantity below that. He also recognizes the importance of the head resistance, the "pace-making" effort of the engine.

(3) A formula proposed by W. H. Searles based on his experiments, and of which Mr. Wellington says it has a "wonderful range of application to all speeds, condition and classes of trains," is of the form

$$4.82\ W + .00535\ V^2\ W + .0004783\ V^2\ E^2$$

(4) The most complete and accurate set of experiments with which I am familiar were made by A. M. Wellington.

The method used by Mr. Wellington, the gravity method, is free from the disadvantages I have quoted, and is as nearly theoretically perfect as we can expect in work of this nature. The method is based on the well-known principle that a body moving down a frictionless inclined plane will have acquired the same velocity at any point of the incline as if it had fallen freely through a perpendicular distance equal to the amount of its descent.

Given a train moving at the top of a grade with a measured velocity, if steam is shut off and train allowed to slide down the grade with gravity as its only accelerating force, and if measurements of the velocity are made at various points on the grade, the difference between these velocities and the theoretical velocity due to the difference of levels will give us a measure of the retarding forces experienced by the train. Mr. Wellington goes further, perhaps, than any one else has done. He divides the frictional resistance experienced by a moving train into

(*a*) Rolling Friction, or the friction of the journals and that between wheel and rail—a quantity independent of the speed.

(*b*) Head Resistance, or the atmospheric resistance experienced by the first car of the train.

(*c*) Side Resistance, or the resistance offered by the atmosphere to the several cars of the train.

(*d*) Oscillating Resistance, or increased journal and rolling friction, depending on the speed.

No. of Cars.	Speed of Train.	Weight in Tons	Res. Per Ton.	Clark.	Rankine.	Searles.	Wellington.	
1	25 9	20	23.5	11.7	18.	14.8	17.7	23.2
1	28.	21	22.	12.4	20 3	16.8	19.5	23.6
1	32.	20	25.	13.8	22 5	19.8	25.	24.4
1	34.	21	25.7	14.4	23 5	22.6	26 8	24.8
1	36.	21	28.3	15.2	24.7	24.8	29.6	25.2
1	43.	20	27.	18.3	28.4	32 4	42.	26.6
1	45.5	20	27.7	19.6	29.6	35.4	46.	27.
1	47.	20	28.	20.3	30.5	37.8	49.	27.4
1	47 5	20	27.3	20.6	30.75	38.5	50.	27.5
1	49.5	20	25.	21.7	35.9	41.4	54.	27.9
2	27.	35	17.7	12.1	15.5	12.7	14.7	18.7
2	39.	35	20.3	16 5	20.5	21.5	25.5	21.1
2	40.	35	25.	17.	21.	22.	27.6	21.3
2	40.25	35	20.25	17.1	21.2	22.3	27.8	21.3
2	42.25	35	24.3	18.	22.3	24.1	30.7	21.5
3	25.	50	16.	11.5	13.1	10.5	11.7	16.4
3	34.5	50	20.	14.6	16.7	15 7	18.8	18.3
3	37.6	50	18.5	15.9	17 9	17.7	21.5	18.9
6	31 8	95	18 3	13.7	11.2	12.25	14.	15.7

FIG. 2.—TRAIN RESISTANCE. COMPARISON OF OBSERVATION AND FORMULÆ

The formula he develops takes account of all these and is of the form $4\ W + .28\ V^2 + .03\ V^2\ C + .005\ V^2\ W$, C in this formula representing the number of cars in the train.

For sake of comparison I have collected in the table, Fig. 2, the results of about twenty observations which I consider the most trustworthy I have been able to get. These observations have all been made on interurban cars running on T rails over a level track at a uniform speed.

In this table the first column gives the number of cars composing the train, the second the speed in miles per hour, the third the total weight of the train, and the fourth the traction coefficient or horizontal effort per ton of train, as calculated from the current consumption. The succeeding columns give the results of the formulæ which I have already quoted applied to these particular cases.

It will be noticed that the formula of Mr. Clark is too low in every case to correspond to these observations. The common fault of the other three formulæ is that the velocity plays too important a part in them. At speeds in the neighborhood of fifty miles per hour their results are too high, and at twenty-five miles per hour they are too low. This is particularly the case with the formula of Mr. Searles and Mr. Wellington where the velocity enters as the square.

I do not propose to base a formula on the results of about twenty experiments, but as I have said, these observations are the most trustworthy that I have been able to collect and it may be of interest to try and find a formula which shall combine their results more nearly than those that have been already proposed. By plotting these results I have decided on the following formula as expressing as nearly as possible the results of these observations:

For a single motor car weighing E tons, pulling trailers weighing T tons, the resistance due to the motor car is $(18 + .2V)\ E$ and that due to the trailers is $(7 + .2V)\ T$. The results of this formula have been worked out in the last column, and by comparing with the observations in Column 4 they will be seen to give a very fair agreement.

In conclusion to this part of the subject, I would say that as far as my own observations go, for ordinary interurban cars running on straight and level T rails, with roadbed of modern construction, the formula $(18 + .2V)\ E + (7 + .2V)\ T$ expresses very fairly the train resistance between twenty-five and fifty miles per hour, and while I do not mean to say these experiments are exhaustive, I hope this statement may be of assistance to other observers in collecting and stating the results of their observations.

ACCELERATION

The next question which demands our attention is the power expended in acceleration. How many pounds of pull does it take to give a certain weight a certain velocity in a fixed time? What accelerations are usually attained in practice? and what are the attainable and limiting rates of acceleration?

The answer to the first of these questions is mathematical rather than experimental. If a force P acts upon a weight W to produce acceleration, leaving out of account for the present the force necessary to overcome friction, the acceleration, F, will be equal to $32.2 \times \frac{P}{W}$. Forces and weights being expressed in pounds and acceleration in feet per second, it will be more convenient in what follows to express acceleration in terms of the gain in one second of velocity measured in miles per hour, which we will write F_m.

Then $F = F_m \frac{5280}{3600}$

Transforming the equation above we get $P = \frac{F W}{32.2}$

Substituting for F, $P = F_m W \frac{5280}{3600 \times 32.2}$ or $P = F_m \times \frac{W}{21.9}$ and if $W = 2000$ lbs., we get the force per ton equal to the acceleration multiplied by 91.5 lbs. or lbs. per ton $= F_m$ 91.3.

The curves in Fig. 3 show the accelerations which are obtained in actual practice. Curve No. 1 shows a start of an eleven-car train on the Chicago, Burlington & Quincy Railroad, copied from data given by Wm. Forsyth in an article, "Tests of Locomotives in Express Service," published in the "National Car and Locomotive Builder," April, 1893.

Curve No. 2 shows the start of a Manhattan Elevated train,

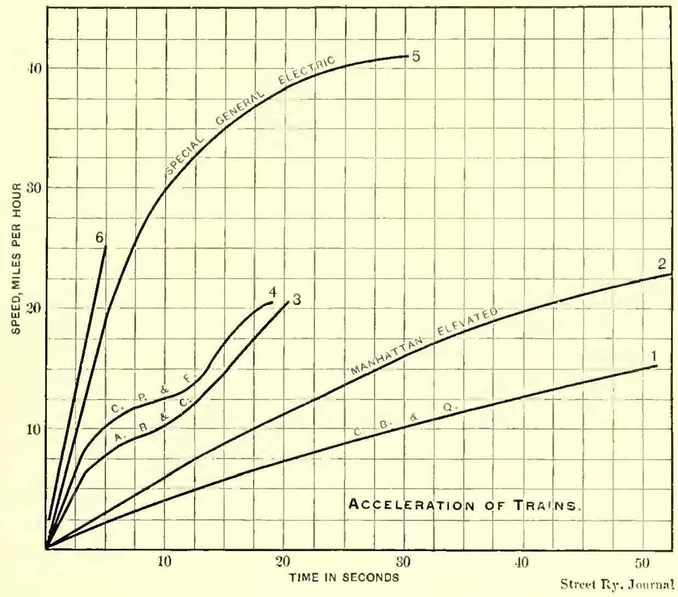


FIG. 3.—ACCELERATION OF TRAINS

taken from an article by Geo. L. Fowler, in the "Railroad Gazette," March, 1897. Curve No. 3 shows the start of an Akron, Bedford & Cleveland electric car. Curve No. 4 is a corresponding observation made on the Cleveland, Painesville & Eastern electric road. Curve No. 5 is taken from an article by W. B. Potter, Engineer of the Railway Department of the General Electric Company, and shows the starting curve of a car equipped by that company with a view to experimenting upon very high accelerations.

The table, Fig. 4, shows the number of pounds per ton used for acceleration in the various starts shown in these curves, calculated from the acceleration by the formula derived above.

The limit of possible acceleration in railroad work is naturally fixed by the slipping of the driving wheels. It can be shown that the start represented in Curve No. 5 is very near to this limit. It is generally acknowledged that the adhesion of wheels to rails, under good conditions, is one-fourth of the weight upon them, and under ordinary conditions, one-fifth. If we assume, however, one-fourth, and assume, moreover, that the whole weight of the car rests upon the driving wheels, it will be seen that the limiting accelerating force is about 500 lbs. per ton, and allowing 30 lbs. per ton for frictional resistance, we have about 470 lbs. as the limiting acceleration. Curve No. 6 shows this limit. That such starts as

ROADS.	A	G	H.E. Per Ton.
C., B. & Q., steam	1	------	365
Manhattan Elevated, steam	2	------	55
A. B. & C., electric	3	------	183
C. P. & E., electric	4	------	238
Special G. E	5	------	348
Limit	--	------	470
Woodland Avenue	--	9 per cent.	180
Seneca Street	--	11 per cent.	220
North Hill	--	13½ per cent.	270

FIG. 4.—HORIZONTAL EFFORT FOR VARIOUS ACCELERATIONS AND GRADES

this are not uncomfortable, if made smoothly, is testified to by the fact that we experience negative accelerations of comparable amounts upon our interurban cars without feeling any discomfort. I have myself noted a stop from twenty-five miles an hour within 90 ft., and from forty-one miles per hour I have seen a stop made in eight seconds. As these represent a negative acceleration of 475 lbs. per ton it is evident that the rails were in pretty good condition, and that we had an adhesion of about one-fourth. I might note that both these were emergency stops and a little more sudden than ordinary, but I am told by motormen upon our suburban roads that, with brakes in good condition, they can always make a stop from fifty miles an hour in five poles, or 450 ft., which represents a negative acceleration of 365 lbs. per ton. From these facts I think we can conclude that the limit of possible acceleration is only fixed by the adhesion of the wheels to the rail, or by the willingness of railway managers to expend extra power for the sake of increased schedule speeds.

GRADE RESISTANCE

It is often stated as an advantage of electrical traction that an electric car is able to mount steeper grades than a steam driven train. This statement, while true, is often misstated, or rather misunderstood by those who make it. The advantage does not lie, as many seem to think, in the electric current *per se*, and when steam railroad managers think it advisable to equip an 800-ton train with 8000 h.p. in motive power, the difference will not be as apparent as it is to-day. The force necessary to lift a train up a grade is the same fraction of the weight of the train that the rise of the grade is of horizontal length. As an example of some of the grades we meet in practice, we may note that the Cleveland City Railway is operating on Woodward Avenue, a grade of 9 per cent and pulling trailers on that. The Cleveland Electric Railway is operating on Seneca Street Hill a grade of about 11 per cent; the Akron, Bedford & Cleveland Railway is operating on North Hill, Akron, a grade of 15.5 per cent. To compare these resistances with those ordinarily experienced in acceleration, the latter part of the table, Fig. 4, shows the number of pounds traction per ton of train necessary to mount such grades. An inspection of the table shows that the tractive effort necessary on ordinary grades is comparable with that necessary for such acceleration as we ordinarily meet in electric railroad practice.

POWER CONSUMPTION

Let us apply the data of the foregoing discussion to some problems in order to determine the power expended in particular cases. Let us take as a first illustration an ordinary city car. These cars, together with the equipments, will weigh about twelve tons. As may be noted any night after 12 o'clock going out of either Prospect Street or Detroit Street, the maximum speed which such equipments will attain on a level after the period of acceleration is past, is about twenty miles per hour. Applying our formula for train resistance $18 + .2V$, the frictional resistance of such a car at this speed is about twenty-two lbs. per ton, giving us a horizontal effect of 264 lbs. necessary to propel a twelve-ton car; 264 lbs. at twenty miles per hour is equal to fourteen h.p.. Assuming that the efficiency of such motors as are ordinarily used at this speed is about 75 per cent, this gives an input at the trolley of 18.8 h.p. or 14 k.w., which, at 500 volts is equivalent to 28 amps. This represents approximately the amount of current necessary to propel such a car.

As a second illustration, let us take as an example an ordinary double truck interurban car. The weight of the car body and truck empty is about fifteen tons. The motors ordinarily used for such equipment weigh about 3000 lbs. We can estimate the total weight, including two motor equipment and a few passengers, at about twenty tons. You may note that these cars run upon a level at a speed of about twenty-eight miles per hour. Applying our formula we get 23.4 lbs. per ton, or a total of 472 lbs. horizontal effort necessary for propulsion. At twenty-eight miles an hour this is equivalent to 35 h.p. Figuring the efficiency of these larger size motors at 82 per cent, this gives us 43 h.p., or 32 k.w. input, which, at 500 volts, gives 64 amps., or 32 amps. per motor, as the ordinary running current.

Another interesting question is—What should the starting current amount to in cars of this weight? If we take the curves of acceleration which are plotted upon the sheet for the A. B. & C. car, you will see that at the maximum as the acceleration begins to fall off, which corresponds to the point where the controller is entirely cut out, we have an acceleration amounting to 1.25 miles per hour per second. This is equivalent to 114.5 lbs. per ton, or for a 20-ton car about 2300 lbs. horizontal effort necessary at this point. As the speed attained with this pull is approximately 18 miles per hour, then the motors are delivering about 110 h.p.; figuring the efficiency of the motors at 80 per cent, we get a total input of 138 h.p. or 103 k.w., which, at 500 volts, represents 206 amps. as the starting current.

Let us consider as a final example the cars of our latest interurban road, the Lorain & Cleveland Railroad. No tests have as yet been published on this, but we are promised by the engineers a complete set of tests as soon as the road is in running shape. and when such tests are published we will have some basis for judging the reliability of these figures. Such cars will weigh, empty, about fifteen tons of 30,000 lbs. They are equipped with four motors, and while I am not acquainted with the data of these motors, they must weigh in the neighborhood of 3000 lbs each. We can safely estimate the weight of car and equipment at twenty-two tons. You will note in riding on the cars that a speed of thirty-five to forty-five miles an hour is common, and that after you have gone a mile or so from a stop you attain a speed of fifty miles per hour. What current do the motors take to propel the car at this speed?

The train resistance on a level is $(18 + .2V)$, since in the present case W is twenty-two tons and V is fifty miles, we have 616 lbs. effort necessary for propulsion. Six hundred and sixteen pounds at fifty miles per hour is 82 h.p., which represents the output of the motors at full speed. For motors of this size we may estimate the efficiency at about 82 per cent. This means 100 input to the motors. As for voltage, a visit to the power house will show that they carry a pretty high voltage (about 600) and heavy feeders, so we can estimate they get 550 volts at the motor terminals; 100 h.p at 550 volts is 135 amps. My estimate, based on the data I have given you, is that it takes about 135 amps. to propel these cars after they have attained full speed.

Another interesting question is, How much current does it take to start these cars? If we are allowed to make some assumption we can estimate somewhere near. These cars seem to me to accelerate at the start a little slower than our ordinary suburban cars. Let us suppose they start with an acceleration of 150 lbs. per ton. One hundred and fifty pounds per ton is a total effort of 3300 lbs. To this must be added about 23 lbs. per ton for frictional resistance, making a total of 3800 lbs.

How much current flowing through these motors will produce a horizontal effort of 950 lbs. per motor? To determine that, it will be necessary to know the speed of which the motors are capable at some definite voltage at this torque. We may note from the car windows that a speed of 35 or 40 miles is very soon attained, but it is not until after we have traveled a mile or so that we reach a speed of 50 miles per hour. We will not be far from correct if we figure that the car maintains an acceleration of 150 lbs. per ton up to about 25 miles per hour, and then as the controller is entirely cut out the motors continue to speed up and current falls off together with the acceleration. An effort of 3800 lbs. at 25 miles per hour is about 254 h.p. Assuming again the efficiency of the motors at 80 per cent we get an input of 317 h.p. or 236 k.w. At 550 volts this indicates a current of 430 amps. as the probable current during the period of acceleration.

It often seems that the equipment of a single car with one or two hundred h.p. in motive power is an unnecessary waste of power, but when we come to consider the weight of car and loads we are operating—the rapidity with which we are compelled to accelerate these weights on account of our frequent stops and the grades which our ordinary highways compel us to climb, we see that ordinary mechanical principles justify the demands of practice for heavy equipments.

SCIENCE: ENGINEERING: INVENTION.

Recent Westinghouse Electric Railway Apparatus

The remarkable extension and development of the electric railway industry which followed the installation of the first commercial electric road in Richmond, Va., in 1888, and which was to a large extent suspended in 1893 and for a few years thereafter, owing to the industrial depression which prevailed throughout the country, has for some time past shown unmistakable signs of revival, new companies having been organized and old ones having extended their lines. The particularly noticeable feature of the more recent progress is the increasing tendency to apply electricity to the operation of longer roads and heavier cars or trains. The natural result of this extension of the electric railway field has been a demand for motors of greater capacity, for larger generating units and for machines especially suitable for rendering the distribution of power on roads of considerable length commercially successful.

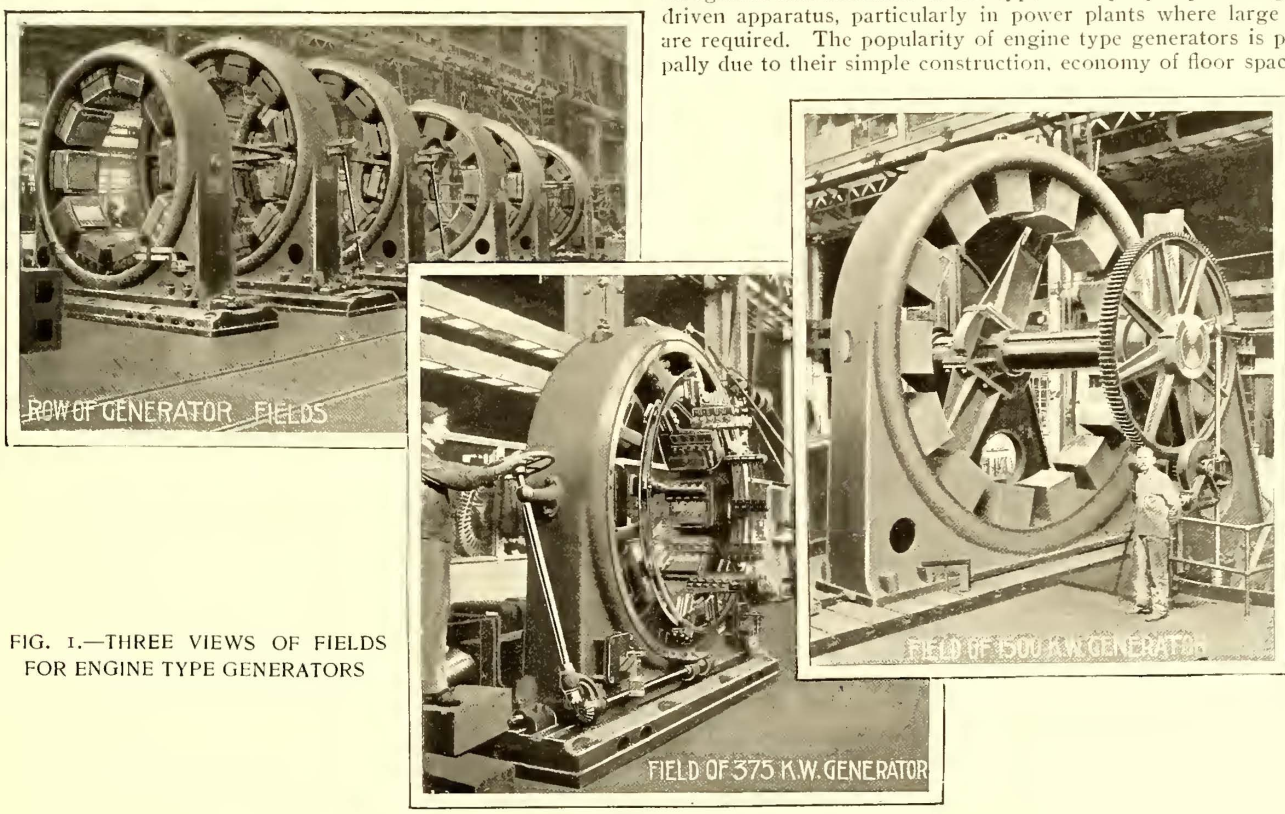


FIG. 1.—THREE VIEWS OF FIELDS FOR ENGINE TYPE GENERATORS

The Westinghouse Electric & Manufacturing Company attained a high position in the manufacture of electric railway apparatus by the introduction of the Westinghouse No. 3 motor in 1891, and has steadily improved the design and construction of its motors, generators and other railway apparatus to an extent that by efficiency of operation and magnitude of achievement justifies the present contribution to railway history.

Twenty thousand motors, aggregating 650,000 h.p., is the Westinghouse record in one branch of the railway field alone. It is the purpose of this article to illustrate and describe some of the latest achievements in electric railway apparatus, as exemplified in the latest Westinghouse generators, boosters, rotary transformers, A.C.-D.C. generators and switchboards. This machinery represents the latest advance in design, construction and performance of electrical apparatus, and it is difficult for one to realize how such progress could be made in a single decade.

DIRECT CURRENT RAILWAY GENERATORS

The standard Westinghouse belt-driven generators are too well known to require any extended description here. They represent the results of the careful study and wide experience during the years since the first Westinghouse four-pole railway generators were placed upon the market. As compared with the former Westinghouse standard line of belt-driven generators the present machines are considerably improved in general proportions, the height being somewhat increased and the length of shaft between bearings decreased. Improved ventilation is thus secured and the temperature of all parts reduced. These generators deliver their rated output continuously for twenty-four hours with but a very moderate rise of temperature and without sparking. They are compound wound and the potential at the terminals increases about ten per cent from no load to full load, the speed being kept constant. The present standard sizes are 100, 150, 200, 250 and 500 k.w. Fig. 9 shows an illustration of a 500-k.w. machine of this type.

Although the practice of mounting the armature directly upon the shaft and thus to a large extent combining the engine and generators in one compact machine originated at a comparatively recent date, the advantages of this method have become so well recognized that machines of this type are rapidly superseding belt-driven apparatus, particularly in power plants where large units are required. The popularity of engine type generators is principally due to their simple construction, economy of floor space, increased efficiency and decreased operating expenses. The machines of this type, manufactured by the Westinghouse Company, combine all the advantages of their standard belt-driven type with those enumerated above. A brief illustrated description of the construction of some modern engine type generators follows, together with data regarding the performance of same.

The general design is similar to that of the Westinghouse standard multipolar belted machines, in that it consists of a circular yoke carrying inwardly projecting pole pieces of laminated soft steel. The field castings are divided vertically and set upon ways on an independent bed plate. This vertical division of the field affords excellent facilities for immediate inspection or removal of armature or field coils without the necessity of removing the outboard bearing or dismantling the engine. The opening of the fields in this way is a great convenience where head room is limited or devices for handling heavy castings are not available. Three views of large engine type fields in different stages of construction are given in Fig. 1. The shunt and series coils are separately wound and insulated, the series coils being composed of forged copper conductors of rectangular section. A shunt and a series coil for a 500-k.w. machine are shown in Fig. 2. The armature core consists of punched discs of carefully annealed steel, held together by cast steel end plates (see Fig. 3). This core is built upon an iron spider, which also carries the commutator. The spider is pressed and keyed directly upon the engine shaft. Ventilating spaces through the spider and armature core are so arranged as to allow a constant circulation of air through the commutator and windings when the machine is running. The winding is made from bars of drawn copper shaped on cast iron formers. After being thus shaped the bars are thoroughly insulated with mica and prepared fullerboard and baked to remove all moisture. The coils are held in the slots by means of retaining wedges of hard fibre driven into notches near the top of the slots longitudinally with the armature. A 200-k.w. armature is shown in Fig. 4 and one for an 800-k.w. machine in Fig. 5. The com-

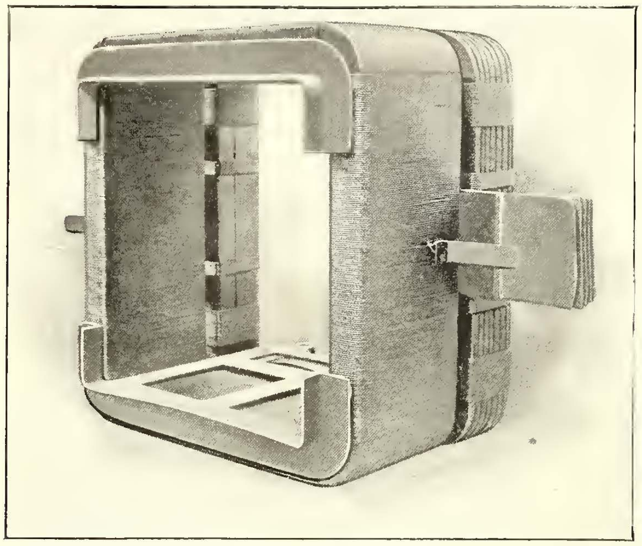


FIG. 2.—SHUNT AND SERIES FIELD COILS FOR 500 K.W. GENERATOR

mutator is composed of hard rolled copper segments insulated from each other by prepared mica of such corresponding hardness that an extremely even wearing surface is presented to the brushes.

The brush holder mechanism is carried by brackets projecting from a ring concentric with, and supported by, the field. A hand

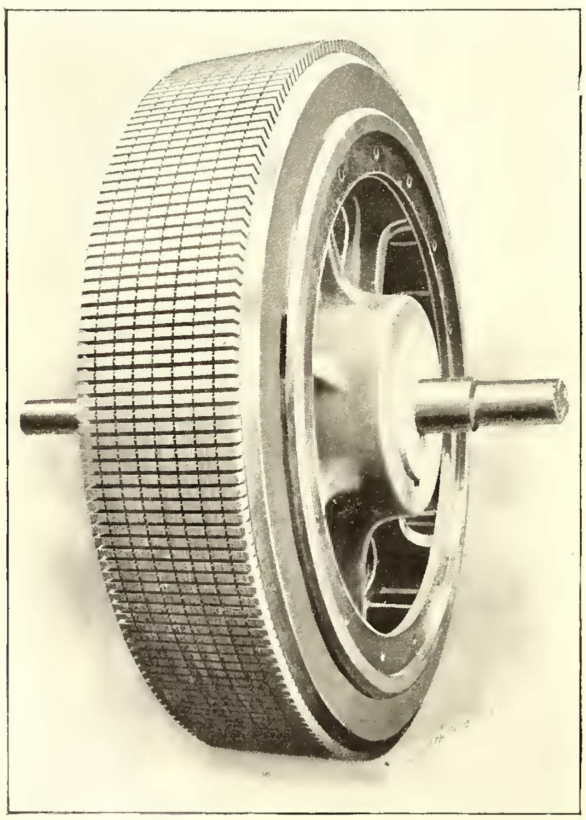


FIG. 3.—ARMATURE FOR 1500 K.W. ENGINE TYPE GENERATOR

wheel worm engaging with the gear on the rim of this ring accomplishes adjustment of all the brushes simultaneously. It will be noted that the brackets carrying the brush holder rods lie close to the field and do not project over the commutator. The commutator and brushes are therefore clear of obstructions and may easily be inspected at any point. Carbon brushes are used in connection with all of these machines. The standard sizes of machines of this type at present manufactured by the Westinghouse Company are 250, 400, 500, 800, 1200 and 1500 k.w. In speed they range from 75 to 100 r.p.m., depending upon the size.

The view in Fig. 6 shows two of four 1500-k.w. Westinghouse direct current machines, as installed in the Thirteenth and Mount Vernon Streets power station of the Union Traction Company, Philadelphia. This station was destroyed by fire in March, 1897, and these machines have been built and installed since that time. They each have fourteen poles and are direct connected to Wetherill cross compound engines operating at 80 r.p.m. At full load each generator carries 2730 amps. at 550 volts, but they are capable of carrying 4000 amps. for one hour. They are com-

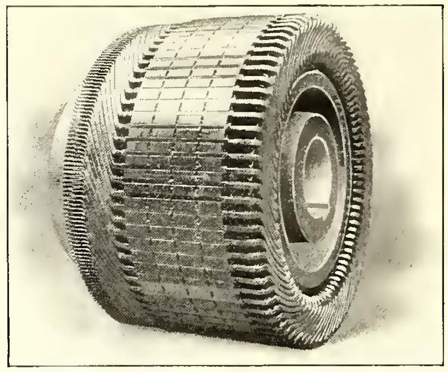


FIG. 4.—ARMATURE FOR 200 K.W. ENGINE TYPE GENERATOR

pounded so that when the shunt field is adjusted for 500 volts at no load the series winding will cause the potential to rise by regular increments, approximately proportional to the increase of current, to 550 volts at full load. The approximate weight of each machine is 100 tons and the height above bed plate 17 ft. 5¾ ins. Another Westinghouse 1500 k.w. machine has been installed in the Thirty-third and Market Street power house of the Union Traction Company, and a second one of the same size is now being constructed. In addition to these six 1500 k.w. machines the Union Traction Company also has in operation three 500-h.p. Westinghouse four-pole Kodak and five 750-h.p. Westinghouse engine type generators distributed among their several power houses.

Fig. 7 shows one of four 800 k.w., 650-volt Westinghouse engine type generators installed in the power house of the South side Elevated Railroad, Chicago. They each have ten poles and

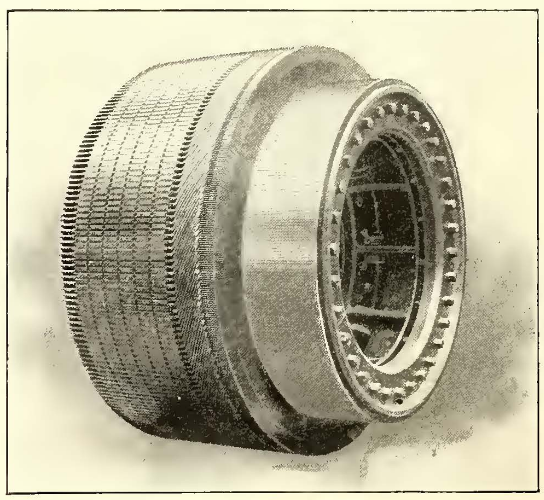


FIG. 5.—ARMATURE FOR 800 K.W. ENGINE TYPE GENERATOR

are direct connected to Allis cross-compound condensing Corliss engines running at 80 r.p.m. The performance of these machines is shown by the curves in Fig. 8. The field winding is so designed that the voltage will rise from 600 volts at no load to 650 at full load, as shown by the regulation curve. It will be noted that from a load of 800 amps. to full load, which is 1230 amps., the efficiency is over 94½ per cent, while even at quarter load it is over 90 per cent. These machines are capable of generating continuously 1230 amps. at 650 volts, and will operate for three hours at 50 per cent over load with a rise of temperature not exceeding 30 deg. C. above the temperature of the surrounding air.

The term "Kodak" as first applied to generators referred to the compact outfit obtained by mounting a Westinghouse generator and a Westinghouse engine upon the same bed plate, but with separate shafts connected together by means of a flexible coupling. There have been a large number of these outfits installed for various purposes. Views of a 575-volt, 225 k.w. Kodak generator and its armature are shown in Fig. 9. This machine is to be connected to a Westinghouse compound condensing steam engine making 250 r.p.m. The flange which forms part of the flexible coupling is clearly shown on the end of the armature shaft.

BOOSTERS

As long as electric roads were of moderate length, such as most of the early street car lines, the question of power transmission required no special attention, as the cost of feeders, even if they were liberally applied, did not amount to very much in comparison with the other investments. Since, however, the electric motor has invaded the field of comparatively long distance roads, the conditions for power transmission have become much more severe, and the ordinary railway system with overhead lines and ground return is inapplicable in many cases on account of the large cost of copper.

The booster system provides one method of meeting the difficulty. The object in using the booster dynamo is to maintain the voltage on the extreme ends of the line within practicable limits at all loads. If only one feeder were to be supplied the proper regulation could be accomplished by using an over-compounded generator. Most stations, however, are operating a number of feeders which have to be regulated independently of each other. This can be done by either putting a properly compounded generator in each feeder, or by the booster system. The booster is a series generator located in the power house and connected in series with a long-distance feeder. The current flowing through the armature excites the field with the effect that the e.m.f. generated in such a machine is almost proportional to the current passing through it, and, as the drop of potential in the feeder is also proportioned to the current passing through it, the duty performed by the booster is simply to add as much to the station e.m.f. as is lost in the feeder. Thus, although the total voltage at the power house may be considerably increased, the voltage delivered to the trolley line does not rise above that of the generator. There are of course various ways of driving a booster generator, but the method usually employed by the Westinghouse company is to drive it by means of a motor which receives its power from the main bus bars of the station. The Detroit, Ypsilanti & Ann Arbor Railway Company, of Detroit, Mich., is now installing a line that affords an excellent illustration of the operation of the booster system. The total length of the line is thirty-two and one-half miles, and there are two power stations, one at Dearborn and the other at Ypsilanti, the distance between them being nineteen miles. The distance from Ann Arbor to Ypsilanti is about nine miles. Four 225-k.w. Westinghouse Kodak generators, two at each station, will supply the power, and there will

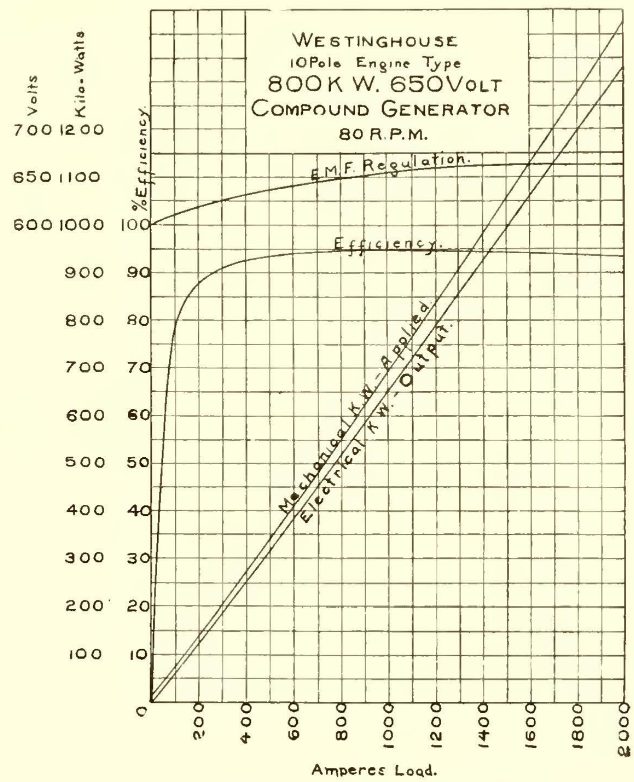


FIG. 8.—CURVES OF 800 K.W. GENERATOR

be two Westinghouse boosters at the Ypsilanti station and one at the Dearborn station. These will be connected in series with the feeders running from the Ypsilanti station toward Ann Arbor and from each station toward the middle of the section between the two stations. Each booster feeder will be about seven and one-half miles long. These boosters will be driven by a motor, the armature of which will be mounted upon the same shaft as the booster armature. Fig. 9 shows one of these booster armatures completely wound. The one on the left is booster armature wound for 300 volts. The common bed plate

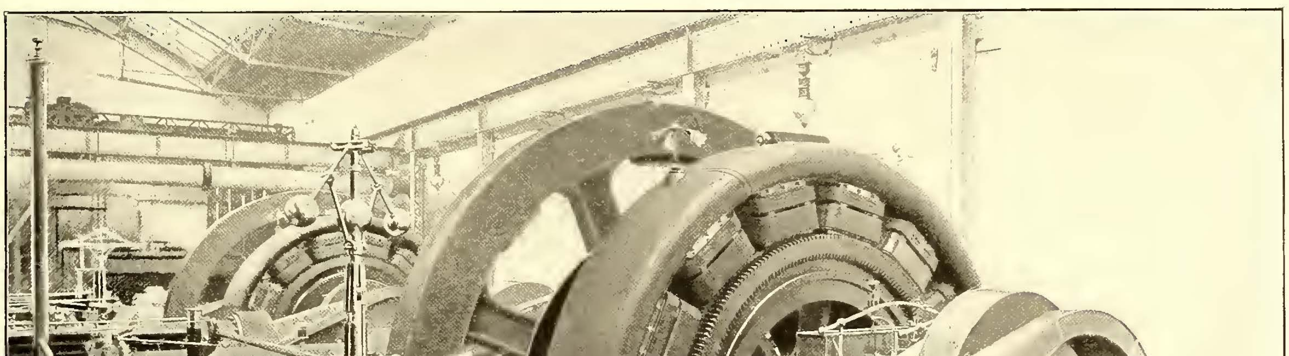


FIG. 6.—TWO OF THE FOUR 1500 K.W. GENERATORS IN POWER STATION OF UNION TRACTION COMPANY, PHILADELPHIA

supports the two fields which are divided vertically, as shown in the view of one of the completed units in Fig. 9. These machines operate at 625 r.p.m., and the booster end of the machine has a capacity of 275 or 450 amps. at 300 volts, the field coils being connected in series for 275 and the two halves in multiple for 450

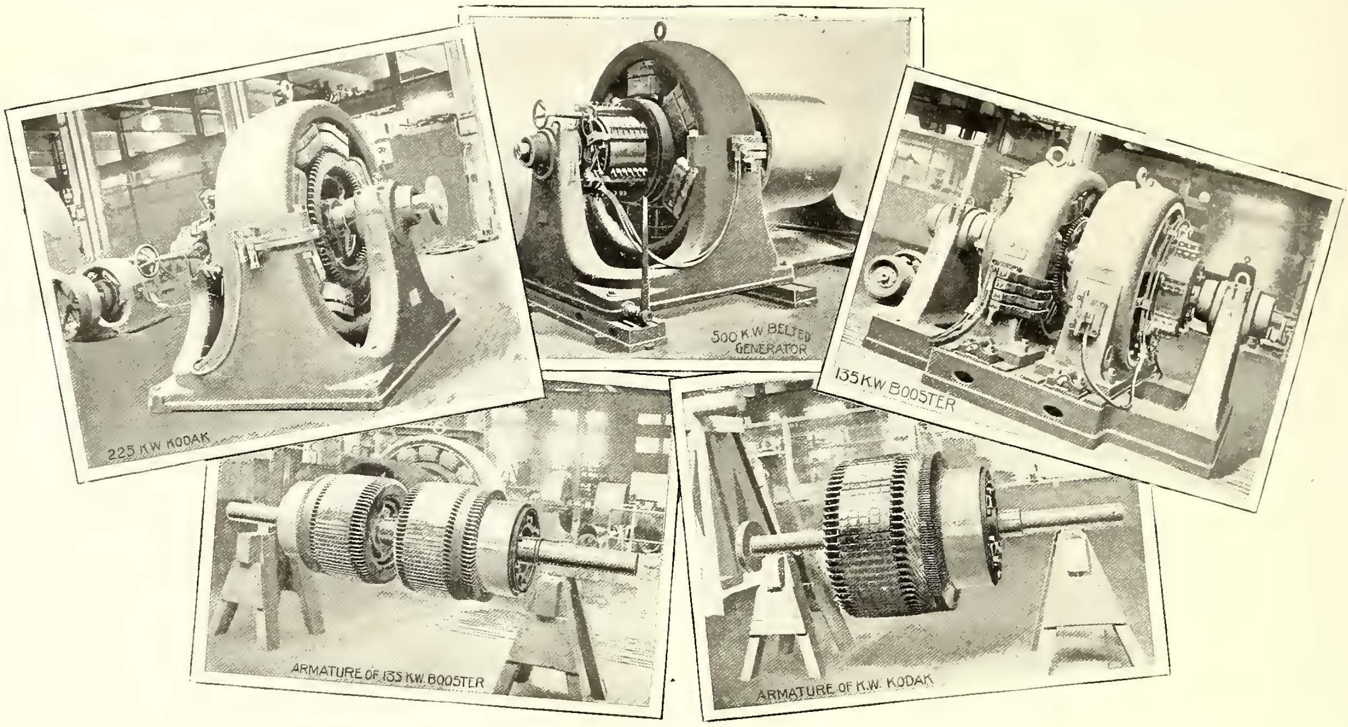


FIG. 9.—GROUP OF DIRECT CURRENT RAILWAY GENERATORS

amps. The field connections are so arranged that the change from series to multiple can be easily and quickly made.

ALTERNATING AND DIRECT CURRENT GENERATORS

Another method of rendering the operation of a long-distance road commercially practicable is by employing at the power stations a type of generator that will supply both alternating and direct currents. The Westinghouse company has been manufacturing machines of this type for several years. The chief advantages to be derived from their use in railway work is in cases where the power plant is located near the road. In such cases current is supplied from the "direct current end" of the machine direct to the local feeders, and alternating current from the opposite end is passed through suitable step-up transformers and transmitted at high potential to sub-stations, where it is passed

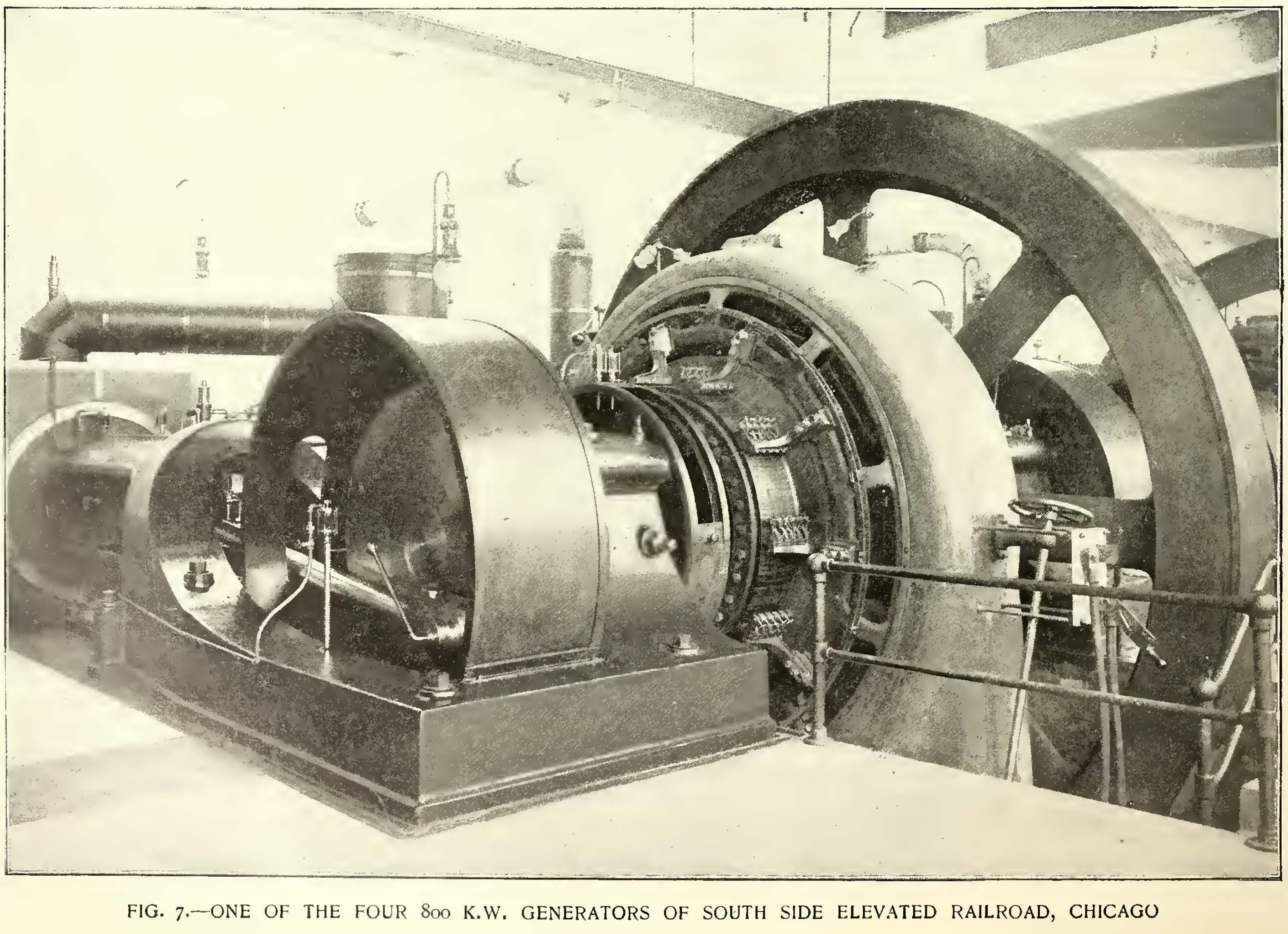


FIG. 7.—ONE OF THE FOUR 800 K.W. GENERATORS OF SOUTH SIDE ELEVATED RAILROAD, CHICAGO

through step-down transformers and supplied to rotary transformers, which commutate the current and supply it to the local direct current feeders, thus securing the advantages of transmission at high potential. In general design and construction these machines resemble the Westinghouse multipolar generators. The armature is wound and connected to the commutator in precisely the same manner as in the case of an ordinary direct current generator, but in addition to the commutator the armature is provided with collector rings which supply the alternating current exactly as in the case of an alternating current generator, the armature winding being tapped at points which give the proper phase relation, by wires which lead through the hollow shaft to the collector rings. The fields may be excited from a separate direct current generator, or as is usually the case, they may be self-excited with current from the commutator of the machine. These machines are provided with both shunt and series field winding, and, if they are self-exciting, the shunt winding is always connected across the direct current brushes. When the machine is operated to produce direct current the main current passes through the series winding, thus increasing the potential as the load increases, just as in the case of a compound wound direct current railway generator. The commutator and collector rings may be placed upon the same or opposite ends of the shaft. The mean alternating current potential is about 71 per cent of the direct current voltage for two-phase machines and about 61 per cent for three-phase machines. The entire output may be utilized for direct current work or for alternating current, or it may be divided up between the two classes of work in such proportions as may be desired.

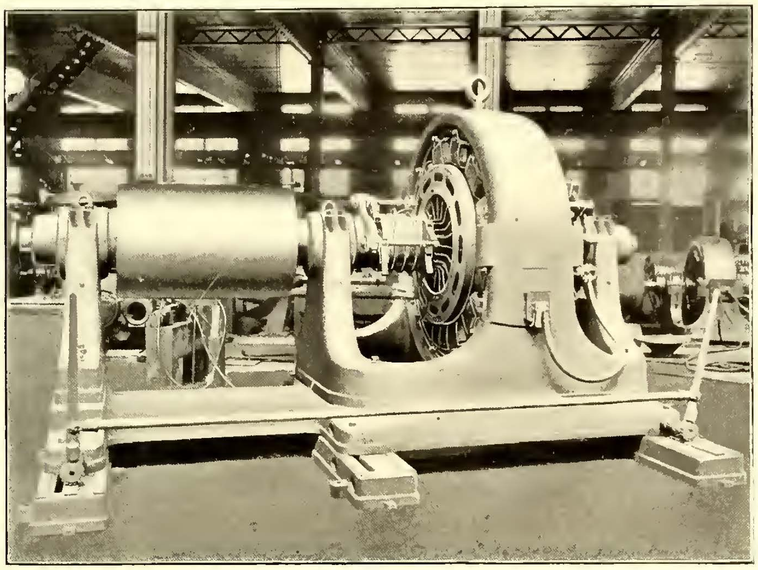


FIG. 10.—250 K.W. A.C.-D.C. GENERATOR

A railway plant now being installed by the Westinghouse company for the Lewiston, Brunswick & Bath Street Railway Company, Lewiston, Maine, is the latest example of the use of A. C.-D. C. generators and rotary transformers. In this plant there will be three Westinghouse belt-driven self-excited generators of the A. C.-D. C. type, each with a capacity of 250 k.w., running at 600 r.p.m. One of these completed machines is shown in Fig. 10. They will furnish direct current at from 500 to 550 volts for local feeders in Brunswick, and alternating three-phase currents at 340 volts and 7200 alternations per minute. Step-up transformers will increase the e.m.f. to 10,500 volts, at which it will be transmitted to Bath, Lisbon Falls and Lewiston. At these stations the voltage will be lowered by suitable transformers to 330 volts and supplied to three-phase 200-k.w. Westinghouse rotaries running at 720 r.p.m. and delivering direct current at 500-550 volts for the local division of the railway.

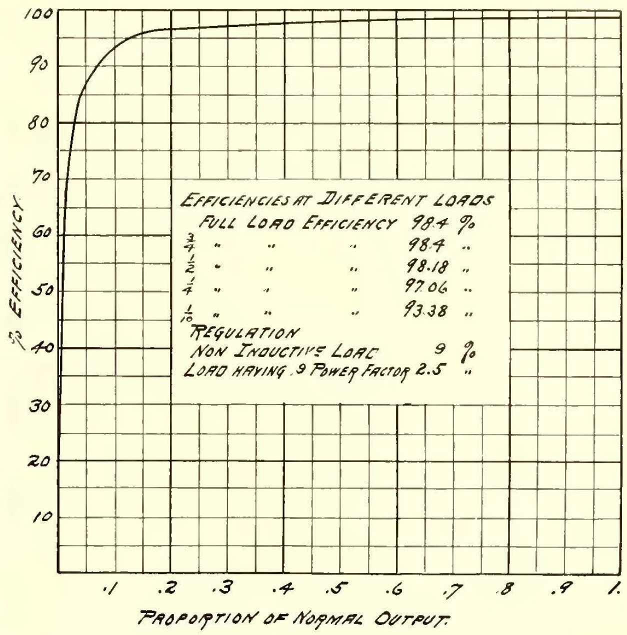
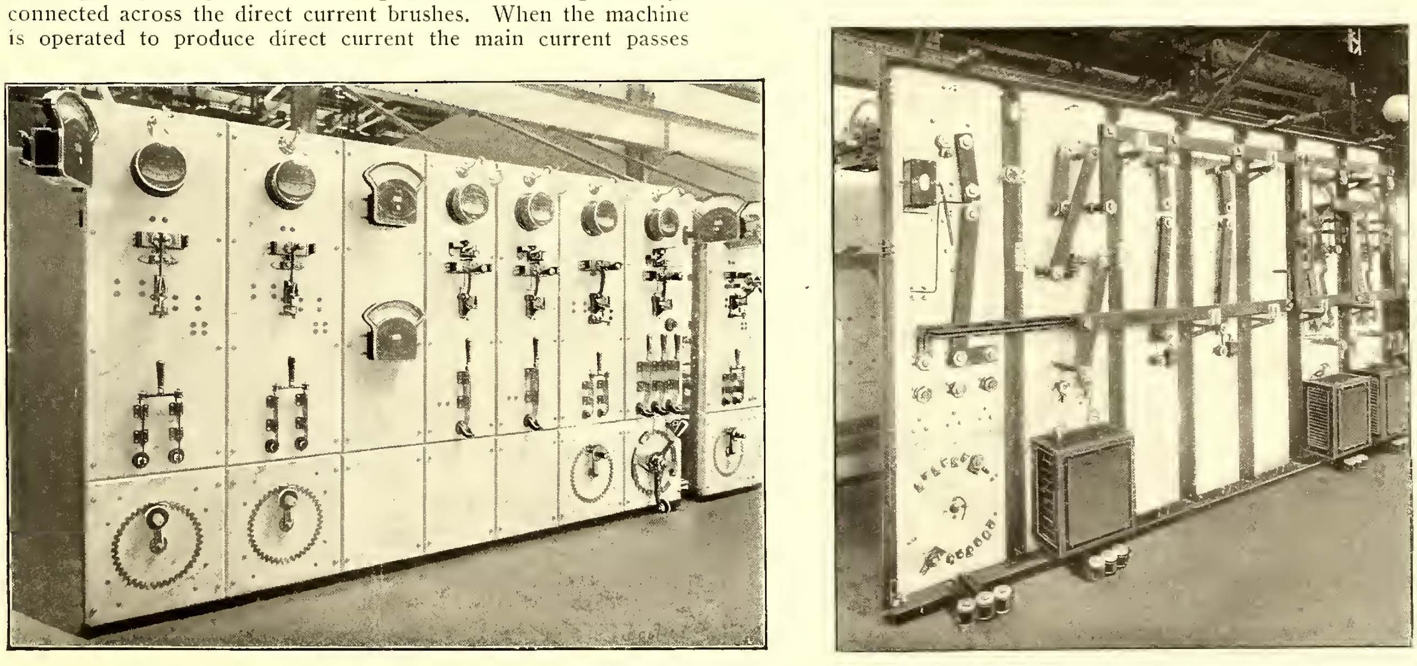


FIG. 12.—EFFICIENCY CURVE OF 375 K.W. TRANSFORMER



FIGS. 13 AND 14.—FRONT AND REAR VIEWS OF STANDARD RAILWAY SWITCHBOARD

ROTARIES

A rotary is simply a commutating machine. When supplied with alternating current at proper frequency and voltage it delivers direct current at the required potential; hence by its use it is possible to secure the advantages of the alternating current for transmission from the source of power and then to transform the electric energy into direct current. In mechanical design and construction and in appearance the Westinghouse rotaries are similar to the A. C.-D. C. generators just described. Alternating current is supplied to the collector rings and the machine runs as a synchronous polyphase motor. Direct current is then taken from the commutator precisely as it is collected from the commutator of an ordinary direct current generator. As in the A. C.-D. C. machines, there is a definite relation in any rotary transformer between the alternating current potential applied at the collector rings and the direct current potential delivered at the commutator. A rotary runs at a perfectly definite speed as a synchronous motor. A machine which is designed for giving the best operation under normal conditions has a very poor starting torque; that is, it requires a very heavy current to start itself. To avoid this heavy current it is the practice of the Westinghouse company to start their rotaries by means of a small induction motor, mounted upon the end of the armature shaft, which requires a comparatively insignificant amount of current.

One of the latest rotaries built by the Westinghouse company is illustrated in Fig. 11, a separate view of the armature being also shown. The latter view shows clearly the secondary of the Tesla polyphase induction motor, which is used in starting. The machine shown is of 200-k.w. capacity, and will be installed in the Bath sub-station of the Lewiston, Brunswick & Bath road. Another similar machine will be placed in a water-cooled type; a spiral of iron pipe through which water is passed is placed in the oil, just inside the case close to the sides, and takes up the heat from the oil. The water-cooling method is only used, however, on the transformers above 500 k.w. in capacity. The construction of the sizes from 10 to 500 k.w. is practically the same and they are all oil insulated, but they are self-cooled. The iron and copper losses in both the water and self-cooled types have been reduced to a minimum, and the efficiency is remarkably high as indicated in the efficiency curve of a standard 375-k.w. transformer, shown in Fig. 12.

SWITCHBOARDS

The Westinghouse company's standard railway switchboards are built up of white marble panels 2 inches in thickness, upon which the necessary instruments, switches, etc., are mounted. These panels are supported upon a rigid iron frame work, the construction being such that the frame work forms part of each individual panel. The panels are set side by side and bolted together and to a channel iron which runs along the whole length of the base. The top of each panel is secured to two wrought iron bars which also run along the whole length of the board. All the connections between the various instruments and switches are completed at the works, rectangular copper bars being used for this purpose. The bus bars are also composed of similar bars of larger cross section. This simple method of construction permits ex-

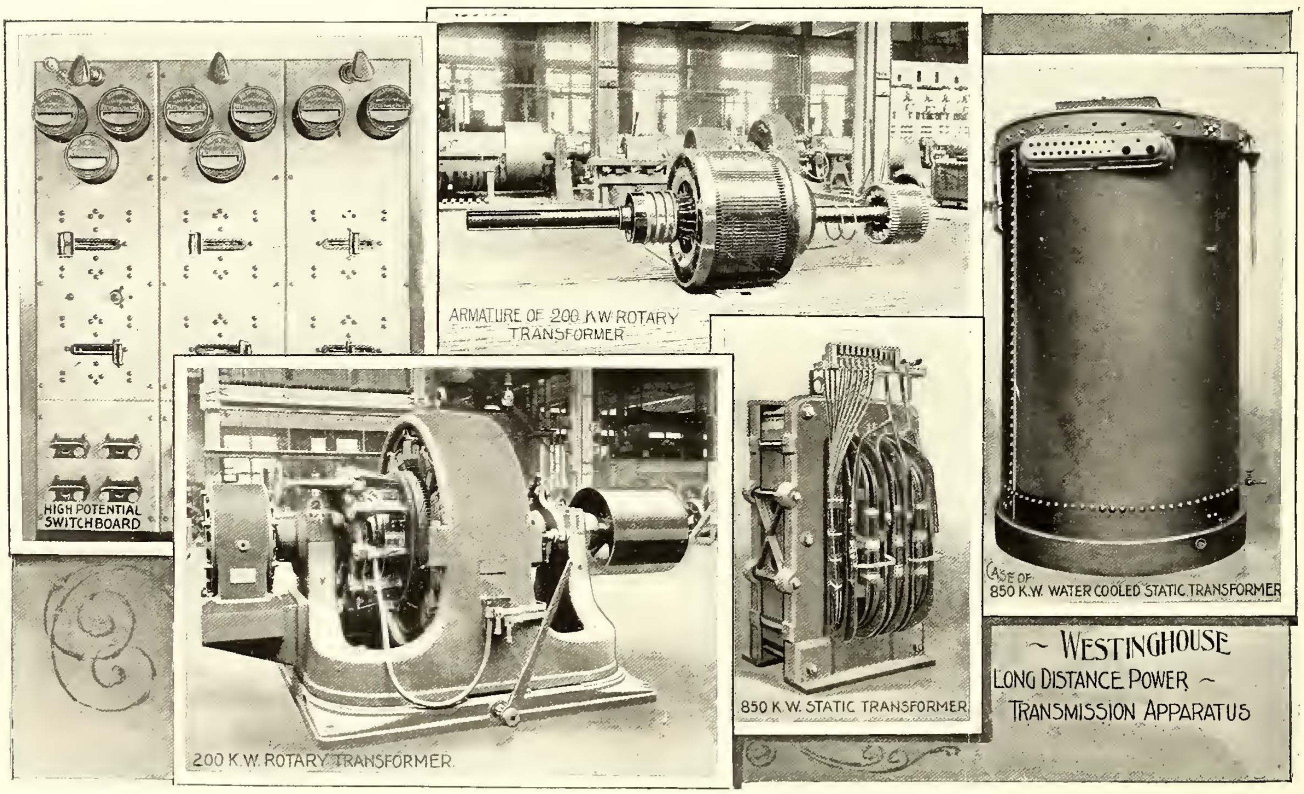


FIG. 11.—GROUP OF ALTERNATING CURRENT RAILWAY APPARATUS

sub-station at Lisbon Falls, and two more of the same size and type will be installed at Lewiston. They are all three-phase tenpole machines, and as shown by the illustration, with the exception of the starting motor, are almost identical in appearance with the A. C.-D. C. machines previously described. The amount of energy delivered from the commutator is equal to the energy supplied at the alternating current end to the collector rings, less the amount required to energize the fields and revolve the armature, and a very high efficiency is attained. In connection with the transmission of power by high potential alternating current, Fig. 11 illustrates an 850 k.w. Westinghouse water-cooled transformer and its enclosing case. This is one of four built for the Cataract Power & Conduit Company, of Buffalo. It will receive power from the Niagara-Buffalo transmission circuits at 22,000 volts and reduce the potential to 2200 volts for local distribution in Buffalo. The view shown illustrates the distinctive features of the Westinghouse oil insulated transformers. The length of the iron core is short, a large portion of the coils extending outside the iron. The winding is composed of deep thin coils, which are spread apart at the ends, thus giving an enormous increase in the radiating surface and increasing the facilities for insulating the bent part of the coils. When completed these transformers are enclosed in an iron case and immersed in oil, which materially strengthens the insulation, prevents oxidation and tends to equalize the temperature. The 850-k.w. transformer shown is of the tensions to be readily made at any time by simply adding the necessary standard panels.

An illustration of a recent standard railway switchboard built by the Westinghouse company is shown in Fig. 13. This board is for the Dearborn station of the Detroit, Ypsilanti & Ann Arbor Railway Company. Commencing at the left end there are two generator panels of 450 amps. capacity; one load panel of 3000 amps. capacity; two feeder panels, 800 amps. each; one booster motor panel, 300 amps., and on the extreme right the panel for the booster, capacity 800 amps. Under the booster panel is the face plate for the motor starting box, while the rheostat face plate under the motor panel is for controlling the motor field. The load panel contains a Weston ammeter and voltmeter, and Weston voltmeters are mounted on swinging brackets at each end of the board. The one on the left is used in throwing the generators in multiple, while one on the right indicates the voltage of the boosted feeder. All other apparatus, including ammeters, circuit breakers, switches, rheostats, etc., are of Westinghouse manufacture. In order to show the arrangement of the connections, bus bars, brackets, etc., a view of the back of the same board is shown in Fig. 14. The connections to the motor starting box from the face plate on the left had not been made when the photograph was made, but otherwise the connections were completed and the convenience, simplicity and flexibility of the construction will be readily appreciated.

New Maximum Traction Truck No. 14 D 2

Much interest was created last month by the announcement that the Peckham Truck Company has designed and built a maximum traction truck on novel lines, and that the truck was in use under one of the electric conduit cars of the Metropolitan Street Railway Company of New York. The special features which attracted attention to this truck were that it was center-bearing and that it was fitted with a swing bolster, both new from a side thrust, also, it is claimed, positively prevents the danger of their jumping the track.

The bolster is located as near the driving wheels as possible and is supported upon springs between two transverse transom bars, secured in pockets to both the side frames of the truck, as shown in Fig. 3. These transom bars act as a guide for the bolster preventing it from moving longitudinally with the car. The spring plank upon which the elliptic and spiral springs supporting the bolster rest, is hung by four links from the transom bars, so as to raise the side of the car body toward which the

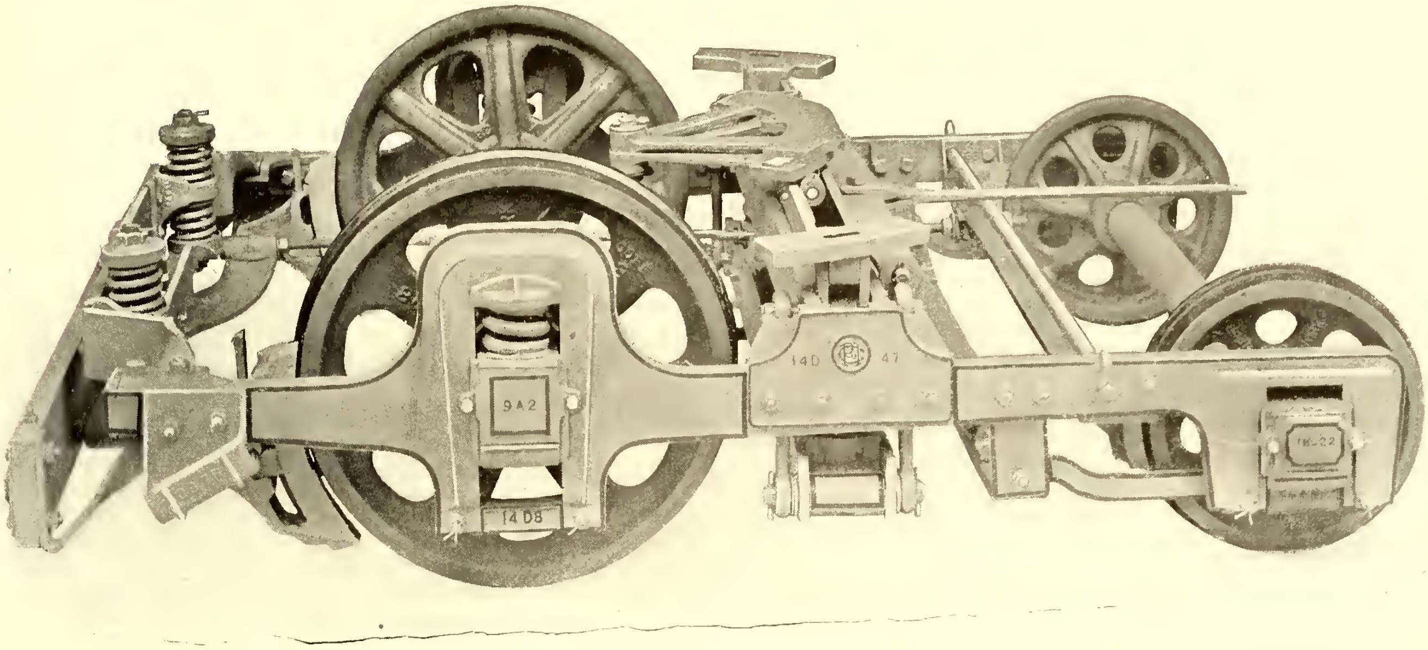


FIG. 1.—MAXIMUM TRACTION TRUCK FOR TROLLEY CARS, USED IN BROOKLYN

features in maximum traction construction, but there are other novel points about the truck which merit description.

One great advantage of maximum traction trucks, of course, is the ability of the large wheels to swing between the side sills. This allows the car to be brought closer to the ground, making access to and egress from it more easy. The diameter of the driving wheels on the truck shown may be 30 ins. or 33 ins., while that of bolster moves when striking a curve. The end spiral springs supporting the bolster being directly underneath the side bearing plates admit of a slight rocking motion which adds greatly to the easy riding of the car, as it permits the wheels on one side of the truck to rise independently of the car body.

In order that the driving wheels may occupy the least possible distance between the car sills, it is necessary to bring the center

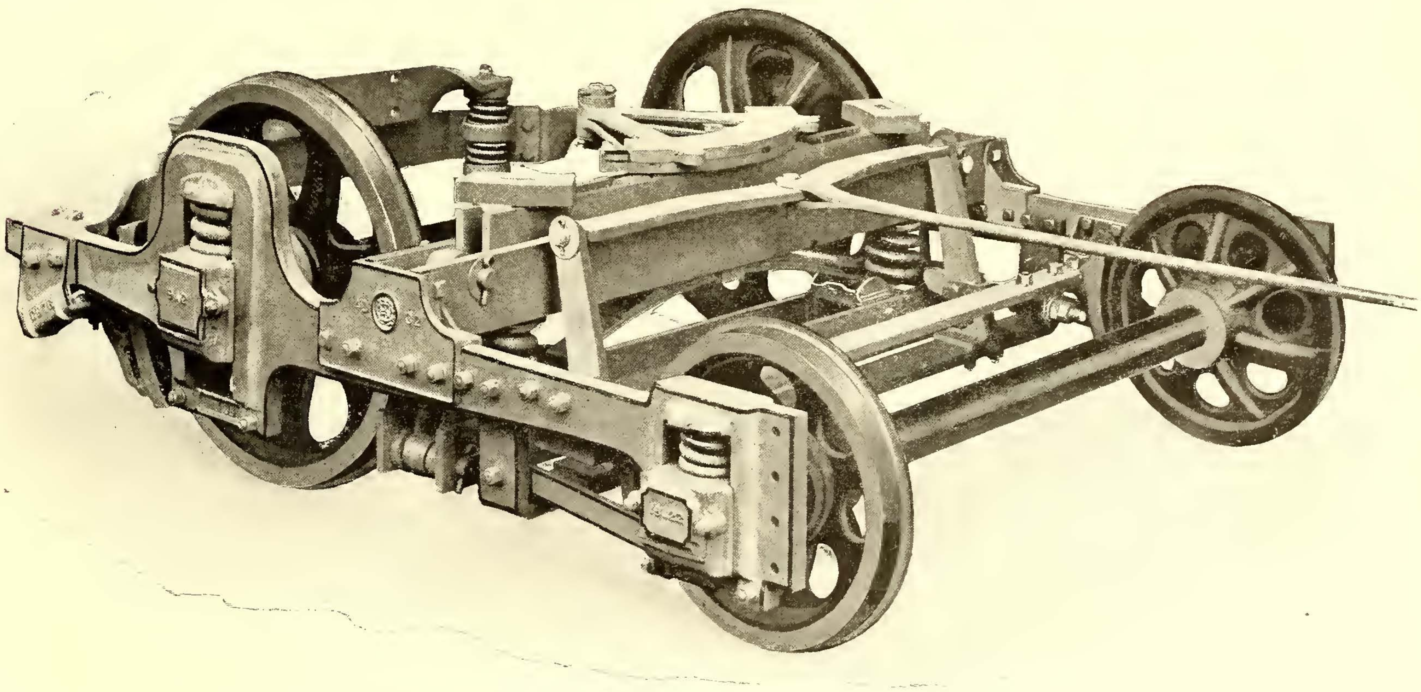


FIG. 2.—MAXIMUM TRACTION TRUCK FOR CONDUIT CARS, USED IN NEW YORK

the small or idle wheels is 18 ins. or 20 ins. This gives the latter plenty of room to swing underneath the car sills.

The advantages of a swing bolster in relieving the truck wheels and car body from side thrusts when the car is rounding curves at high speed have proved of such value that Mr. Peckham, in designing this truck, decided to retain it, although to secure the short swing necessary certain changes had to be made in the usual method of attaching the bolster to the car body. The use of a center-bearing swing bolster in relieving the small wheels upon which the car swings near the center of the driving axle. To accomplish this, and at the same time provide a fixed center, the swivel plate is constructed of two segmental parts, male and female, one section being attached to the swing bolster and one to the underside of the car body bolster. The upper and lower plates are connected by a "king" pin, which serves to fix the center of the swing. This point is adjusted ordinarily about 6 ins. from the center of the axle, but can be changed as desired, so as to make the swing more or less.

These swivel plates, as stated, are made with male and female connections, the lower plate having the projection to fit into the upper, so that without having the addition of the king pin, this truck would swing to the correct center. As these swivel plates cover each other, excepting when the truck is rounding a curve, the surfaces are protected from dust and grit. The lower circular plate is provided with an oil well for thorough lubrication.

The side frames of the truck are made of solid steel castings having pockets in the upper portions of the pedestals for springs upon which they are supported upon the journal boxes. These springs are made sufficiently large and strong to carry the weight of the truck and also the car body. Where the small or idle wheels are used less than 20 ins. in diameter, the journal box

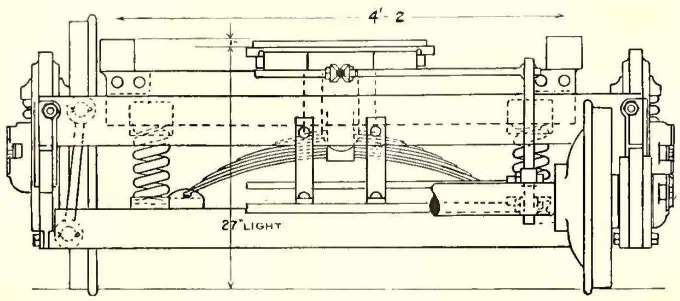


FIG. 3—SECTIONAL VIEW OF SWING BOLSTER

springs are constructed alongside the journal boxes instead of upon them. These side frames are constructed so that they are low enough to swing under the rim boards of open cars when the trucks are turning a curve.

The brake rigging is of the ordinary upright lever type, but provision is made to apply reduced pressure to the idle wheel shoes in proportion to the weight they carry. The upright levers in this truck are carried in the center next to the bolster. The attachments of the rods connecting the floaters to the sway bar at the center of the car are brought so near to the center on which the truck swings that no provision is necessary for compensating for said swing, and the rods can be pinned to the center of the floater.

The brake beams are carried in "gravity" slides instead of links. The use of these slides entails but four wearing parts besides the shoes in the brake rigging of each truck. This device also does away with the troublesome kicking and rattling incident to link-hung brakes.

Fig. 2 shows the truck as constructed for the electric conduit cars of the Metropolitan Street Railway Company, of New York. As will be seen, provision is made for the attachment to the ends of the side frames outside of the small wheels of the electric plow support. Fig. 1 shows the construction for overhead electric trolley cars. Trucks of this latter type are in use on the Brooklyn Heights Railroad, of Brooklyn.

Mechanical Insulation for Electric Cars

BY W. F. D. CRANE

The mechanical strains and the severe service to which the insulation in the commutators, brush holders, starting rheostats and controllers on electric cars are subjected necessitate the employment of an insulating material with superior qualifications for these important parts of the electrical apparatus. The commutator demands for its mechanical and electrical integrity that the insulating material shall be the strongest and most durable obtainable. The bushings which insulate the brush holders must be reliable insulators and at the same time sufficiently strong and durable to complete the required mechanical connections between studs and yoke. Rheostat bushings must also possess similar strength and durability.

For the insulation between the commutator bars experience has demonstrated the superiority of sheet mica for the purpose. The confinement between the flat surfaces of the bars furnishes an ideal condition for the mica sheet, which has its greatest strength under compression. But in the insulating and retaining rings or washers at the ends of the commutator the conditions are so different as to necessitate the use of some stronger insulating material than the mica alone. Similar mechanical strains exist in the brush holder bushings where the strains are also due to compression, vibration and exposure. To meet the requirements the desired material must be tough and strong; it must not shrink or crack under pressure or impact; it must not absorb moisture or oil, or be injuriously affected by unusual temperatures.

In controllers the conditions surrounding the insulating materials are extremely severe. Not only must the insulating material possess unusual strength to provide durable mechanical connections between the insulated metal parts, but it must also possess qualities which will enable it to retain its insulating properties without undue deterioration in the presence of the high temperatures and atmosphere of the arcs formed by the breaking of the electrical contacts.

In the selection of the insulating material to be used in an electrical device the engineer must first consider the nature of the work to be performed. If the parts to be insulated will be relatively stationary and not subject to unusual jar or mechanical injury, practically any material which will furnish the necessary insulation and not absorb moisture will answer the purpose. If, however, work in the sense that the insulating material becomes an essential part of the mechanical construction is required of the material in addition to its function as an insulator, quite a different material would be selected than would, for instance, be suitable for a binding post or a condenser. In early days the scheme of the armature insulation was for a time applied to the insulation of the commutator, to the extent that commutator ring and sleeve and segment insulation were built up imperfectly of mica, shellaced paper, muslin, wood or fibre, as happened to be the case, and brush holders and terminal bushings were made of hard rubber, fibre or prepared wood, with the result that the parts were soon apt to become loose and exaggerate the consequences of legitimate wear and tear. With progress a fuller appreciation of the practical requirements of all the materials entering into the construction of the electric motor has resulted in the utilization of only such materials as experience has demonstrated to be the most durable and economical for the conditions of service. This is particularly true in the case of railway motors, which must operate continuously and inexpensively under extraordinarily severe conditions of jolting, torsional strains and heat, dirt, water and oil. We therefore notice the change in commutator rings and bushings from hard rubber, fibre, porcelain and wood to the more durable material, vulcabeston, which is now universally employed in their stead. Vulcabeston is moulded in the exact size and shape required. It is a composition of asbestos and India rubber vulcanized under pressure, and possesses a combination of valuable characteristics not found in any other insulating materials. The asbestos furnishes a firm, heat-proof substance; the rubber thoroughly waterproofs the asbestos, and the pressure exerted during manufacture creates a hard, dense, tough, yet slightly elastic composition, adapted in a superior manner for incorporation with metal parts in the construction of strong and durable electrical machinery. Vulcabeston commutator rings, field magnet spools and bushings for brush holders and rheostats are furnished for the various types of electrical apparatus on the market, and are found in the stock bins of the manufacturing and railroad companies with other standard repair parts and materials.

The high temperature resistance and the toughness of vulcabeston peculiarly recommend it for service in controllers, and practically all the street car controllers throughout the country are insulated and protected by this material. The various styles of and changes in the controllers of the manufacturing companies have resulted in the production of a great number of controller pieces in all sorts of sizes and shapes. The number has been still further increased by the proprietary prices for repair parts or improvements made to order for the railroad companies.

New Material For Car Curtains and Seats

A new material for car curtains and for upholstering car seats, chairs, lounges, etc., is being manufactured by the Boston Artificial Leather Company, of Boston, Mass. This material is known as "Moroccoline," and is an excellent imitation of leather. Moroccoline has a hard but flexible surface that is not easily scratched or rubbed off. It will not grow hard and crack or become soft and sticky in extremes of temperature or climate, as it contains no rubber or other unreliable matter. It is claimed that this material will last as long as the best upholstering leather. From a sanitary point of view Moroccoline is particularly desirable for upholstering car seats, etc., as it can be thoroughly washed at frequent intervals without injury to the fabric.

Moroccoline is made on one single thickness of either drill or duck and with a good heavy surface coating. This is a departure from some imitations of leather which are sometimes made of two pieces of cloth pasted together. These are apt to separate and cause the surface to blister. Moroccoline is embossed by the same process as is used in embossing real leather, so that all the leather grains can be furnished if desired, and when used for upholstering it is very difficult to tell this material from real leather. Moroccoline costs about one-third as much as hand-buffed upholstery leather.

New Figure "8" Trolley Wire Ears

With the increased use of figure "8" and similar styles of trolley wires has arisen a demand for a variety of different forms and designs of ears and clamps especially adapted for them. To more fully meet the individual requirements of those who are interested in the construction and maintenance of trolley lines the Ohio Brass Company, of Mansfield, Ohio, has recently placed several new patterns of splicing and strain ears upon the market, cuts of which are shown herewith. These are in addition to the figure "8" devices listed in this company's supplement to catalogue No. 3,

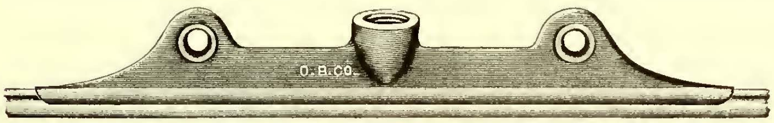


FIG. 1.—SOLDERED STRAIN EAR

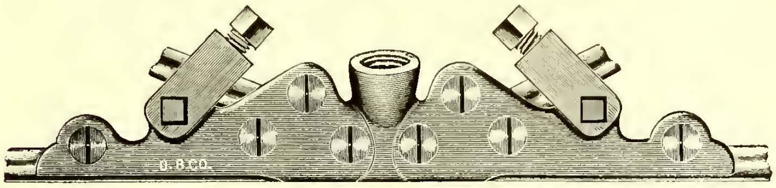


FIG. 2.—MECHANICAL SPLICING EAR

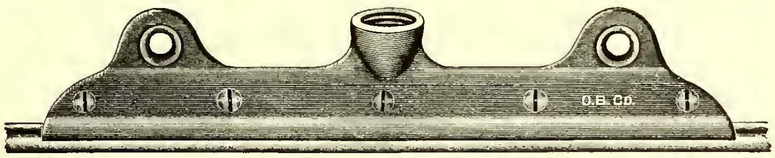


FIG. 3.—CLAMP STRAIN EAR

and differ from those which they most nearly resemble in some detail of design or construction.

These ears have been in use for a sufficient length of time and in large enough quantities to demonstrate their entire practicability. As will be seen from the illustrations they have been well designed and they will undoubtedly be found of great value wherever figure "8" wire is used in overhead construction. Fig. 1 shows a soldered strain ear; Fig. 2, a mechanical splicing ear, and Fig. 3, a clamp strain ear.

Double Truck Kinetic Motor Car

The general principles of the motor car of the Kinetic Manufacturing Company have been described in the Street Railway Journal. As will be remembered, it is a stored steam system, in which the cars are equipped with a large receiver in which hot water and steam to a temperature of about 380 degrees F., corresponding to a pressure of about 200 lbs. per square inch, is stored. The boiler is well jacketed to prevent radiation. As steam is admitted to the engine cylinders, the boiler pressure is

FIG. 1.—SIDE VIEW OF TRUCK

reduced immediately, upon which part of the water passes into steam. The machinery is similar in general principles to that of an ordinary steam engine. The system, which has been developed by A. P. Dodge, general manager of the company, differs in several respects from the ordinary stored steam motors, many of which are in use at present in Europe. The principal points of difference are in the use of a condenser, which is carried on the car roof and muffles the exhaust, and in the employment of a small furnace on the car partly to compensate for the heat lost by radiation, and also to raise the boiler pressure during long stops and when running down grade. The system has recently been put in service on the Babylon Street Railway, of Babylon, N. Y., where single-truck cars are employed, and the company is equipping several other roads, among them the Detroit & Mt. Clemens Railway, running from Detroit to Mt. Clemens, Mich.

On this latter road a double-truck car, built by the Jackson & Sharp Company and shown in the engravings, will be used. This car has four cylinders, two on each truck, necessitating a flexible connection from the receivers containing the hot water and steam to both trucks. In the case of a double-truck car equipped with

FIG. 2.—END VIEW OF KINETIC MOTOR CAR

power on one truck only, the receiver would be mounted on the frame of the truck and move with it. Where both trucks are equipped with motive power, the receivers are suspended under the middle of the car body betwen the trucks, the body trussing being arranged with special reference to this both as to strength and position. The steam pipe connecting the receiver with the cylinders has a ball and socket joint at each connection, so as to avoid any risk of leakage at those points from any twisting of the car while running. About the center of this pipe is a reducing valve through which the steam passes to enter the pipes that carry it to the cylinder. These pipes have joints placed as near the king bolts as possible to permit the swinging of the trucks without straining the pipes.

The general arrangements of the trucks are essentially the same

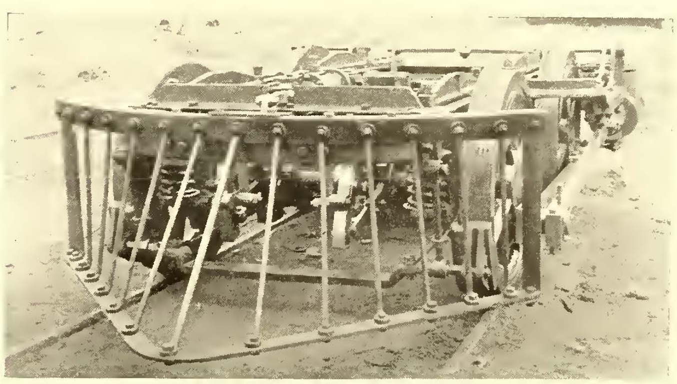


FIG. 3.—END VIEW OF TRUCK

as to wheels, axles, cylinders, connecting rods, eccentrics, links, etc., as a four-wheeled locomotive of the same size. In the car illustrated, 33-in. steel tired wheels are used. The cylinders are 8 ins. in diameter, with 12-in. stroke. The weight of the car body is carried on elliptic springs, transmitting the weight to the truck frames, which in turn are carried by eight spiral springs on each truck. As the whole weight is on the driving wheels there can be no slipping.

After exhaustion from the cylinders, the steam passes into a receiving box on each truck, where it has a chance to expand to nearly atmospheric pressure. From these boxes it passes to the condensers on the roof of the car. In the case of a double-truck car, the condenser is composed of six nearly similar parts, three forward and three back of the center of the car. The division into three is arbitrary and for convenience, but the division at the center of the car is to admit a supply of fresh air and thus avoid using in the rear end of the car the air that becomes heated by passing through the forward part of the condenser. It will be seen that by this arrangement the efficiency of the condenser is doubled. After condensation the water is received by tanks under the car, from which it may be drawn at convenience, or a part of it used to sprinkle the road to lay the dust.

There are manifestly many small details of convenience and necessity that cannot well be described in detail, but all the essential features of the machine are very like the well-known locomo-

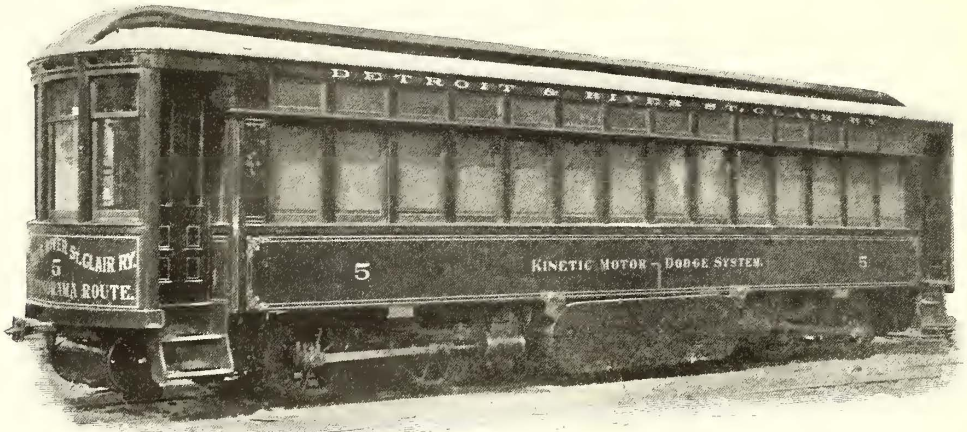


FIG. 4.—SIDE VIEW OF KINETIC MOTOR CAR

tive, but improved and made more efficient by the storage of hot water and the condensation of the exhaust after the steam leaves the cylinders.

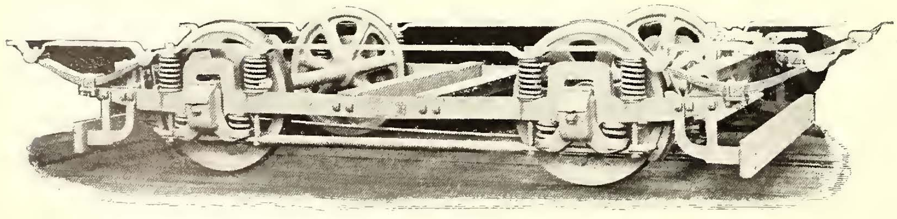
The throttle valve and reversing levers are operated from either end of the car at convenience, so that either end of the car may be the forward end as may be desired.

The system of stored steam, generally speaking, is not a new one, but has been shown both here and abroad to have a distinct economy under many conditions. From the entrance of the steam into the cylinders to its exhaustion from them the means of getting the best service from the heat, which is the true measure of power, is the same as with the well-known locomotive. In the methods of carrying the heat before admission to the cylinders and the disposal of the unused heat after leaving them, are to be found the great improvements over the locomotive or any other system of motive power.

The results from operation in Babylon and Detroit will be watched with interest by railway managers in all parts of the country.

21 E Truck in Boston

The truck shown in the accompanying illustration is known as J. G. Brill truck No. 21 E., and several hundreds of this type are in operation on the lines of the Boston Elevated Railway. These trucks have solid forged axle box frames, half-elliptic



TRUCK IN BOSTON

springs at each corner and springs between the journal boxes and the axle box frame. They are practically the standard type of the Brill Company, with the exception that there is a slight difference in the brake rigging, which is peculiar to the Boston Elevated system.

Circuit Breakers

In the early days of electrical engineering work circuit breakers were looked upon more as a luxury or a "fad" than as a necessary part of the station equipment, but these instruments have been so fully developed and improved that they are now quite generally considered an indispensable part of the power house apparatus. A very great amount of credit for the present state of perfection to which breakers have been brought both mechanically and electrically is undoubtedly due to the Cutter Electrical & Manufacturing Company, of Philadelphia, Pa. This company was one of the pioneers in the field, and for some years past it has devoted

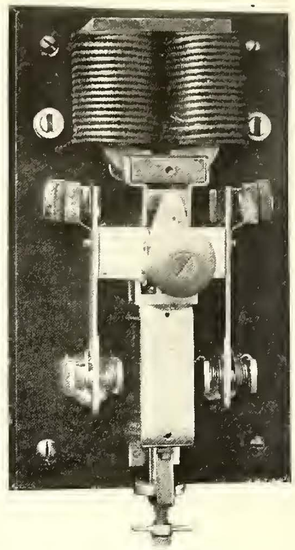


FIG. 2.—REGULATING CIRCUIT BREAKER

almost its entire attention to the subject of breaking automatically, electric currents, and its line of instruments includes everything that can be desired in this connection.

The trade name of the Cutter instruments is "I. T. E.," signifying "Inverse Time Element," and this feature is a particularly important one. "Inverse Time Element" means that the more severe the conditions which cause the instrument to operate the quicker will be its operation. Tests of these instruments show that they will open in five one-thousandths of a second upon the occurrence of a short circuit, and the current, which might normally reach 200 amps., is severed before 80 amps. have passed through them.

Wilbur M. Stine, of Armour Institute, Chicago, in a report made on these instruments, says: "Circuit breakers appear in their action to be independent of the manner in which the load comes upon them, *i. e.*, it is immaterial whether the load is suddenly thrown on or is gradually brought up to the capacity of the machine. Further, they were absolutely free from any sticking, and at no time during the test did they fail to act. The margin within which the apparatus operated successively was also very narrow, not exceeding 3

FIG. 1.—CIRCUIT BREAKER FOR MOTORS

per cent of the capacity." Other tests made elsewhere show practically the same results, and the many large switchboards throughout the United States which are equipped entirely with this form of protection give evidence of the great popularity among the leading engineers of "I. T. E." instruments.

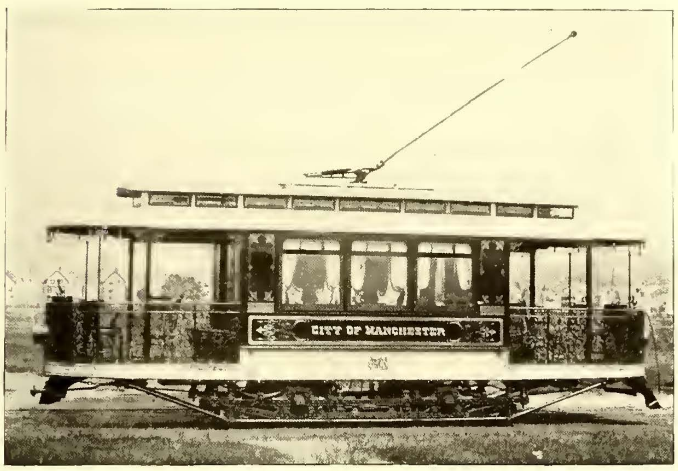
The Cutter Electrical & Manufacturing Company builds its instruments for direct or alternating currents and of any capacity and for any desired voltage. It makes double and triple pole instruments, as well as single pole.

Fig. 1 illustrates a type of circuit breaker which has been designed specially for service in connection with motors. It has an over-load function and also "no voltage" release, the "no voltage" release coil being placed in shunt between the two poles of the circuit. Fig. 2 shows a modification of this same instrument designed to open automatically upon a predetermined over-load or short circuit, and also to open automatically in case the current drops to zero. These instruments were originally made with single pole only and of a limited range, but have recently been built so large as to demonstrate their entire success for any required capacity. These are in use both in America and abroad, largely in connection with storage battery work.

In the "I. T. E." circuit breakers the mechanical features are carefully considered, as well as electrical details. The instruments are also designed to be graceful and pleasing in appearance. The Cutter Electrical & Manufacturing Company has recently published a very large and handsome volume, which is devoted exclusively to the important subject of switchboards and the appliances used thereon, and this book should be in the hands of every one interested in power station apparatus.

Parlor Cars in Manchester, N. H.

The Briggs Carriage Company, of Amesbury, Mass., has recently completed a very handsome private car for use in Manchester, N. H. An exterior view of this car is shown herewith. The car measures 30 ft. over all, and the interior is finished in



PARLOR CAR IN MANCHESTER

mahogany and oak with quartered oak flooring. The door lockers have heavy plate glass coming down to the belt rail of the car. Both platforms are protected by means of heavy spring roller curtains, also with storm curtains to separate the car from the space occupied by the motorman if desired. The grill work and main panels are painted in royal blue with gold decorations, and the sills and concave panels of the car body are finished in cream.

Preparations for Cleaning Cars

The Modoc Soap Company, of Cincinnati, Ohio, has devoted a number of years to developing its Modoc liquid car cleaner, which is especially adapted to cleaning the exterior and interior of street and steam railroad cars. It is a linseed oil preparation, and is used daily on many of the principal railroad, sleeping car and street car companies of America and Canada, but it is intended for terminal and yard cleaning only. It is to be applied with waste thoroughly saturated, on cars after they have made their trips, and then wiped down with dry waste, which will prove a thorough cleaner, giving the highest possible lustre, which it retains, preserving the varnishes and making old coaches like new. It is claimed that this material will effect a great saving in the cost of cleaning cars, and that it is far superior to ordinary soap and water. Modoc powdered soap is a preparation for the thorough cleaning of cars in shops before revarnishing. It is one of the mildest soaps made, and contains less alkali than many ordinary powders and soaps, and can be applied after diluting it with water or direct with a wet brush. It is peculiarly well adapted for cleaning, being most effective, yet does not cut into or burn the paint, and comprises materials that produce the greatest friction without scratching. Because of these combined qualities it reduces the amount of labor and produces the results sought for without the slightest injury to the paint.

The Modoc Soap Company is very confident that if its directions are carefully followed the use of its cleaning materials will show a decided decrease in the expense account because of increased length of service of cars before repainting or revarnishing will be necessary, and in addition the equipment will always be in an attractive and pleasing condition. The company advocates, however, very strongly the systematic cleaning of cars, believing that if the cars are cleaned regularly and before they are allowed to become too dirty a great economy can be effected, both in the cost of cleaning and in the longer life of the cars.

Solenoid Blowouts

The engravings shown herewith present two remarkable views of the action of a solenoid coil on the arc formed between the contact finger and cylinder in the type "S" solenoid blowout street railway controller, manufactured by the Walker Company, of Cleveland.

This controller has proved very popular since it was placed on the market about a year ago, and its makers say that it has given

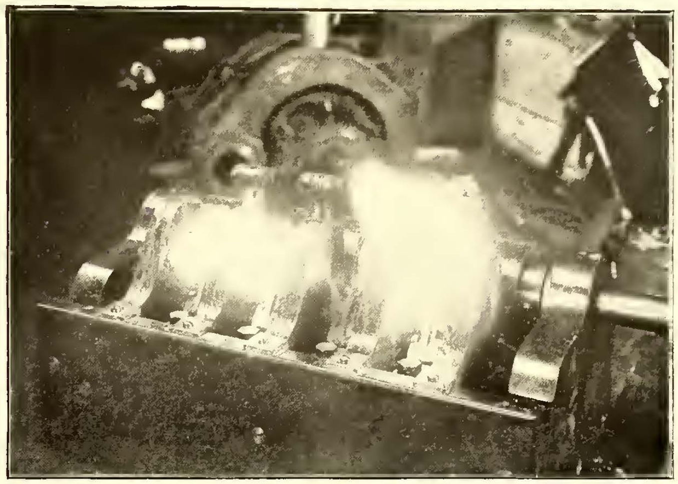


FIG. 1.—ARC WITH SOLENOIDS INOPERATIVE

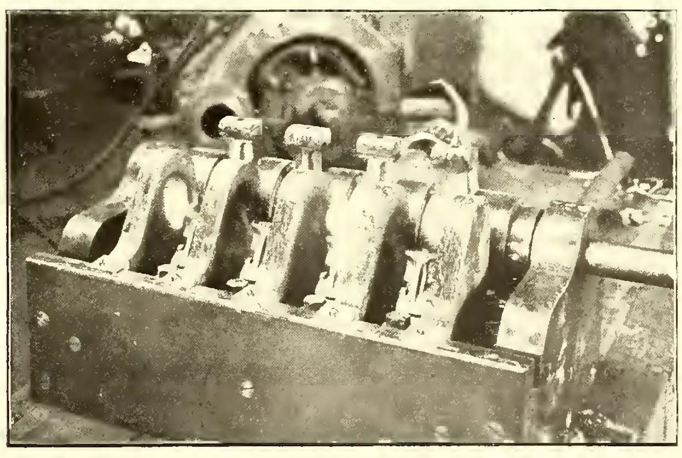


FIG. 2.—ARC BLOWN OUT BY SOLENOIDS

universal satisfaction. The principles used in its construction are new and most ingenious.

The remarkable effect of the solenoid blowout is shown very plainly in the two illustrations, Figs. 1 and 2. These pictures are taken direct from photographs without retouching or alteration of any kind. The apparatus shown is a short section of a controller cylinder, with contact fingers and solenoid partitions in exactly the same relation to each other and working under the same conditions as in a complete controller in practical operation.

Fig. 1 shows the arc formed with the solenoids inoperative, and it will be readily seen how destructive such an arc would be to contact fingers, insulation, and in fact every thing that it could reach. Fig. 2 shows how the arc from the same current and under the same conditions is blown out by solenoids. These views, more than any argument, show the immense advantage of the solenoid blowout in controller construction.

Modern Methods for the Prevention of Scale in Boilers

The general laws of nature are such that water from any source except rain water is impregnated with scale forming salts, mainly lime and magnesia, and when this water is used in a steam boiler these salts form an incrustation which destroys the efficiency of the boiler in proportion to the thickness of the scale. This has led for years to all sorts of expedients for getting rid of the deleterious deposit. Many of the remedies have been much worse than the disease, and hundreds of boilers have been pitted, corroded, and in the end utterly destroyed by the action of the volatile oils and salts which have been used for this purpose. The usual method has been to remove the scale after it has formed, but a substance has now been discovered which when put into the feed water prevents the formation of scale. The development of this method on a scientific basis is the foundation of the immense business built up by the Dearborn Drug & Chemical Company, of Chicago, who, previous to this time, had conducted an analytical and pharmaceutical laboratory exclusively.

LABORATORY

TESTING ROOM

The mineral deposits or scale found in boilers is usually entirely different in different localities, the mineral salts embodied therein not only having different chemical properties, but different physical properties as well. The difference in the percentage of salts in each water is governed by the nature of the soil from which the source of supply is obtained. Under these conditions the preparations prescribed for preventing scale in one water could not be applicable to another. The Dearborn Company has large chemical laboratories equipped with the most modern apparatus and employs a staff of expert chemists, who, analyzing the water from any locality, determine what mineral salts and scale producing elements predominate in it, and after these are discovered it is easy to introduce the proper chemical for neutralizing and destroying those elements without causing any injurious effects on boilers or connections.

LABORATORY SHOWING OFFICE

This company is making free analysis and prescribing treatment for feed waters in all portions of the country, and has on file some 14,000 different analyses of water for which it is constantly furnishing preparations suited for each individual case. In this way the subject is handled in an intelligent and systematic manner, getting at the root of the existing evil, overcoming the difficulties and insuring the safe and economical running of steam boilers and all other steam receptacles. These methods also enable the steam user to always obtain identically the same especially prepared and uniformly made preparation. This company also makes a specialty of the analysis of all kinds of lubricating oils, taking up the subject of lubrication in all its forms from a scientific standpoint, and, after analysis, specifications are given naming the proper oil for each individual case, not only from the scientific, but from a practical standpoint as well. The Dearborn Drug & Chemical Company controls the refining of its own products, which are shipped subject to its inspection; each barrel of oil is re-strained, and flash, fire, viscosity, gravity and cold tests are made of each individual barrel, and if found to be correct it is sealed and shipped as a sealed barrel of inspected oil to the consumer. The laboratory apparatus for this work includes: Thurston's friction machine and accurately adjusted viscosimeters (Tagliabue) and (Carpenter) hydrometers (Baume), flash and fire cups with time watches, thermometers reading 700, freezers, separators, and every thoroughly revised instrument built for determining the nature, composition, etc., of lubricating oils, greases and all classes of high grade lubricants. The accompanying illustrations show different views in the laboratory.

The officers of this company are W. H. Edgar, president; R. F. Carr, vice-president, and Chas. M. Eddy, secretary and treasurer.

Overhead Line Material

The Western Electric Company, of New York, is constantly adding to and improving its excellent line of street railway material. One of the most conspicuous improvements which this company has brought out is the "W. E." form C suspension, which is a modification of the West End type of hanger. In this device all of the good features have been retained, making a much lighter and more symmetrical hanger, without decreasing its strength. These hangers are carried in stock made up in both malleable iron and bronze.

The Western Electric form D or cap and cone suspensions are made with heavy, high-grade malleable iron bodies, which hold the caps and cones of standard "W. E." insulation. The trolley ears made by this company have extra deep milled grooves, and are properly designed to fill all modern requirements.

In addition to this class of goods the Western Electric Company carries a full line of flexible and adjustable bracket arms, carbon brushes, gears, pinions, trolley wheels and many other kinds of material for the construction and maintenance of electric railways. Convention delegates and visitors who will return by way of New York are cordially invited to visit this company's handsome new building in that city and inspect its stock, which is large and complete.

Cars in Boston and Vicinity

The accompanying illustrations show a few of the more prominent types of cars in use on the street railway lines in Boston and vicinity. Fig. 1 shows a closed car of the Hingham Street Railway. This car was built by Jackson & Sharp Company, and is mounted on a Peckham truck. It will be noticed that the car has extra long bonnets with bonnet posts. Fig. 2 illustrates a closed car of the Gloucester, Essex & Beverly Street Railway. This car is mounted on a Peckham truck and is vestibuled. Fig. 3 is a closed car in operation on the lines of the Commonwealth Avenue Street Railway Company. This car is mounted on a Dupont truck, and was built by Jackson & Sharp Company. Fig. 4 shows a nine-bench open car built for the Boston Elevated Railway by the Laconia Car Company. Fig. 6 also shows a nine-bench open car in use on the Boston Elevated Railway. This car is the type of which the J. G. Brill Company has recently furnished seventy-five to the Boston Elevated Railway. Fig. 5 shows a recent type of closed car built by Laconia Car Company for the Boston Elevated Railway.

In addition to the above there are a number of cars in operation in Boston which will be of interest to delegates. The John Stephenson Company, of New York, has built a large number of 25-ft. box cars, which are standard on the Boston Elevated. J. M. Jones' Sons, of West Troy, N. Y., built the long open cars in operation on the lines of the Commonwealth Avenue Street Railway.

FIG. 1.—CLOSED CAR—HINGHAM

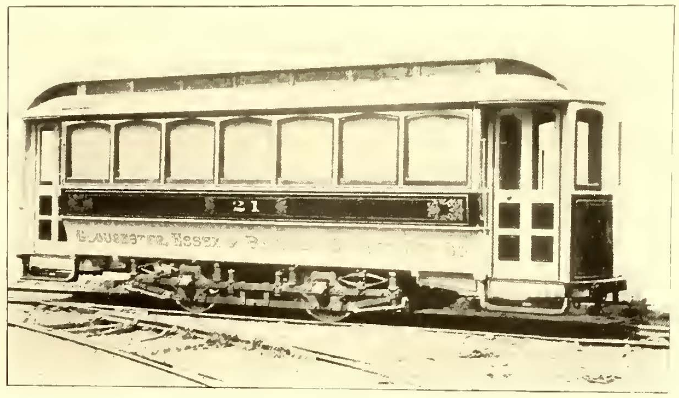


FIG. 2.—CLOSED CAR—GLOUCESTER

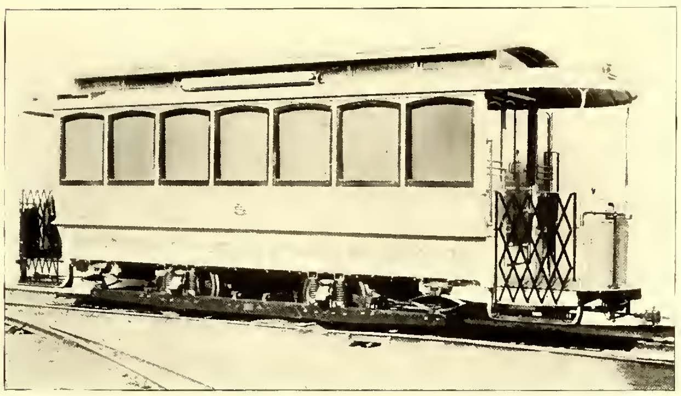


FIG. 3.—CLOSED CAR—BOSTON

FIG. 4.—OPEN CAR—BOSTON

FIG. 5.—CLOSED CAR—BOSTON

FIG. 6.—OPEN CAR—BOSTON

Well-Known Electrical Dealers

The business now carried on by The Albert & J. M. Anderson Manufacturing Company in South Boston was commenced in a very modest way by Albert Anderson in 1877. Mr. Anderson's first work was in the line of small jobbing and various kinds of small metal wires, including locks and keys. By dint of hard, persistent work he increased his business little by little until it was necessary to secure larger quarters, and in 1881 he moved to 5½ Dock Square, at which place he continued the same general line of work and manufactured hardware, locks, door knobs and a variety of special metal and iron work. The room at Dock Square being insufficient to hold the steadily increasing business an additional branch shop was started at 21 Hamilton Street. This branch was devoted mainly to the manufacture of dies, presses, etc.

In 1890 J. M. Anderson, who had been connected with the business for several years, was admitted to partnership, and the firm name of Albert & J. M. Anderson adopted. Still further increase in the business made another move necessary, and in 1893 land was purchased on A Street, South Boston, and the factory which the company now occupies erected, buildings being of brick and planned most advantageously for the work which the concern is doing. The location is convenient to freight facilities, and at the same time within easy reach of the business center of the city, being but ten or fifteen minutes' walk from the post office.

In 1897 the firm of Albert & J. M. Anderson became incorporated under Massachusetts laws under the name of The Albert & J. M. Anderson Manufacturing Company. From the early history of this concern it has been engaged in the manufacture of electrical devices for a variety of purposes, and made the switchboard used at the experimental power station at Allston when the West End Street Railroad first undertook the equipment of its line with electricity for a motive power. Since then a great part of the material used for the overhead construction of the West End has been furnished by the Andersons, and by reason of the excellent quality of the material furnished by them and the widely-known reputation of the West End Road for superior equipment, the material which the Andersons have made has become widely known for its high grade.

The switchboards in the five Edison stations in Boston have practically all been made by this company, including all the new apparatus for storage batteries. All the recent works in this line is well worthy the attention of electrical engineers. The plant at 289-293 A Street includes a brass foundry, a very completely equipped machine shop and a blacksmith shop where drop forgings are produced.

Woodwork for Street Railway Cars

J. P. Sjoberg & Company, of New York City, make a specialty of supplying woodwork for cars. This company makes new car bodies complete to be shipped "knocked down," and it also supplies woodwork for repairing and rebuilding; special attention has been given to the equipping of cars already in operation with vestibules. Several roads have ordered these vestibules, among them being the Consolidated Traction Company, of Jersey City, and the North Hudson County Railway Company, of Hoboken, and seem very well pleased with them. The vestibules made for these two companies project a few inches over the dash to avoid the necessity of moving the controller box, and have a center sash operating on hinges and designed to swing to one side. An engraving of the Sjoberg vestibule is given on another page of this issue.

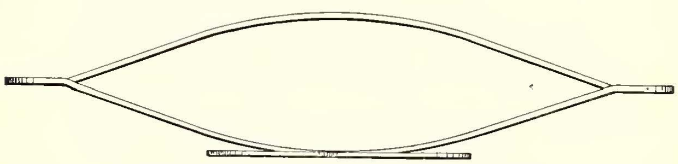


FIG. 1.—SIDE ELEVATION OF SPRING

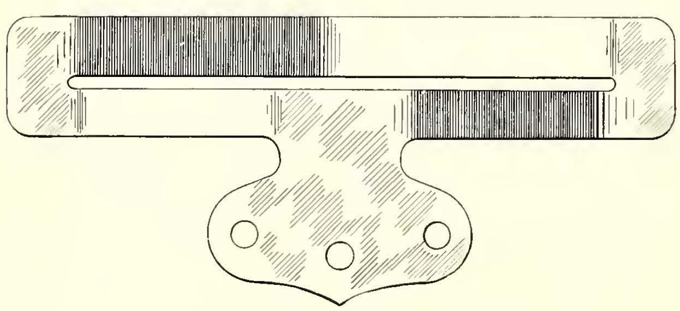
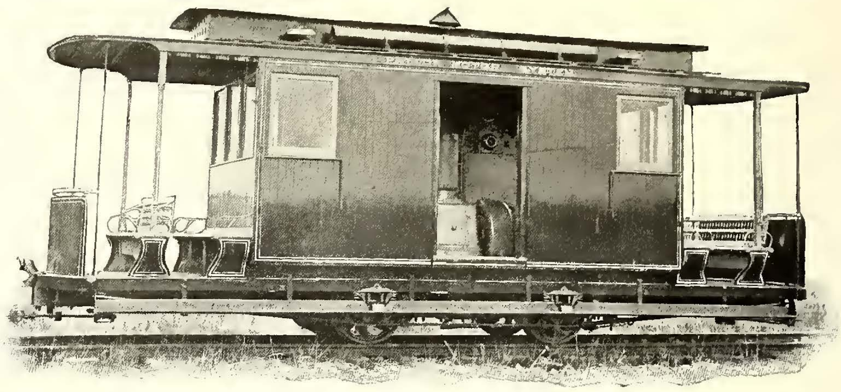


FIG. 2.—TOP VIEW OF SPRING

J. P. Sjoberg & Company have designed a new patent sash and blind spring for street cars, for which there is an increasing demand. This spring is shown herewith. It is composed of high carbon steel, tempered and then bronze-plated. Being made of steel it always keeps its spring, and it is easily attached to the sash. Over 100,000 of these springs were sold last year.

The Development of The Patton Motor

The Patton motor has been undergoing an experimental stage for several years past, one or two crude machines having been put in service and operated under the most trying conditions and adverse circumstances. The new company, however, which now controls the invention is making rapid strides with it, having put upon the market within the last year a number of substantial, well built machines, which have given excellent satisfaction to the purchasers.



SIDE VIEW OF MOTOR CAR

The Patton electric motor system proposes a solution to the problem of reducing operating expenses by doing away with the power house and its expensive equipment both in first cost and maintenance, and with overhead construction and bonding. The apparatus is all concentrated in the car itself in the form of a gasoline engine direct connected to a dynamo and a storage battery in parallel circuit between the dynamo and the motors.

It is claimed that while the system preserves the desirable features obtained in other forms of electrical propulsion it eliminates at the same time many of their undesirable qualities and conditions.

It no longer becomes a question of distributing steam power by means of electricity, primary power being generated in an entirely different and more economical way. This system has great flexibility of application and is as easy on the roadbed as any form of rotary motion can be. The method of operation is very simple. In starting the engine the generator is for a moment turned into a motor, drawing its current from the batteries, and then automatically changes into a generator again as the engine takes hold of its work.

The capacity of the Patton electric motor system both as to speed and work accomplished is very large. During high speeds it is under the perfect control of the driver, the starting and stopping device being similar in all respects to that used upon the present trolley car. The saving in installation, maintenance and operation is undoubtedly large enough to render many projected roads feasible and profitable in operation where the initial cost of the trolley system would be prohibitive.

The gas engine used in this system is provided with a muffler, which reduces the sound of the exhaust and renders the engine practically noiseless in operation, and also a device is provided which renders it odorless and entirely unobjectionable.

The efficiency of the system has been proven in some remarkable tests which have been made. On March 20 and 21 of this year one of the motors was run from Chicago to Cedar Falls, Ia., a distance of 274.1 miles, without accident and at an average speed of 16.36 miles per hour for the trip, the total expense for fuel being $2.90. This trip was fully described in the STREET RAILWAY JOURNAL for April, 1898.

The total expense of operating the system is confined to the motor itself. The amount of gasoline used in the gas engine is about one pint per h.p. hour. One man operates the equipment and attends to the gas engine and generator at the same time, which in reality requires but very little attention. The repairs on the motors are exactly the same as are met with motors used in the trolley system. The gas engine is a very simple piece of machinery, requiring very little attention, and does not need as many repairs as steam engines, and since in this equipment there are no furnaces, boilers and other accessories which are required in a power house, the repair bill will of course be smaller than that in a power house.

In equipping suburban or interurban roads, especially where the line is more than ten miles long, the company claims a reduction in both first cost and operation. In equipping very long lines, where more than one power house would be needed, the system is especially applicable. The Patton system can be installed on almost any style of car, either single or double truck, designed for pulling trailers only, as a dinky steam engine would do, or built to carry passengers as well as pull trailers.

Time or money has not been spared in preparing this system to meet the demands which the phenomenal growth of electric traction has developed, especially on suburban and interurban roads. The Patton Motor Company, of Chicago, now owns all the patents covering this system.

A New Conduit Railway System.

The accompanying diagrams illustrate the new Jenney conduit railway system, designed for street railway service. Fig. 1 is a cross section through conduit and car truck, showing the relative arrangement of conductor rail, the supports and insulators for same, and the contact device and its supports. Fig. 2 is part section and side elevation through center of conduit.

It will be observed that but one conductor is placed in the conduit, the current being returned through the rails, as is the case with the overhead trolley system. The conductor is in the form of a rail having a flat top surface, as shown in section in Fig. 1. These rails are supported only at the fish plates, which have upwardly inclined arms, the ends of which are bell shaped to fit over the upper ends of the insulators. The insulators are of the form shown in Fig. 1, and fit on metal rods or pins, supported by brackets attached to the side of conduit. These insulators are cast of a rubber composition with a series of "petticoats" or "eaves," which very effectually prevent surface leakage from the conductor rail to the supporting brackets. Much of the trouble heretofore experienced in placing conductors in conduits has been due to the leakage over the surface of the insulators.

It will be noticed that the supporting arms for conducting rail extend from same at an upward angle, which causes any water which gets on same to drip off at bottom of rail. In order to prevent dirt, water, etc., from dropping through slot onto rail the rail is placed to one side of center of conduit.

The arm supporting contact device consists of two flat metal bars bolted together. A flat groove is formed on the inside of each of these bars, thus leaving a space in which a flat insulated copper conductor is placed to form connection from the contact device in conduit to the motors on truck. This bar is supported by a very ingenious frame, which is suspended to the truck by four links. This method of attaching the bar to the truck permits a free side motion of the bar to enable it to pass freely between the slot rails without binding or having undue friction on it. It will also be noticed that in the method of supporting, the bar when swinging is maintained in a vertical position, thus insuring a uniform contact at the conductor rail.

In order to allow for imperfections in the track, as well as for

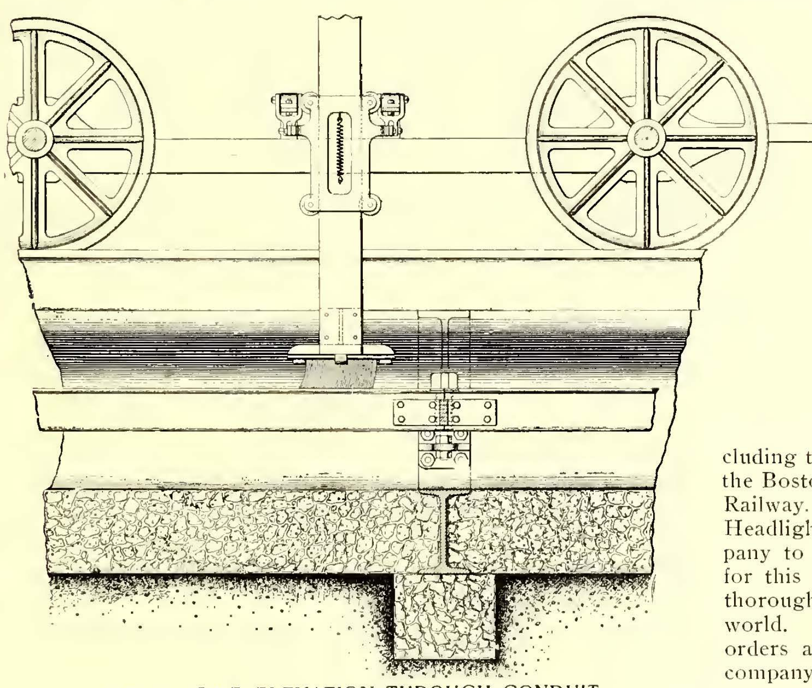


FIG. 2.—SIDE ELEVATION THROUGH CONDUIT

variations in the level of conductor rail, the bar which carries the contact device is arranged to have a vertical motion, and to prevent undue friction and wear the bar is guided through the supporting frame by four small flanged wheels, as shown in Fig. 2.

The contact device shown is a steel wire brush, which insures many points of contact with the conductor rail with very little pressure on it. The weight of the bar is more than sufficient to give proper pressure, and a simple coil spring is placed at each side, as shown at Fig. 2, to compensate for a part of the weight of bar.

The main points of advantage claimed for this system over other conduit systems are: Comparatively small first cost, owing to there being but one conductor and on account of the method of supporting and insulating same; thorough insulation, simplicity and little liability of trouble from "short circuits" or leakage.

Particular attention is called to the simple construction required for branching or crossing tracks of the same construction. No switches or mechanism of any kind are required in the conduit for turning out or crossing, as in such cases the conductor rails

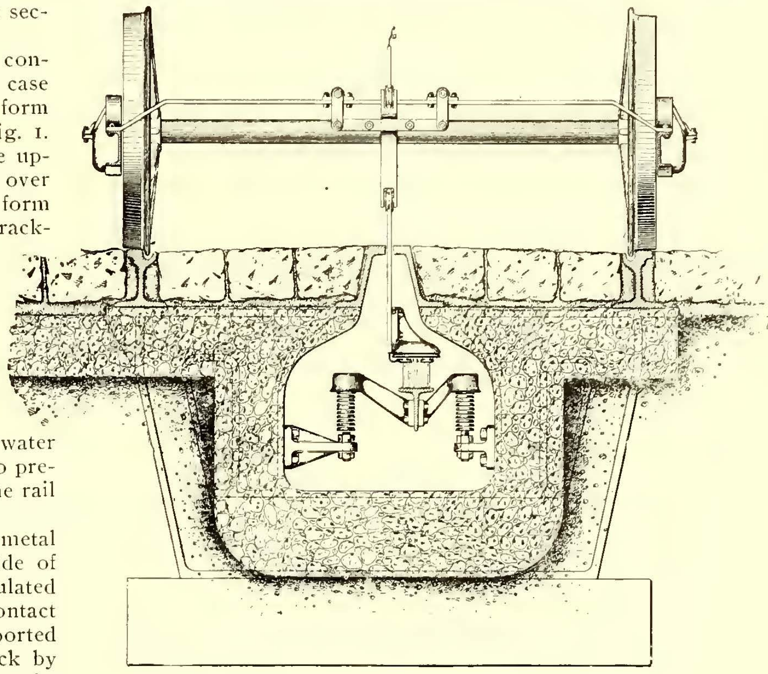


FIG. 1.—CROSS SECTION THROUGH CONDUIT

are simply joined with their top surfaces on the same level, thus maintaining a continuous connection at such points and overcoming all difficulty experienced in other systems where the circuit is interrupted and re-established by the momentum of the car.

This system was patented several years ago by Chas D. Jenney, who has been well known in the electrical field for many years, more particularly in the line of manufacturing apparatus for electric lighting and stationary power service. Although the above described system was patented several years ago no attempt has been made to introduce it till now. The Jenney Electric Manufacturing Company, of Indianapolis, Ind., which controls Mr. Jenney's patent, is now negotiating with parties in the railway field to introduce this system.

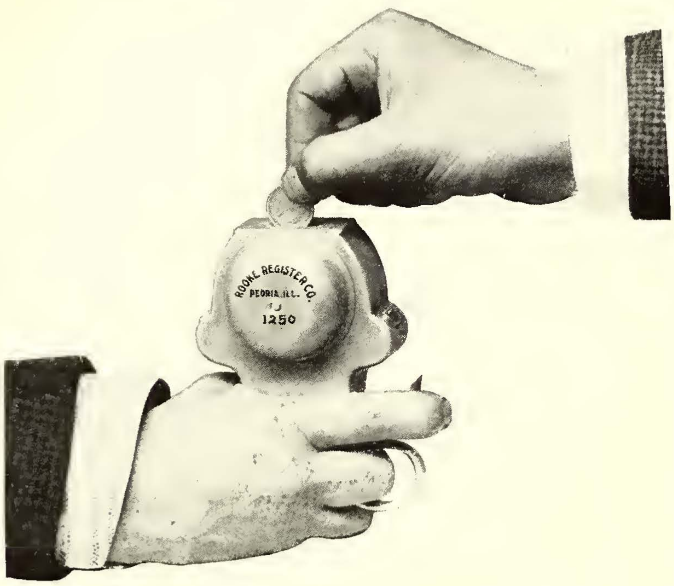
Electric Headlights

The Neal Headlight Company, of Boston, Mass., has had several years' experience in the manufacturing of electric headlights, and the Neal headlight is now the standard on over 200 street railway companies, including the Metropolitan Street Railway Company, of New York, the Boston Elevated Railway Company and the Brooklyn Heights Railway. This headlight was invented by J. H. Neal. The Neal Headlight Company licensed the United States Headlight Company to manufacture under its patent and became selling agent for this company, which is claimed to be the largest and most thoroughly equipped concern manufacturing headlights in the world. The volume of business is constantly increasing, and orders are being received from all parts of the country. This company is under the management of F. E. Huntress.

The Southern Electric Railway Company, of St. Louis, Mo., is erecting a new office building and power station, to cost $160,000.

A New Portable Fare Register System

The practice of registering fares is a comparatively old one, so that any radical departure in the methods of collecting and registering employed is of more than usual interest. For this reason the portable register, which is shown in the accompanying engraving, will attract considerable attention.



REGISTER IN SERVICE

As will be seen, this is a simple device having a chute running from top to bottom. In the opening at the top each passenger deposits his fare, and, when the coin has entered, the releasing mechanism is automatically operated by its passage. This closes the entrance of the chute. By the same action the lower end of the chute is opened to allow the coin to fall into the hand of the conductor holding the register, and the operation also causes the recording of the fare and the ringing of a bell. The coin once entered cannot be taken out, but must pass through into the conductor's hand. The closing of the entrance of the coin passage or chute prevents another coin from entering until the machine is reset by the conductor, which is done by pressing a trigger. This puts the register in position for receiving and recording the next fare. The machine is so constructed that it cannot be tampered with in any manner without detection, as it has a seal attached to the inner construction.

The record is kept by two independent counters, thus insuring a correct count. The counters are fastened directly to the operating mechanism, and are covered by heavy glass. They are positively interlocking with the mechanism in such a way that the register cannot be used without turning the counters, the connections not depending on any springs or ratchets.

The register is constructed of the best quality of steel with German silver case heavily nickel-plated, and is very simple and durable. When not in use it is suspended conveniently on a bracket attached to a strap, which goes around the neck of the conductor. Several of these machines have been in use for some time, and have demonstrated the entire practicability of the system. It is thought that this system will greatly reduce operating expenses, as the use of all spotters and detectives will be unnecessary and at the same time a full account is kept of every nickel which is handed in as a fare. If the passenger has not the exact fare the conductor furnishes full change. Another advantage claimed for this system is that the conductor can use all the money collected on a trip for change, which is not the case with some forms of portable registers.

This register is the invention of George F. Rooke, and was devised after a careful and thorough investigation of the different systems of registering fares. It is manufactured by the Rooke Register Company, of Peoria, Ill.

Large Car Works in New England

The Laconia Car Company Works, of Laconia, N. H., with branch offices at Boston, has the largest and most complete car manufacturing plant in New England. This corporation has been newly reorganized, with Frank Jones, of Portsmouth, N. H., president, and E. H. Gilman, of Exeter, N. H., general manager and treasurer. The plant has been enlarged and improved by the addition of new machinery, and it is now thoroughly modern and up-to-date. This company is in a position to build all kinds of electric and steam cars, and with the large force of men employed and facilities for turning out work rapidly, can handle large orders and make prompt deliveries.

So far this year it has delivered 100 electric cars for the Boston Elevated Railway, and some fine ten-bench open cars for the West Roxbury & Roslindale Street Railway. In addition to the electric cars, it has delivered nearly 500 freight cars to the Boston & Maine Railroad, and some stock cars to the Cutting Car Company. The orders now on hand include electric cars for the Laconia Street Railway, of Laconia, N. H., the Norfolk Suburban Street Railway, of Hyde Park, and the Taunton Street Railway, of Taunton, Mass. It has also a large order for passenger and freight cars from the Southern & Hutchinson Railroad, of Kansas, and for coal cars from the Arlington Mills, of Lawrence, Mass.

The malleable iron foundry connected with the Laconia Car Company's works is one of the largest and best equipped in the East, and this company is receiving orders for malleable castings from all over New England, and as it is turning out some first-class castings and making prompt deliveries it is rushed with orders.

The Dickinson Trolley in Germany and Austria

The Dickinson trolley side contact system has proved quite popular in Germany, where it has been introduced by the Electricitäts-Gesellschaft Felix Singer & Company, of Berlin. In this system the trolley wheel can not only rotate around its axle, but also turns about a vertical axis. This arrangement prevents the wheel from catching in the trolley wire, and also from jumping off the wire. Another important advantage of this system, of course, is that the trolley wire can be strung a lateral distance of three meters from the center of the track. This permits of a much lighter overhead construction than where it is carried over the center of the track, especially at curves, and eliminates from the streets and public squares the span wires which are so often a disfigurement to the landscape. The installation of the Dick-

FIG. 1.—MOTOR CAR AT SMICHOW-KOSIRE, USING DICKINSON TROLLEY

inson system, therefore, is looked upon with favor where æsthetic considerations exclude the use of the common overhead structure. The cost of installation is claimed to be less with the Dickinson than with the usual system, and the reliability of operation is also greater since no slipping of the contact wheel from the trolley wire can occur. The wear on the overhead wire is also said to be less than with the centrally located trolley wire, as, owing to the revolution of the trolley wheel about a vertical as well as a horizontal axis, the grinding effect of the flanges against the wire is eliminated. Figs. 1 to 3 show some illustrations of electric railways installed by the Electricitäts-Gesellschaft Felix Singer & Company in Europe, according to the Dickinson system.

For generators and motors this company uses those of the well-known Walker type. As a result of the careful design of these machines they have been adopted extensively. The truck used by the company presents a strong and durable appearance, and is illustrated in Fig. 4.

FIG. 2.—MOTOR CAR AT LIEGNITZ

FIG. 3.—MOTOR CAR AT TRAIT-PLANCHES

Besides the ordinary hand brake, operated from the two platforms, the Walker system includes the use of an electric brake, if desired. The application of this can be varied at will, and at full

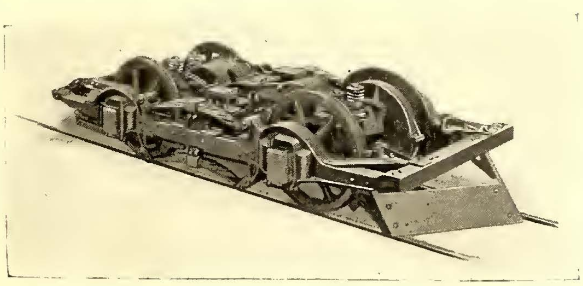


FIG. 4.—MOTOR TRUCK

power enables the motorman to stop the car at full speed in a few seconds. This brake is operated by simply reversing the controller handle beyond the zero point.

The company's controllers are supplied with solenoid spark blowouts. Arcing in the controller is in this way positively prevented, the sparks being blown out radially from the controller spindle. The Walker controller has seven positions for direct operation, and about four for braking. In positions 1 to 3 the motors are in series with a rheostat in the circuit; in 4, the motors run in series without the resistance; in 5 and 6, the motors are in parallel with each other, and in series with the rheostat; in 7, they are parallel with the resistance cut out. The rheostats are made up of iron strips wound spirally on a cast frame, the windings being insulated from each other by asbestos.

Legal Definition of Locomotive Steam Power

An interesting decision was recently rendered by the Appellate Division of the Supreme Court, Third Department, of the State of New York, in the case of the People ex rel. Babylon Railroad, Relator, against the Board of Railroad Commissioners of the State of New York et al., Respondents. The case was brought to review the determination of the Railroad Commissioners in refusing to permit the Babylon Railroad Company to change its motive power from horses to Kinetic power or steam, i. e., the Dodge stored steam system.

Judge Landon, rendering the opinion of the Court, decided that legally the Kinetic motor was not a steam engine, where steam was legislated against. He said, in part:

Section 100 of the Railroad Law, Ch. 565, L. 1890, provides that: "Any street surface railroad may operate any portion of its road by animal or horse power, or by cable, electricity, or any power other than locomotive steam power, which may be approved by the State Board of Railroad Commissioners and consented to by the owners of one-half of the property bounded on that portion of the railroad with respect to which a change of motive power is proposed."

"We think, however, that the Kinetic motor of the relator is not the 'locomotive steam power' contemplated by this statute. The statute evidently contemplates the locomotive steam engine commonly employed upon other than street surface railroads, an engine obviously unsuitable and unsafe for use upon the surface of city and village streets. The relator's motor is so constructed and operated as to be free from the noise, smoke, cinders and escaping steam of the ordinary locomotive steam engine. It is a steam engine, but the steam is generated from water heated in a stationary boiler and transferred to a reservoir under the car and under the motor and kept from cooling by a slow hard coal fire beneath the reservoir. It is a sort of dummy steam locomotive engine, forming part of the car, and is essentially different from the well known 'locomotive steam power' mentioned in the statute. It may be yet in its experimental stage, but the requisite consents to its use by property owners along the line of the road seem to afford some evidence that the property owners have no fear upon that account. We think when the Board of Railroad Commissioners decided that the statute forbade them to give their approval they misconceived the law. The relator had the right to have its application considered free from such misconception, and hence the determination should be reversed."

Long Distance Transmission of Power

The Westinghouse Electric & Manufacturing Company, of Pittsburgh, Pa., has issued a catalogue recently, which contains considerable information of great interest and value. The catalogue contains a long list of the plants where Westinghouse alternators have been installed for transmission of power over distances ranging from one to seventy-eight miles, although it is stated in the catalogue that the Westinghouse Company is prepared to furnish machines for transmitting over much longer distances. The catalogue gives the principal features of 185 plants equipped with Westinghouse apparatus for transmitting power. These are located in twenty-nine of the United States and eight in foreign countries. The aggregate h.p. of the generators in these plants is 219,649; of the motors and rotary transformers, 35,511; of the static transformers, 51,598, making a total h.p. of 306,758.

The voltage of these plants varies from a few hundred to 22,600 volts, there being six with over 15,000 voltage, twelve with voltage from 10,000 to 15,000, and 167 with less than 10,000 volts. Among the plants having 15,000 volts or over may be mentioned the station of G. & O. Braniff & Company, at Tlalnepantla, Mexico, having 22,000 volts; the station of the Cataract Construction Company, at Tonawanda, N. Y., having 21,000 volts, and the station of the Colorado Power Company, at Colorado Springs, having 20,000 volts.

Large Railway Generators

The Walker Company has always been noted for building large direct current generators, and recognizing the economy of large units from the point of view of operation and maintenance, railroad managers have been demanding larger and larger sizes until one would think that the recent productions in Walker railway generators had reached the limit in size of practical and desirable machines. This company's latest generator, however, eclipses anything else ever attempted in the way of a railway dynamo.

In the field magnet lies the chief difference between this generator and other smaller ones of the type. This magnet is of steel and is cast hollow. It is provided with hand holes, one for each pole, so that the bolts, which hold the laminated iron pole pieces in the frame, are easily accessible. The structure of the frame is strengthened by transverse ribs. The armature is 15 ft. 6 ins. in diameter and will be wound in the power station in Boston, as it would be impossible to ship the completed member on account of tunnels and narrow cuts on the railroad. The commutator is so large that a very tall man could stand inside the ring while the segments were being formed up before turning. Its exact outside diameter is 8 ft. 9 ins. Its twenty-four brushes are held in place by a ring 11 ft. 6 ins. in diameter.

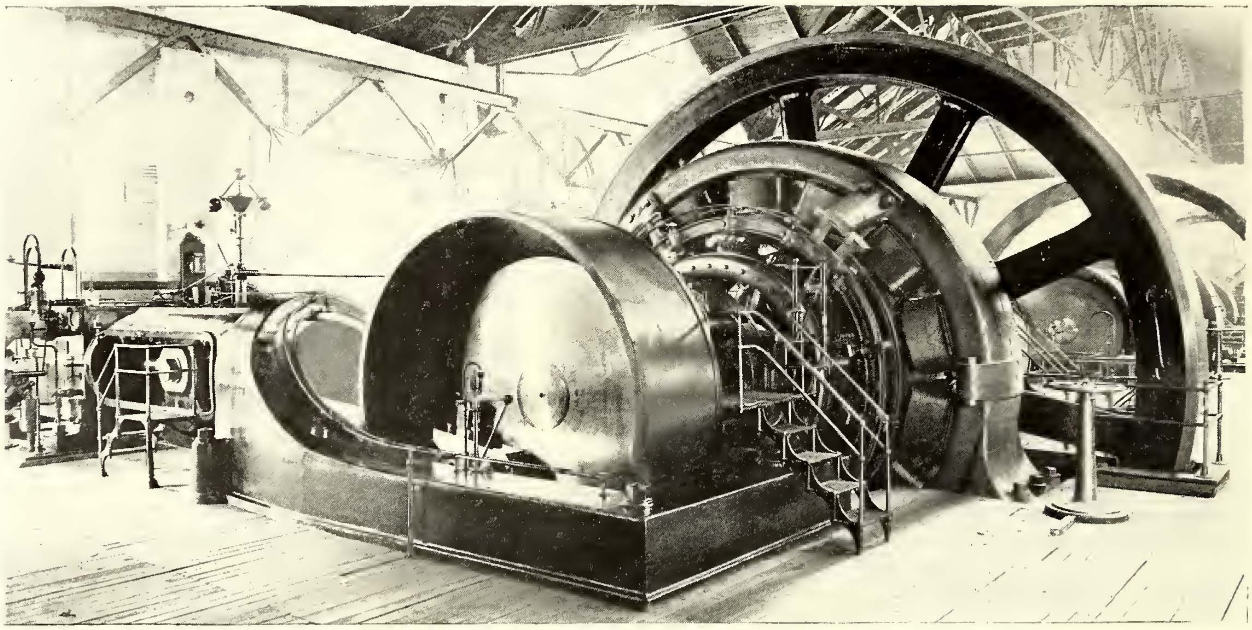


FIG. 1.—1600 K.W. GENERATORS IN KENT AVENUE STATION, BROOKLYN

This generator is being built for the Boston Elevated Railway Company, of Boston, Mass., and will be rated at 2700 k.w., giving a current of 4500 amps. at 600 volts. Its rating is so low, however, that it will be capable of very heavy overloads, and the engine will be of 4500 h.p. in order to be able to respond to any such requirements.

In a generator of this type, which follows somewhat the design of other Walker machines, smaller only by comparison with this one, weights and dimensions are the most interesting items. The approximate weight of this machine complete without engine shaft will be 300,000 lbs., and the armature alone will weigh 115,000 lbs. The engine shaft to support this mass of copper and iron is 37 ins. in diameter. The field magnet is 21 ft. 8 ins. in diameter and 25 ft. on the foundation supports. It has twenty-four poles.

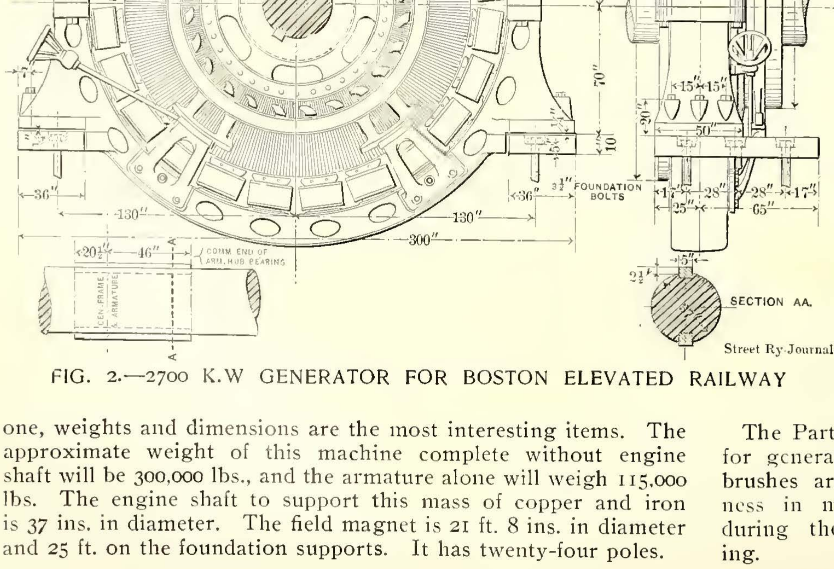


FIG. 2.—2700 K.W GENERATOR FOR BOSTON ELEVATED RAILWAY

In regard to the capacity of this generator, more popular measure would be that of h.p., which will be about 3600, and that means that the one dynamo will be able to drive 300 ordinary street cars at once at normal load. In the matter of size and weight, this will be the largest generator in the world. It is designed to run at the low speed of 75 r.p.m.

Walker Company has built a number of generators of 1600-k.w. capacity, among them one at Kansas City, one in New York and two at the Kent Avenue Station in Brooklyn. These latter are shown in the accompanying illustration. This station is one of the finest in the world, and contains in all six generators aggregating over 100,000 k.w.

A remarkable instance of efficiency is afforded by the station at Kansas City where one Walker 1600-k.w. generator furnishes power at a cost of .4867 cents per k.w. hour, including the cost of coal, attendance and supplies.

Self-Lubricating Brushes

The Partridge Carbon Company, of Sandusky, Ohio, is putting on the market a new brush for motors and generators, which is known as the Partridge "Perfection" carbon brush. This device has been designed to meet an increasing demand on the part of power station engineers for a carbon brush having a high conductivity and soft enough to reduce the wear on the commutator to the minimum. It is thought by the manufacturers that this new design will exactly fill the want.

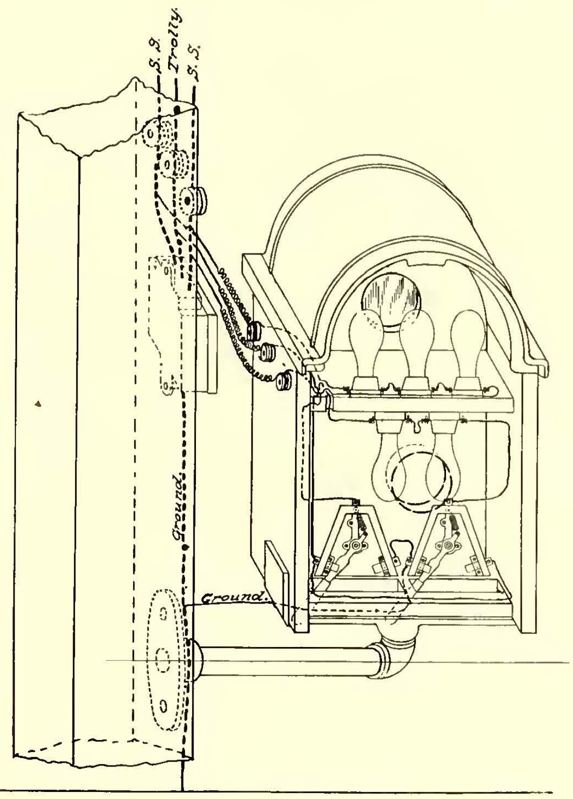
The "Perfection" brushes are somewhat higher in price than ordinary types, but it is claimed that the saving in wear of the commutators and the longer life of the brushes will more than balance the increased first cost.

The Partridge Carbon Company also makes a plumbago brush for generators, designed to carry a very heavy load. These brushes are giving entire satisfaction. This company's business in motor and generator brushes has been very good during the last year, and its trade is constantly increasing.

Signal System for Single Track Roads

The latest type of Ramsey signal box for single-track roads is shown herewith. This signal system, which is owned by Williamson & Company, of Allegheny, Pa., has been adopted by a large number of railway companies, who speak in highest terms of its value.

It is a regular block signal system, by which the crew of a car,



SECTION OF SIGNAL BOX

when it arrives at a turnout, are apprised of the fact as to whether there is another car on the track between it and the next turnout, and consequently whether it is safe for them to proceed. This prevents the delay of the entire system if one car should get behind the schedule time. On certain roads, where a telephone system is used, these boxes are employed in place of it for signaling, as they are considered more desirable.

The signal box, which is shown in section, has a partition horizontally through the middle, dividing it into two compartments. In one are placed three, and in the other two, incandescent lamps, the lamps of each set being visible from one direction only. In each box are two double pole switches, which make contact with a ground wire or with a branch of the trolley wire. The group of three lamps in one box is in series with a group of two lamps at the next, a No. 12 w.p. iron or copper wire being carried on poles to make this connection. It will be seen that when the lamps in a circuit are not burning, the two switches must both be either on the ground connection or both on the trolley connection. In either case the movement of one switch only is necessary to turn the current through the lamps. Five lamps are used in series to cut down the voltage, since the lamp current is taken from the trolley wire.

The operation of the system will then be readily understood. Conductor *A* goes to No. 1 turnout; here he finds no red light to stop him. When it is his leaving time he turns on the lower lights in the box that he leaves behind at No. 1 turnout, and this will, at the same time, light the lamps in the upper part of the box at No. 2 turnout. These lights at No. 2 turnout stop all cars coming toward him, and those at No. 1 stop all cars from following him.

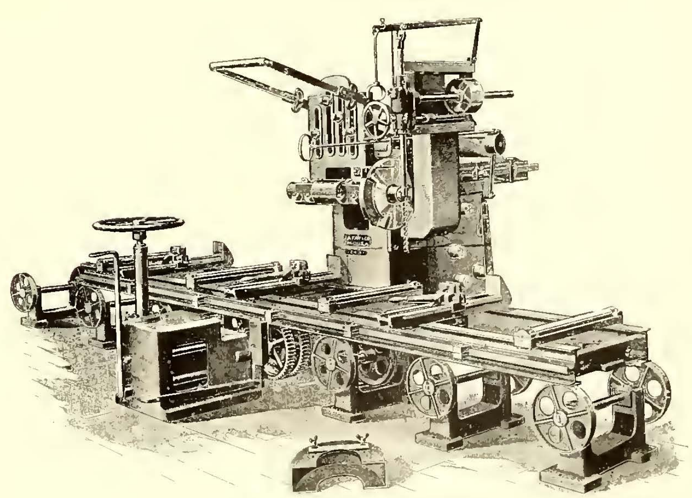
He proceeds then to No. 2 turnout; here he finds no car or red light to stop him. Being guided by the lamps in the lower partitions only, or those shining toward him, he puts out the light he came in on, and turns the light in the next turnout ahead, leaving one behind as before, and proceeds to No. 3 turnout. Here he finds a car to pass him, say *B*. *B* and *A* both leave the lights alone, *A* taking *B's* lights and going to the next turnout, and *B* taking *A's*, each knowing that he has a clear track in front of him. When *A* reaches No. 4 turnout he finds no light or no car to pass him; he puts out the lights that *B* made when he passed No. 4 turnout and lights the light in No. 5 turnout, leaving a light behind. *B* proceeds to No. 2 turnout and here he finds no car to pass and no light to stop him. He puts the lights out that *A* made when he passed there and lights the light in No. 1 turnout, leaving one behind him. This will clear up No. 4 and No. 3 block. This plan is followed throughout the day.

Extra cars can be taken off or put on the line, or disabled cars can be taken off the line at any time without interfering with the balance of the cars. The motorman runs altogether on his schedule time and on the signals. If his time is up and he has no signal to stop him, he makes one and leaves it behind him, and makes one at the next switch to stop any car from coming toward him and goes ahead to the next switch. When two cars meet at a turnout they merely pass and do not change the signals, since both are burning and properly protect the trains.

The system insures safety even when out of order in the following way: The conductor tries the signal and cannot make a light; when it is his leaving time he will proceed cautiously, ringing the bell going around curves and dangerous places, knowing that the car, if one should be coming toward him, has found the same difficulty; that is, if No. 1 cannot make a light in that block, No. 2 car coming toward him cannot make a light, as they are both connected together. This will make both careful and will not affect any other block on the line. Of course the trouble should be reported to the repair men as soon as possible, so that the system may be repaired.

Extra Large Automatic Car Gaining Machine

J. A. Fay & Company, of Cincinnati, Ohio, have designed a new automatic car gaining machine embodying a number of new features, which it is expected will commend themselves to all requiring a machine of this kind. Its capacity is for timber up to 16 ins. in thickness and 20 ins. in width. The machine is shown in the accompanying illustration. As will be noticed the gaining arbor or head is supported on a large and powerful automatic ram that is gibbed to the top of the column in planed ways. The countershaft is placed above it with a direct belt communication to the pulley on the gaining arbor by means of idlers, thus insuring a perfectly uniform tension of the belt in gaining at any position of the head across the face of the timber. The feeding mechanism is so arranged that gaining is done both upon the forward and backward stroke. The ram feeds forward and backward, automatically stopping at each end of stroke. It has three speed of feeds to suit narrow, deep and wide gaining.



CAR GAINING MACHINE

The timber carriage is made of steel beams to secure strength with lightness, has an automatic feed 100 ft. per minute, which is under the control of the operator through an upright lever in front. It is also provided with a hand feed for bringing the carriage to a determinate point for accurate adjustment. With this machine either a wire rope feed or a rack and pinion feed is furnished as desired. A vertical boring attachment or an independent vertical column boring machine is furnished, to be used in conjunction with the gaining machine when desired.

Preserving Wood Ties and Poles

One of the main difficulties which has stood in the way of the adoption of the more general processes of wood preservation for ties and poles has been the fact that the first step usually required the erection of elaborate and expensive plants, or where the amount of timber to be treated did not warrant this expense the added cost of transportation to and from esablished plants added very considerably to the cost, and in many cases caused annoying delays. There has consequently been a call for some means of preservation that can easily be applied at small expense. This is supplied by a compound made by the Fitch Chemical Company, of Bay City, Mich. It is shipped in 50-gal. barrels. A long wooden vat is built 10 ft. wide, 24 in. deep and 50, 100 or more ft. long, as the capacity of the railroad would require. In these wooden vats are coils of steam pipe laid on the bottom. The vat is filled with the liquid, triple chlorides, the ties put in and boiled until they become thoroughly saturated with the chemical, which preserves their life from twice to three times the natural duration. This liquid is a very penetrating chemical. The company now has tanks which have been holding this material for forty years, and the tanks have been exposed to the weather during this entire period. Two years ago the tanks were removed and put up again and found in a perfect state of preservation, which is positive proof of the preserving qualities of the chemical.

Prof. Roth, a prominent scientist, discusses some causes and remedies of timber decay, and gives the following range of durability in railroad ties: White oak and chestnut oak eight years; chestnut, eight years; black locust, ten years; cherry, black walnut, locust, seven years; elm, six to seven years; red and black oaks, four to five years; ash, beach, maple, four years; redwood, twelve years; cypress and red cedar, ten years; tamarack, seven to eight years; long leaf pine, six years; hemlock, four to six years; spruce, five years. It is claimed that the life of these woods can be increased several times their natural duration by impregnating them with the Fitch chemical, which prevents the fungus from feeding on the wood.

Combination Car in Providence

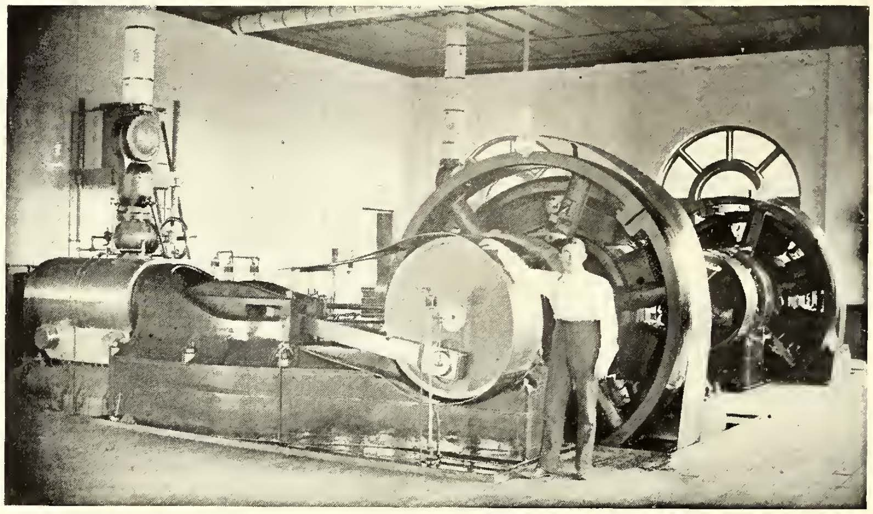
A rather novel combination car has recently been built for the Providence & Taunton Street Railway by the American Car Company, of St. Louis. This car is shown in the accompanying illustration. As will be seen the smoking compartment is located at the center of the car body occupying the space of three windows in length and extending into the aisle for a distance of 4 ft. 6 ins., a set of twin doors leading in to the compartment from the aisle. The seats in the smoking room are upholstered in "Pantasote" and are arranged around the walls. There are six plush upholstered Hale & Kilburn walkover seats on each side of the smoking room in the main part of the car body. The glass partitions forming the walls of the compartment admit of a clear view by the conductor from end to end of the car.

COMBINATION CAR IN PROVIDENCE

The car bodies are mounted on high speed trucks and are 36 ft over all, 26 ft. over corner posts, with platforms 4 ft. 6 ins. long at each end, enclosed with vestibules, having regulation folding doors on each side. The car is handsomely finished in mahogany, and all the windows are made of polished plate glass throughout.

New Station Near St. Louis

A general description was published in the last issue of the STREET RAILWAY JOURNAL on the system of the St. Louis, Belleville & Suburban Railway, extending from Belleville, a distance of fourteen miles, to East St. Louis. The road is a high speed line, the cars frequently making as high as sixty miles an hour.



INTERIOR OF NEW STATION NEAR ST. LOUIS

The accompanying engraving shows the interior of power station made from a photograph received too late for use in last issue. The engine equipment consists of two Russell four valves semi-Corliss engines of 500-h.p. each, running at a speed of 150 r.p.m., and built by Russell Engine Company, of Massilon, Ohio. Each engine is directly connected to a Walker generator capable of working up to 650 amps. each at 550 volts. The boilers are of the tubular type with seventy-two 4-in. flues, also furnished by Russell Engine Company.

Brake Shoes with Cork Inserts

The investigations of the committee on laboratory tests of brake shoes, of the Master Car Builders' Association, made within the last few years were the most thorough that have ever been conducted upon the subject. The committee's report gives the results of several tests made on cast-iron shoes with wooden plugs or inserts. These tests show that this type of brake shoe, which has already proven very popular in practical service, is very efficient and a great improvement over plain cast-iron shoes. In speaking of these shoes the committee says: "That a more uniform friction is given by this shoe than by any of the others, and it has the advantage of not giving the sudden rise in friction at the end of a stop." The report further states "that the friction is highest at the beginning of the stop, and does not increase as rapidly as the others at the end of the stop, and that excessive vibrations do not occur."

Composite, or "Compo" shoes are now made exclusively with plugs of cork instead of wood, this material having been found more desirable than wood in the high speed service of steam railroads where considerable heat is generated through the friction of the shoe on the tread of the wheel. The cork is of the best quality and is forced in place by a special machine. In making the shoe the corks used are originally somewhat larger than the sockets in the shoes, and being elastic they are held firmly in place.

The success of the "Compo" brake shoe in practice has been striking. It is employed as standard upon many of the larger street railways in this country, including nearly every one in New England. The widespread adoption of the shoe in that section of the country convinced the manufacturers that it would prove equally popular elsewhere if arrangements could be made for manufacturing the shoes at different distributing centers, and so reducing transportation charges. This has been done and the Composite Brake Shoe Company has been particularly fortunate in securing representative concerns for making the shoe in the South and West. The firms who are now making "Compo" shoes under patents belonging to the Composite Brake Shoe Company are the Sessions Foundry Company, of Bristol, Conn.; Barbour-Stockwell Company, of Cambridgeport, Mass.; East Buffalo Iron Works Company, of Buffalo, N. Y., and Wells & French Company, of Chicago, Ill. The company has appointed Hayes & Arthur, of Cleveland, Ohio, and J. C. Carry, of Chicago, Ill., sales agents.

It would be incomplete in reviewing the work of the Composite Brake Shoe Company to omit reference to the pioneer experiments of its well-known president, W. W. Whitcomb, whose name is so closely associated with this shoe. He was its originator, and to his far-seeing confidence in the principles upon which it is based, is due largely the success which has followed it.

Reorganization in Pueblo, Col.

A complete reorganization of the street railway and electric light companies of Pueblo, Col., has been effected. A new company has been organized which has purchased the property of and consolidated into one company the Pueblo Electric Street Railway Company, the Pueblo Electric Light & Power Company, the Pueblo Light, Heat & Power Company, and the Pueblo Gas & Electric Light Company, the owners of the stock of the different companies taking bonds and stock in the new company. All the different properties will be operated hereafter from one large power station, and there has been added to the equipment three McIntosh & Seymour compound condensing engines, of which two are 800 h.p. and one 600 h.p. The generators are General Electric direct connected, there being two 225-k.w. generators for street railway work and one 250-k.w. monocycle generator for incandescent lighting. There will also be one 125-light Brush arc machine, two 80-light Wood arc machines, four 500 T. H. arc light machines and two 75-k.w. Wood alternators.

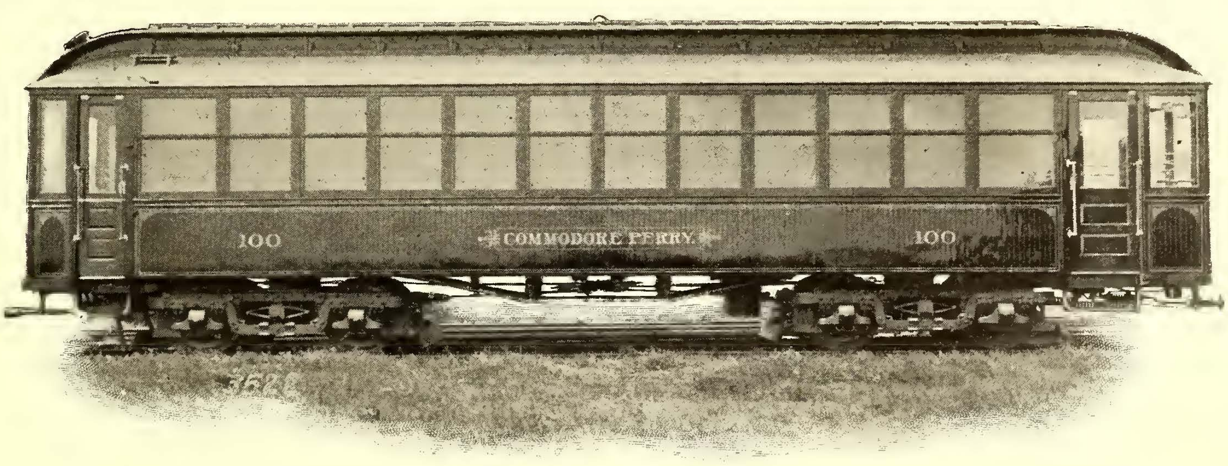
The entire equipment of the street railway company is being rebuilt and over $100,000 will be spent in making the plant one of the finest in the country. The officers of the new company are M. D. Thatcher, president; J. F. Vail, general manager, and E. B. Brown, chief electrician.

Combination Open and Closed Car

The necessity of keeping a separate style of car for summer and winter use requires the storage of half the equipment all of ning open cars in summer and the obligation to use closed cars ning open cars in summer and the necessity of using closed cars in winter on most of the roads in this country has compelled them to follow this plan. The advantages of a really good combination car are great, and by a really good car is understood one that can be easily changed from an open to a closed car without too much expenditure of time and labor, and also one in which there are not many adjustable parts or joints to become loose. A car which, it is claimed, combines these valuable points is illustrated on this page. It was built by the Pullman Car Company for the Toledo, Bowling Green & Fremont Railroad, of Toledo, Ohio, under he George F. Brown patents. The car has a body length of 32 ft. 6 ins., and measures 43 ft. over all. It is finished in solid cherry throughout, with quarter sawed oak head lining, nicely decorated. There are twelve seats on a side, spaced 2 ft. 6 ins:, with an aisle 20 ins. in width. The seats are of the "walkover" type without arms on the aisle seat, and are covered with rattan. The engravings give respectively the appearance of the car open and closed.

COMBINATION CAR, OPEN

As will be seen, the water table or sill is quite low, and about the height of the seat arm. Another noticeable feature is the fact that the windows are quite large and made in two parts. This permits both sash to be dropped between the inner and the outer lining of the car. This leaves a much larger opening than could be given by making the sash in one part or by making the upper sash stationary. The pocket for receiving the sash is arranged so that the latter do not touch each other when lowered, so that there is no rattling or disagreeable noise from them when the car is used as an open car. Another attractive feature is that when the sash are in the pocket the opening or top of the pocket is perfectly closed so that there is no indication of the pocket, a perfectly smooth surface being represented for an arm-rest; this overcomes the objection of storing the sash away in summer where they are liable to be warped or otherwise damaged, and where it is difficult to reapply them when required. But located as they are in the car they can be readily gotten at and the car can be quickly changed from an open to a closed one. This is particularly desirable in case a heavy storm should come up sud-

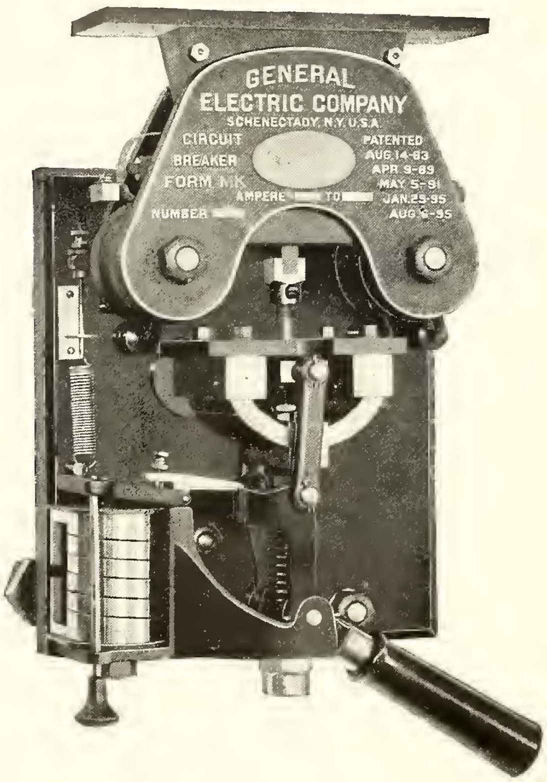


COMBINATION CAR, CLOSED

denly, or when in the early spring or late fall the car is to be used as a closed car a portion of the day and an open car during the balance, if the weather is agreeable.

Magnetic Blow-Out Automatic Circuit Breakers for 500 Volt Direct Current Circuits

The inherent tendency of all circuit breaking devices to draw an arc at the last point of contact introduces a serious problem in the design of all switches and cut-out appliances. The roughening effect of the arc on the contacts destroys in a short time the usefulness of the apparatus, and as the voltage and current increases the difficulty is rapidly magnified. The only commercially practicable way of breaking direct current circuits at 400 volts and above has been ascertained by exhaustive experiment to be by the use of a magnetic field, which destroys the arc at the instant of its formation, and promptly and positively opens the circuit and prevents injury to the contacts. The advantages of the use of the magnetic blow-out wherever a direct current electric circuit is to be opened are familiar to all users of electrical apparatus. By adding to a switch equipped with a blow-out magnet, a tripping device to open the circuit at a predetermined current, an automatic circuit breaker is obtained which, for convenience and reliability, may be said to surpass any other form of cut-out.



MK CIRCUIT BREAKER

The General Electric Company manufactures four different forms of magnetic blow-out automatic circuit breakers for different classes of service. Each is rated by two numbers, the first indicating the lowest current that will automatically open the circuit, and the second number the maximum normal current carrying capacity, except in the case of the form MM circuit breaker, when the second number indicates the maximum capacity on the basis of intermittent service common in railway work. The tripping point is adjustable to any desired current, from the lowest rating to 50 per cent in excess of the maximum capacity, by adjusting the calibrating spring of the tripping armature.

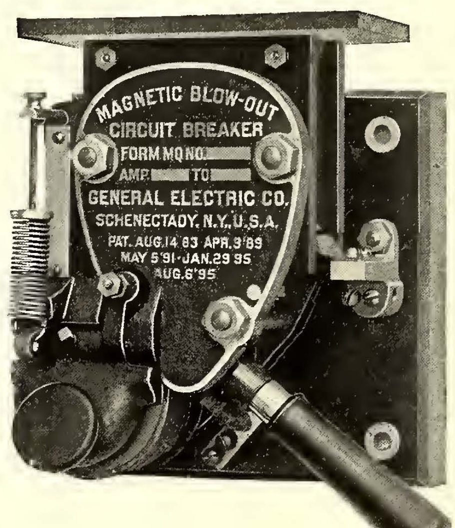
The four different forms in which these circuit breakers are made have certain radically different features which adapt them to the special classes of service for which they are designed. All of them may, however, be used on any direct current circuit, and, with reasonable care and attention, will operate satisfactorily under the most severe conditions. Indeed, every case of injury to the circuit breaker may be traced to improper adjustment or neglect of some simple precaution.

In the designation of the different forms of General Electric circuit breakers, the first letter represents the general principle of operation; the second letter is arbitrary, or denotes some features of construction. For example, the first letter in the form designation of all magnetic blow-out circuit breakers is M; the second letter is arbitrary. The circuit breakers, formerly known as K, L, Q and M, are now known as MK, ML, MQ and MM, respectively.

The form MK circuit breakers are made for 150 to 8000 amps., and are especially intended for severe service, such as on generator and feeder panels, where the circuit is subject to repeated and violent overloads. This circuit breaker can be recommended for the most severe conditions met in any class of service. The parts are extra heavy, in order to withstand constant and rough use. Destructive arcing is prevented by the use of supplementary contacts placed in a strong magnetic field, and arranged to break the circuit a moment after the main contact. The transfer of the arc from the main to the supplementary contacts and the immediate extinguishing action of the magnet has made possible the construction of effective circuit breakers for 8000 amps. capacity. The main contact, which is built up of leaf spring, bears upon the main contact blocks when the breaker is closed. The coil of the blow-out magnet and the secondary or plug contacts are in multiple with the main contact. Owing to the comparatively high resistance of the secondary contacts practically no current passes through them until the main contact opens, the whole current then passes through the magnet coils, and the strong magnetic field extinguishes the arc as soon as it is formed on the plug contact. The plug is not withdrawn until after the leaf contacts have left the contact blocks.

The plug, or secondary contacts, and the inside of the boxes enclosing them, should be frequently examined, and any accumulation of carbonized material removed. If the secondary contacts are not kept in good condition and properly adjusted the current will be broken on the main contacts and injury to the circuit breaker will result. A little vaseline on the secondary contacts tends to keep them smooth and increases their life. All parts of the circuit breaker should be kept clean.

All sizes of MK circuit breakers are furnished for back connection, up to and including 800-1200 amps. capacity; they can also be furnished for front connection. Circuit breakers up to 1200-2000 amps. capacity are made when desired, with an automatic locking device operated by a handle. When the circuit breaker is open it can be locked open by removing the handle. As the circuit breaker cannot be closed without the handle, removal of the handle prevents accidental or unauthorized closing of the contact. When the circuit breaker is closed the handle cannot be removed. The automatic locking device is especially valuable in street railway service, as it permits circuit breakers to be left open without danger of accidental closing. All the circuit breakers in a station may be thus placed under the exclusive control of a single operator.



MQ CIRCUIT BREAKER

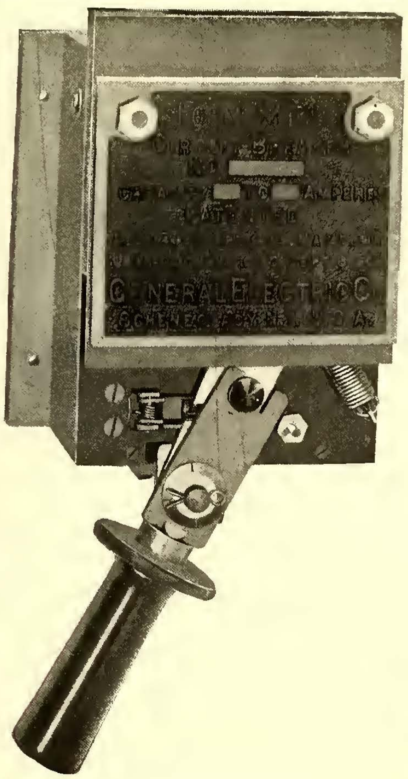
For power circuits and classes of work where the conditions are less severe than in regular railway service the General Electric Company manufactures the form ML circuit breaker for 100 to 800 amps. Its principle of action is the same as that of the form MK, but the moving parts are somewhat lighter, and differ slightly in general form. The form ML circuit breaker is made for both front and back connections, and in two capacities; 100-500 amps. for front or back connection, and 200-800 amps. for back connection only.

As in the case of the form MK, the main contacts of the form

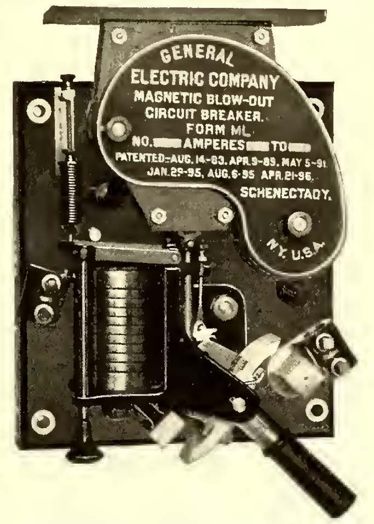
ML are laminated and connected in multiple with a secondary plug with a contact, upon which the arc is broken. The automatic locking handle is supplied on this circuit breaker.

The form of MQ circuit breaker is made from 15 up to 100-175 amps. only, and is designed especially for protecting power circuits and stationary motors. In general appearance it is somewhat similar to form ML, but it has no secondary contact. The current is broken on a segmental contact similar to the contacts used in railway controllers. This form of contact has been found amply sufficient for the maximum capacity of this circuit breaker. There is but one coil for both the tripping magnet and the magnetic blow-out. The magnetic circuit is so arranged that the arc is ruptured in its field. The positive and instant action of form MQ circuit breakers affords greater protection to electric motors than fuses, or any other form of cut-out.

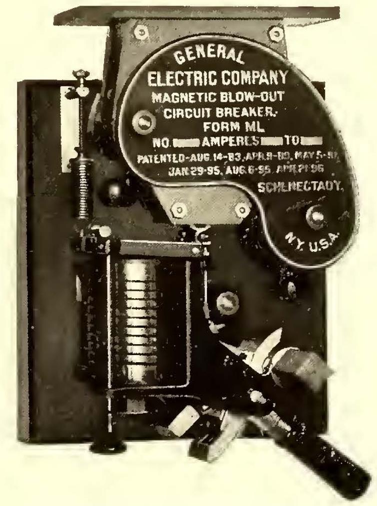
The form MM circuit breaker, for 15 to 150 amps., is designed especially for street car work, and consequently its rating is based



MM CIRCUIT BREAKER



ML BREAKER, FRONT CONNECTED



ML BREAKER, BACK CONNECTED

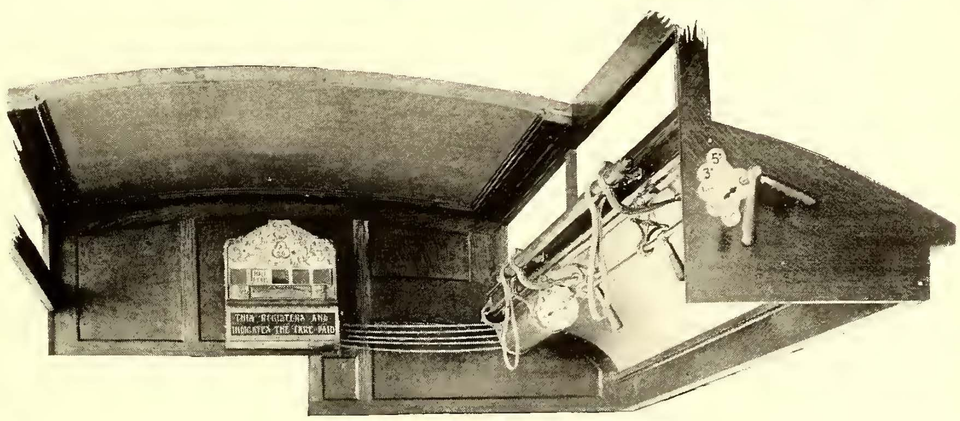
on the intermittent currents usual in railway service. It should not be used where it will have to carry its maximum rated capacity continuously. The form MM circuit breaker is intended to supersede both the old hood switch and the fuse box. The fuse box, which has heretofore been the only protective device available for motor and other car equipment appliances, has usually been placed in a more or less inaccessible position beneath the car. The blowing of fuses resulted in annoying and troublesome delays, and the form MM circuit breaker was at once received with favor, as it affords perfect protection to the apparatus and can be instantly reset. It resembles a main motor switch in appearance, and answers the purpose of a switch in every way, being intended for location in the same position under the hood of the car platform. It can be set to open at any current within certain ranges, and can be closed and opened by hand, exactly like the old main motor switch.

Extensive Electrical Construction in Germany

The Allgemeine Electricitäts Gesellschaft, of Berlin, Germany, has made an excellent record during the past year. According to a statement issued by the company on July 30, 1898, it had built during the year, or had started construction work upon, fourteen electric railways with the overhead system in Germany, five in Spain, three in Italy and one each in Argentine, Chile, and Russia. These roads have a total length of about 450 km., and a rolling stock of 750 motor cars. For the coming year the company has already received contracts for the construction of sixteen German railways and a number of railways in Spain, Italy, Belgium and Holland.

New System of Recording Fares

John F. Ohmer, of Dayton, Ohio, has recently devised and is introducing a new system of registering fares which is designed to greatly reduce the labors of conductors in making their daily reports on roads where more than one rate of fare is charged, and also to make it feasible to register on one machine different rates of fares. The principal feature in this invention is the provision for keeping a separate record of the total number of each rate of fares collected, whether tickets, transfers or three-cent, five-cent ten-cent, or any other cash denomination. The register employed also gives the total of all fares combined and the record of each conductor for each trip. In addition to indicating these



NEW FARE REGISTER

records the register automatically prints them on a slip at the end of each trip.

The use of this device does away with the necessity of the conductor making any written report whatever. He simply turns in all the cash fares, transfers or tickets which he collects on a trip, and the register gives the necessary classified record on a printed sheet.

The register is shown in the accompanying illustration. The totalizing wheels are not exposed, and only those with authority can take away the printed statement. If more or less fares of any denomination are returned by the conductor than the number registered by him the printed slip will immediately disclose the error.

As will be seen from the illustration, the register is so arranged that the denomination of the fare rung up is plainly indicated in the car and also at the front and back platforms. This enables the passenger, wherever he may be, to observe whether or not the conductor registers the proper fare. The denomination of the last fare collected remains exposed to view until another fare is rung up. The register is made in sizes to indicate any number of denomination of fares from three up to eighteen.

This system, in addition to relieving the conductor of considerable work, also greatly simplifies the bookkeeping at the head office, as the printed statements are easily handled and the records transferred to the proper books.

The Status of the Air Brake

There has been a decided tendency in electric railway construction during the past year toward heavier and longer cars and higher speeds. This has been observed, not only on suburban and interurban lines, but even in cities where the larger carrying capacity of the long cars produces a distinct economy. Under these conditions there has been a greater demand for power brakes, and it is not surprising to find that the air brake companies have been working full time, and report many orders on their books. The advantage of the air brake for heavy, high speed cars does not consist only in the force with which the brake shoes can be pressed against the wheels or the quickness with which it can be applied. The moral advantage, even greater, perhaps, than those mentioned, is the confidence with which it inspires the motorman. With a brake of this character, with which he is perfectly familiar, and in which he possesses absolute confidence, he is much more likely to remain cool and collected in any emergency.

During the year the Christensen Engineering Company, of Milwaukee, has equipped with its apparatus several hundred cars, ranging in capacity from those designed for the heaviest elevated and steam railroad service to that of ordinary city traffic. It is a noticeable fact that the majority of these orders have been placed by companies who have first employed a few equipments, which have been given a thorough test. This indicates that the skepticism, which was at one time more general, on the value of air brakes, is gradually disappearing.

Various modifications and improvements have been made by the Christensen Company in the details of its air brake equipment during the past year. These have been notably in the introduction of a double spiral gear and pinion to form the drive between the motor and compressor, and in a small change in the air pump valves, which, with the gearing mentioned above, produces a practically noiseless machine. A change has also been made in the method of lubrication and in the arrangement of piston packings and cylinders, which have increased the efficiency of the compressors fully 15 per cent.

Fig. 1 shows the type of compressor used at present. As will be seen, it is all boxed in to protect it from dirt and moisture, and is bolted to the lower part of the car body. For the No. 1 compressor this box is about 21 ins. cube, and with the motor compressor and forgings complete weighs about 400 lbs. This apparatus is suitable for one double truck motor car and one double truck trailer of the size used in ordinary suburban service, but is especially designed for single, heavy, high speed cars, and has proven eminently satisfactory. As will be seen, the box is fitted with doors to provide ready access to air valves, commutator and brushes. The experience of the company has been that the location of the compressor under the car is better than on the platform, where it is more or less in the way, except where there is a separate vestibule for the motorman.

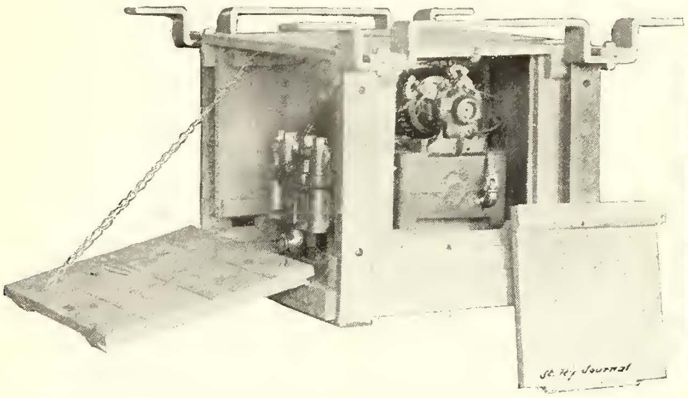


FIG. 1.—MOTOR COMPRESSOR WITH CASE OPEN

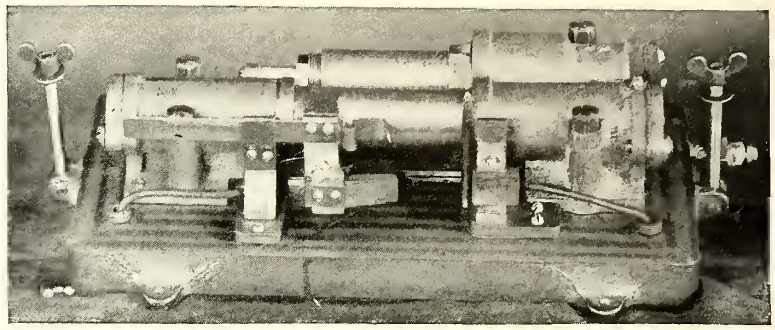


FIG. 2.—AUTOMATIC CONTROLLER

Fig. 2 shows the automatic switch controller, by which the variation in the air pressure in the reservoir starts and stops the compressor. Recent improvements have been made in the details of this apparatus, by which its efficiency and reliability have been increased. As now built, it consists of practically only two moving parts, and it is fitted with carbon breaks and powerful air blasts for extinguishing the arc.

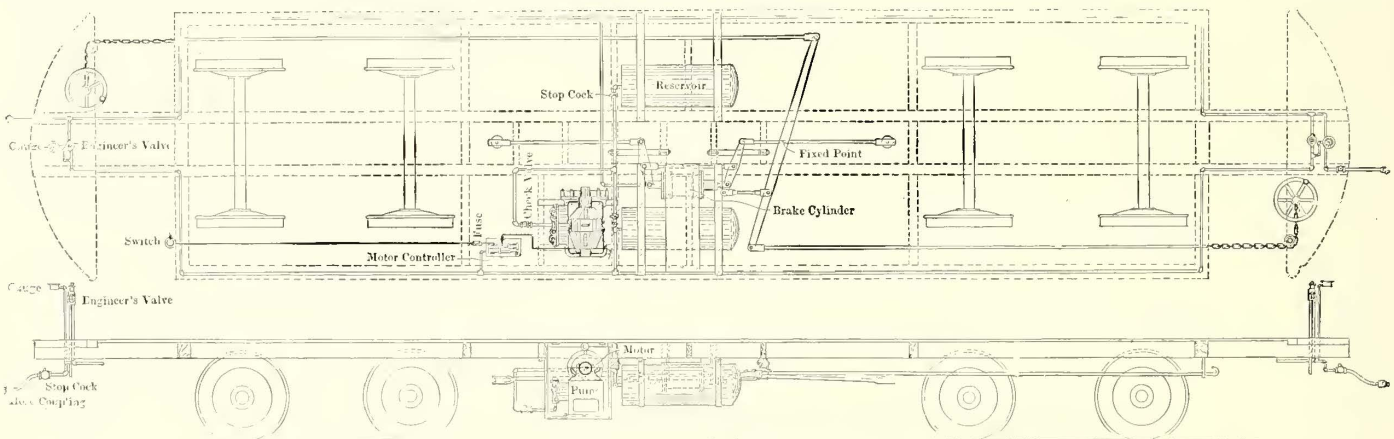


FIG. 3.—DIAGRAM OF EQUIPMENT FOR MOTOR CARS

FIG. 5.—CAR IN TAUNTON EQUIPPED WITH AIR BRAKES

Fig. 3 shows the arrangement and connection of the apparatus for a motor car with compressor arranged beneath the car floor. Fig. 4 shows a notable installation made by the company during the past year in Brooklyn, in a train on the Brooklyn Elevated Railroad, on which the independent motor compressor apparatus was used. The motor car complete without passengers weighs over thirty tons. Another example of a high speed railway for heavy traffic equipped by the Christensen air brakes is the New Canaan Division of the New York, New Haven & Hartford Railroad, all of the cars of which are employing independent motor compressor apparatus. A description of this system is given by Col. N. H. Heft on page 540 of this issue. Fig. 5 shows a type of road using smaller cars equipped with Christensen air brakes. This is the Taunton & Brockton Railway, and the air brake order for these cars was given to the Christensen Engineering Company after a test of a large variety of brakes extending over a considerable time. The two latter illustrations are intended particularly to show the variety of service for which this apparatus is applicable, covering the heaviest, as well as the lightest.

FIG. 4.—BROOKLYN ELEVATED RAILWAY TRAIN EQUIPPED WITH AIR BRAKES

"S" Brake Shoes

The proper shape and material for making brake shoes for street railway cars has been a subject of discussion among engineers for some time, but particularly since the advent of the electric motor. When horses were used the problem was not of such vital importance, but with the heavier electric cars, greatly increased traffic and higher speeds, the question of stopping a car becomes almost as important as the question of the best method of running it. As the manufacturer of a well-known type of brake shoe has recently put it: "In those days the main use of the brake was to keep the car from running over the motive power (mule), and an emergency stop was accomplished by turning the motive power sideways and running into it."

The supreme test of a brake mechanism is the emergency application. The brakes must go on with all possible speed, and the shoes must hold with the greatest efficiency, in order that the train be brought quickly to a stand-still. The emergency application is only called forth when danger threatens and the train must stop, when every effort must be put forth *to stop*, and that system of brakes which will bring the train to a stand-still in the shortest space of time is the most successful and efficient.

Service stops do not indicate the true efficiency of the brake mechanism. These stops are made with ample warning, the amount of pressure applied being dependent upon the rapidity with which the stops are desired, and consequently the full effort of the brake mechanism is not brought into play. Under such conditions an inferior brake mechanism may show practically equal results to the superior one. It is only when trouble comes, when the difference of a few feet means life or death, the real merits of the device are brought into sight.

The brake shoe is the end of the brake system. It is as important in its place as the power that moves the brake at the other end. The brake shoe is the medium through which the power, the air from the main reservoir or muscular exertion at the end of the brake handle, reaches the wheel and controls the speed of the train, and as the brake shoe is good or bad, so the control of the car is complete or incomplete.

A brake shoe to be theoretically good should retain the beneficial features of the plain cast-iron shoe and at the same time should possess the durability and toughness of steel. One of the recent types of brake shoes for which these advantages are claimed is the "Diamond S." This shoe consists of a body of cast iron, of unchilled but dense and strong metal, cast about a bundle composed of strips of expanded sheet steel. Each strand of the insertion is completely surrounded by cast iron, the whole forming a homogeneous and symmetrical mass. The iron is intimately bound up by the steel strands, which extend throughout the length of the shoe, and as the face of the shoe wears down in contact with the wheel, the strands of steel appear and disappear, always preventing the rapid disintegration of the cast iron but never presenting a continuous steel contact with the wheel. The angle at which the insertions are placed with regard to the face of the shoe is such that as the shoe wears down the steel moves its point of contact across the face of the shoe, and as each layer wears out it is succeeded by the next at a different spot in the face of the shoe.

These expanded steel inserts produced from thin sheets of mild steel, when intimately bound up by the cast iron, give to the shoe the feature of toughness which prevents rapid disintegration, and by the simple combination of plain cast iron with bundles of strips of expanded metal, is produced a brake shoe which, it is claimed, will wear from four to five times as long as a plain cast-iron shoe, at the same time giving equal or superior friction.

A series of tests were made of the "Diamond S" shoe on the brake shoe testing machine, of the Master Car Builders' Association at the works of the Westinghouse Air Brake Company at Wilmerding, Pa. These tests were conducted by the mechanical engineer of the company, who made the tests for the Master Car Builders' Committee (whose report appears in the 1896 proceedings), and in the same manner, plain cast iron being the basis of comparison. It was found that the introduction of the expanded sheet steel into a body of cast iron produced a brake shoe which generated over 15 per cent greater friction, resulting in a corresponding decrease in the distance necessary to stop a car under precisely similar conditions as when shoes of plain cast iron were used. More than this, the test clearly demonstrated that the new type of brake shoe took hold of the wheel with greater force at the instant of application and continued to retard the wheel with superior friction until near the end of the stop, when the friction became practically the same as that of the plain cast-iron shoe, which rose rapidly at the end of the stop. This clearly proves that the new type of brake shoe, while retarding the wheel with greater force when speed is highest and when retardation is most needed, will not grip the wheel with any more force at the end of the stop, where sliding is liable to occur, than plain cast-iron shoes, and this fact is one of considerable importance and well worth the careful consideration of all who are interested in the subject of brake shoes, because, of course, the brake shoe should not slide the wheel.

The name "Diamond S" has been adopted for the new brake shoe on account of the diamond-shaped appearance of the sheet of expanded metal as it comes out on the face of the shoe. The patents are owned by the American Brake Shoe Company, of Chicago, and the "Diamond S" shoes are made by responsible companies which have been long engaged in the manufacture of brake shoes.

The Price Friction Brake

The advantage of utilizing the power stored in the moving car to operate the brakes when the car is to be stopped is important, and it is, of course, theoretically much more desirable to do this than to generate additional power for this purpose. For this reason friction brakes have always possessed an attraction for railway managers. Realizing this, Mr. Peckham, of the Peckham Motor Truck & Wheel Company, has decided to complete his truck system by the addition of a practical friction brake, and for this purpose has secured the exclusive rights for the manufacture and sale of the Price momentum brake. This brake is employed on the Chicago City Railway, where some hundred are in use, and are giving excellent results. It is also in use on several other electric railways, among which is the Brooklyn Heights Railroad.

The regular brake rigging is employed, but instead of leading the brake chain to the brake staff, the end is attached to a drum sleeved on one of the axles, as shown in Fig. 1. This drum is not keyed to the axle, and does not turn with it except when a stop is to be made. By a series of levers the edge of the drum, which is in the form of a disc, is then pressed against a corresponding disc on the inside of the car wheel. Between the two discs is a leather washer to take up the wear. The friction caused by pressing the drum against the car wheel causes the former to revolve, winding up the chain and setting the brake. The details of the brake are carefully worked out, and include its thorough lubrication, with provision for keeping the oil away from the leather washer, etc.

The application to a single truck car is illustrated in Fig. 1, and as arranged for a double truck car, in Fig. 2. The brakes on trail cars can also be applied from the motor car, and simultaneously with those on the motor car, by this system.

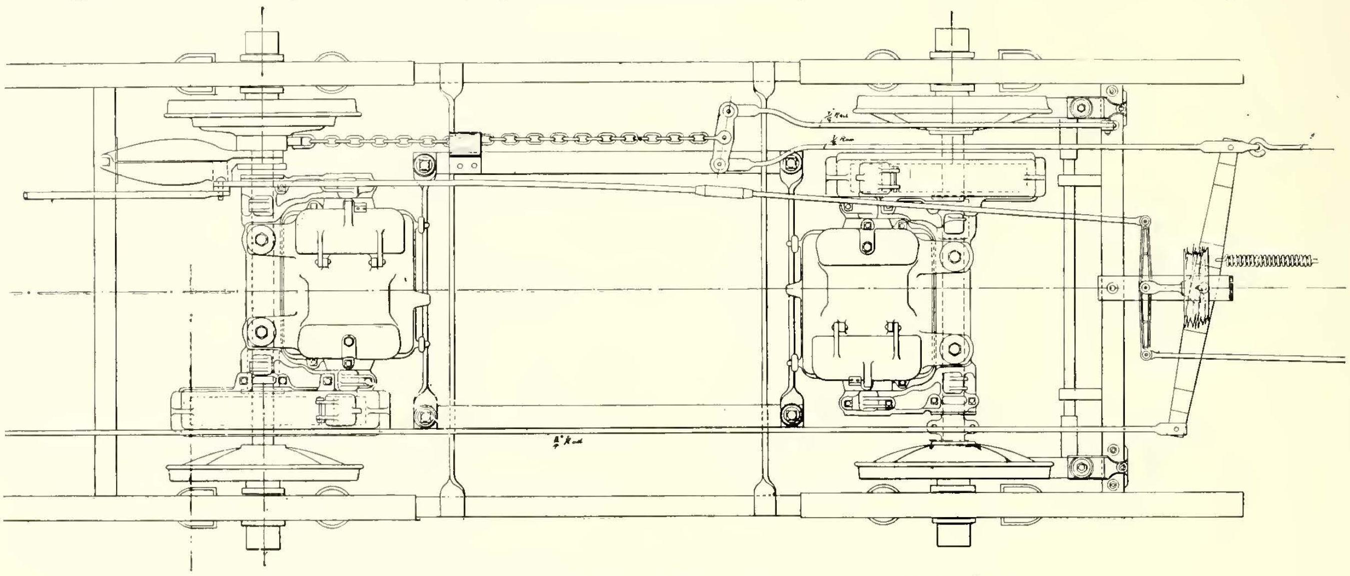


FIG. 1.—FRICTION BRAKE APPLIED TO SINGLE TRUCK CAR

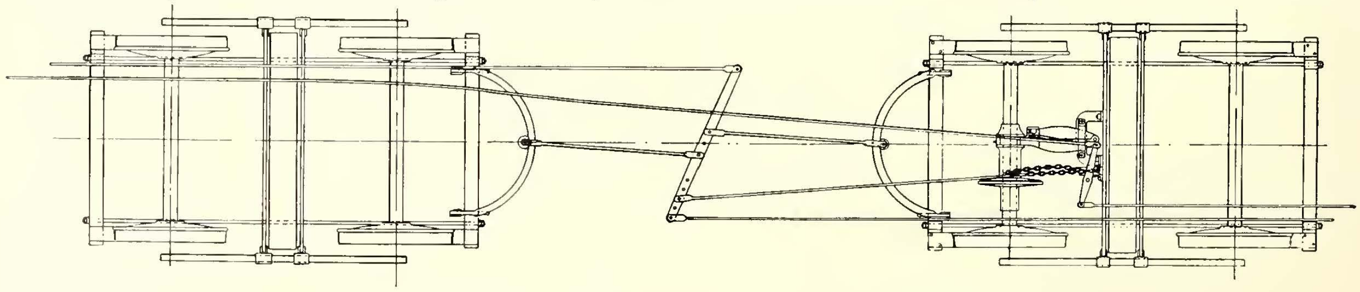


FIG. 2.—FRICTION BRAKE APPLIED TO DOUBLE TRUCK CAR

Late Forms of Overhead Appliances

The design of electric railway line material has now become almost crystallized into conventional forms upon which improvement can only be called for by new conditions of street railway operation and conditions hitherto unforeseen. In the design of the line material manufactured by the General Electric Company this conventionality of form is peculiarly noticeable, but it is a conventionality which long experience and unparalleled facilities for appreciating the requirements of the most economical street railway operation has shown to be a type upon which street railway managers can place full reliance for perfect service. The strains and wear on each device in service have been carefully studied, and every feature incorporated, even in the smallest device, has been determined with the object of producing apparatus, as durable as the most economic service can demand.

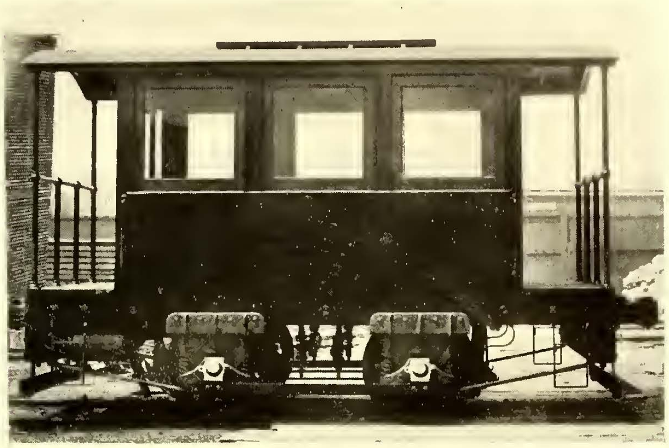
In the frogs and crossings the straight under run is retained under all strains up to the actual strength of the trolley wire. Thus no permanent set in the casting or bending down in the middle is possible, and the run of the trolley wheel is not obstructed. In the form *F* the tongues have lips which fold over the wire; in the form *G* mechanical clamps are used and no solder is necessary. In all other respects the designs are similar. The right angle crossing is a single casting with a small compression member dropped into place after the trolley wires and secured with a cotter pin.

The form *L* insulated crossing does not require the cutting of either trolley wire in placing it in position. It is fitted with the form *G* clamp and requires no solder. The insulation is of selected wood, the replaceable runways are of white fibre, and are made shorter than in previous types, giving the device a more compact form and lighter weight. The form *L* section insulator is, similarly, built more compact than the previous forms. The use of wood for these devices provides an ideal insulation without unduly increasing the size of the castings, which, were moulded insulation used, would be of great weight and cumbersome design.

In the suspensions the forms *D* and *G* are both retained as standard. The ears have, however, been improved, in that the hub is made to fit equally well all G. E. suspensions; thus in ordering ears it will no longer be necessary to specify the type of suspension with which they are to be used. The form *G* clamping ear is, perhaps, the simplest on the market, consisting of two light but strong pieces, with jaws which grip the trolley wire, and are held together by the stout screws. No change has been made in the turn-buckles, strain insulators or splicing sleeves, the present forms having proved satisfactory in every respect.

Electric Locomotive for Switching

The accompanying illustration shows a heavy electric locomotive built for switching purposes. It is one of two recently built by the McGuire Manufacturing Company, of Chicago, for the General Electric Company, one to be used by the New York Sugar Refining Company, in New York City, the other, by the Hoboken Railroad, Warehouse & Steamship Connecting Company, of Hoboken, N. J.

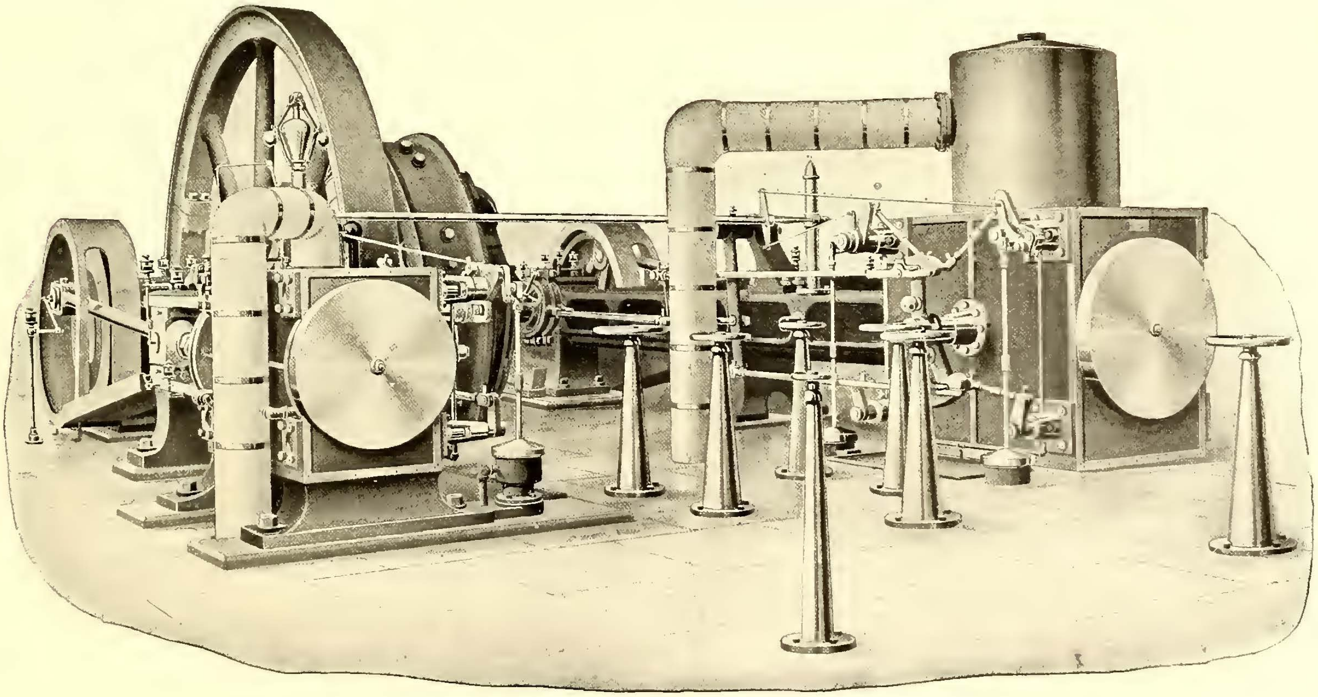


ELECTRIC SWITCHING LOCOMOTIVE

The locomotive will be equipped with two G. E. 51 motors, and has a total weight of 28,000 lbs. The wheels will be 36 ins. in diameter, with M. C. B. specifications, and the wheel base is 5 ft. 6 ins. The car will be equipped with Westinghouse air brakes, a 5-in. air whistle, for which special reservoirs are carried, a regular locomotive bell, etc.

Large Engine in San Antonio, Texas

The San Antonio Street Railway Company, of San Antonio, Tex., has recently installed at its power house one cross-compound condensing Corliss engine, directly connected to a 425-k.w. railway generator. This engine was built by the Murray Iron Works Company, of Burlington, Ia. The cylinders measure 20 ins. and 36 ins. in diameter, and the stroke is 48 ins. The cylinders are mounted on the box girder frame of the Murray Iron Works, and the engine is fitted with a 17-in. shaft and 16-ft. fly wheel. The engine is fitted with double eccentrics, and runs at 80 r.p.m. It is so piped that either or both cylinders can be run simple, condensing or non-condensing.



CROSS COMPOUND ENGINE IN SAN ANTONIO, TEX.

A New Principle in Brake Shoes

In the early history of railroading, the main work demanded of a brake shoe was to stop the wheels from turning in the shortest possible time, and very little attention was given at first to the wear of either wheels or brake shoes from friction. It soon became evident, however, that the wear on the tire of the wheel was very expensive, and it became necessary to make the brake shoe of a softer metal in order to transfer the wear from the wheel to the shoe, and to produce that degree of friction necessary to stop the train at short distances without skidding the wheels and causing undue oscillation of the cars.

In considering the action of a brake shoe against the wheel, it is, of course, true that skidding takes place when the pressure of the shoe against the wheel produces a greater coefficient of friction than that produced between the wheel and the rail upon which it is rolling. The ideal surface for a brake shoe is one which will act upon the wheel to its full retarding limit without reaching the skidding point, as in this way the maximum braking effort can be produced and the quickest stop made without causing flat wheels. After years of experimenting, a shoe has been produced by the Allen & Morrison Brake Shoe & Manufacturing Company, of Chicago, which, it is claimed, embodies in its construction the necessary features for giving the maximum braking effort without skidding, and one which is almost absolutely noiseless in its action.

The surface of this shoe which bears against the tire of the wheel is a mineral cement and commutated iron placed in and formed into a frame of iron under high hydraulic pressure with chilled inserts to regulate the braking power. In practical service some of these shoes have run over 22,000 miles with nearly one-half the wear on the tire of the wheel occasioned by soft iron shoes.

The Allen & Morrison shoes are now running on the South Side Elevated Railroad, of Chicago, and the trains are stopped practically without noise, there being none of the screeching often heard where ordinary brake shoes are used. The Lake Street Elevated Railroad, of Chicago; the Kansas City Railroad, of Kansas City, and many other roads are using these shoes, and they have proven in practice that they entirely fulfil the claims of the inventor. It is the testimony of the roads that have bought these appliances that their use reacts economically on the wear and tear of the rolling stock, and a better and more satisfactory service is obtained than with any shoe which has been placed before the public. To substantiate the claim that flat wheels cannot be made when using the Allen & Morrison brake shoe, it is stated that the South Side Elevated Railroad, with its numerous stops and heavy high-speed trains, has not had a flat wheel since the adoption of this shoe on its system.

Hollow Forged Shafts of Fluid Compressed Steel

The hollow-forged engine shafts of fluid compressed steel made by The Bethlehem Iron Company have become very popular among station designers, particularly for use with large units. Among the forgings recently produced at the plant of the company at South Bethlehem, Pa., is that shown in the engraving herewith, which represents six similar shafts furnished to the Edward P. Allis Company, Milwaukee, Wis., for the 7500-h.p. engines to be installed at the Ninety-sixth Street power station of the Metropolitan Street Railway Company, New York City.

The material used was fluid compressed, open hearth steel, and the shafts were forged hollow on a mandrel. They are of the following dimensions: elastic limit, 35,000 lbs. per sq. in.; elongation, 25 per cent; diameter of fly-wheel fit, 37 ins.; diameter of journals, 34 ins.; diameter of crank-web fit, 30 ins.; diameter of axial hole, 16 ins.; length over all, 27 ft. 4 ins.; weight, estimated, 70,000 lbs.

ENGINE SHAFT FORGED FROM FLUID COMPRESSED STEEL

The makers have in hand also a shaft of extraordinary quality for the Boston Elevated Railway. This remarkable forging is to be made of the highest grade of fluid compressed nickel steel, annealed and oil-tempered, the specification being the most comprehensive ever drawn for stationary-engine work. This and the shaft shown in the cut are the largest engine shafts ever made.

The dimensions of this shaft are: elastic limit, 50,000 lbs. per sq. in.; elongation, 18 per cent in test pieces 1-in. diameter and 10 ins. long; diameter of fly-wheel fit, 37 ins.; diameter of journals, 34 ins.; diameter of crank-web fit, 32 ins.; diameter of axial hole, 17½ ins.; length over all, 27 ft. 10 ins.; weight, 63,000 lbs. (estimated).

The shaft is for an 8000-h.p. engine, built by the Corliss Steam Engine Company, and will be finished complete with crank-disc and fly-wheel hub forced on and will be delivered at the power station in Boston on a car of 130,000 lbs. capacity, made especially for the Bethlehem works.

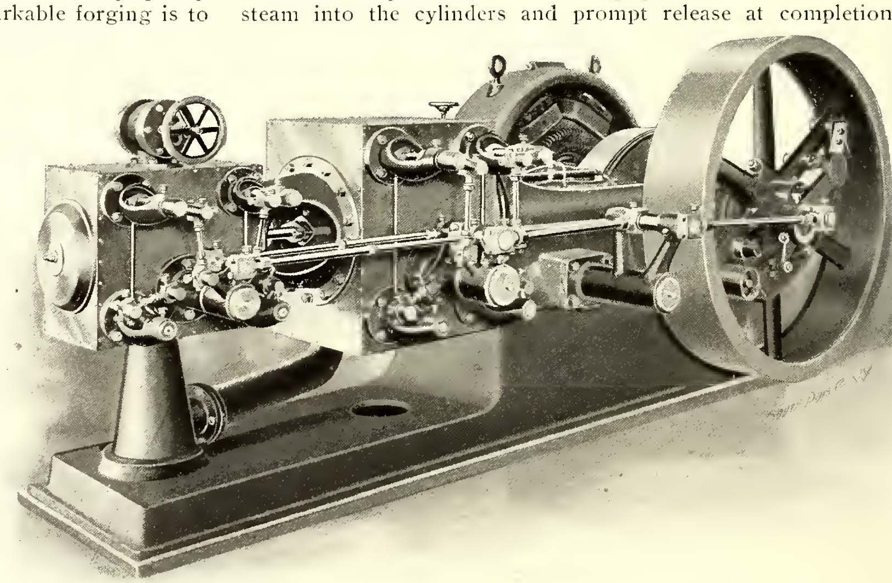
The Boston Elevated Railway Company will use also two other shafts made by the Bethlehem Company of open-hearth steel, hydraulic forged hollow on a mandrel and oil-tempered, for two other Corliss steam engines. The main dimensions of these shafts are: elastic limit, 45,000 lbs. per sq. in.; elongation, 20 per cent in test pieces 1 in. diameter and 10 ins. long; diameter of fly-wheel fit, 19 ins.; diameter of journals, 17⅛ ins.; diameter of axial hole, 6 ins.; total length, 19 ft. 9⅛ ins.; weight, 16,100 lbs. These two shafts are to replace two made of wrought iron, which failed in service.

The annual returns of the street railway companies of St. Louis for the year ending June 30, 1898, show the total number of trips on all lines in the city to have been 1,355,988, and total passengers carried 30,013,201. The best showings were made by the Lindell Railway and the Missouri Railroad.

A New Corliss Engine

A new type of horizontal tandem compound engine, designed and built by the Ball & Wood Company, of New York, is illustrated herewith. It is believed that in this engine are embodied all the best features of the well known Corliss type, together with a number of important and interesting improvements designed by the engineers of the Ball & Wood Company, with the object of obtaining the best possible distribution of steam, close regulation and high efficiency.

The valve gear is generally Corliss in type, but is without the usual Corliss tripping devices or dash pots. Instead of this the admission valves are operated by an independent wrist plate. The exhaust valves are actuated by a second wrist plate by means of an adjustable eccentric, and both wrist plates are connected to the Ball & Wood inertia governor, which is well known to be one upon which extremely small variations of speed have an immediate corrective effect. The valves are multiported on both steam and exhaust cylinders, thus insuring quick and full admission of steam into the cylinders and prompt release at completion of stroke. The exhaust motion is very rapid, and by means of the independent eccentric any desired adjustment is obtainable. The steam valves have large openings, and, being operated by the Corliss plate, quick angular motion is obtained.



NEW CORLISS ENGINE

It is evident that the economy of this type of engine should be exceedingly good, and its regulation as nearly perfect as is possible to attain in engine practice. These new engines are manufactured in large and small sizes, for railway and lighting service, and in connection with the vertical and other types built by the company enable the latter to furnish to customers practically any type of engine desired.

The street railway employees of the Bay Cities Consolidated Railway Company, of Bay City, Mich., have organized a branch of the Amalgamated Association of Street Railway Employees of America.

Automatic Couplings

The accompanying engravings show two of the standard couplings manufactured by the W. T. Van Dorn Company, of Chicago. Fig. 1 shows the Van Dorn latest improved draft appliance connected to this company's No. 4 coupling as applied to the new motor cars of the Metropolitan West Side Elevated Railroad

FIG. 1.—NEW DESIGN OF COUPLER

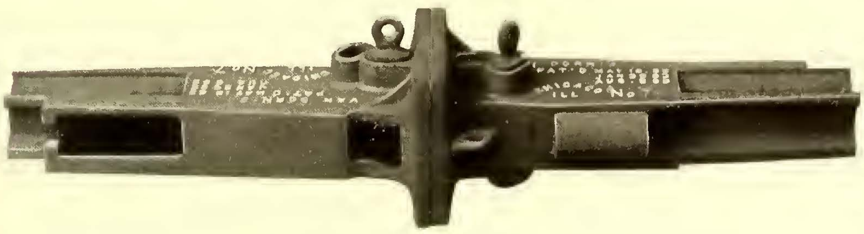


FIG. 2.—STANDARD COUPLER FOR STREET CAR

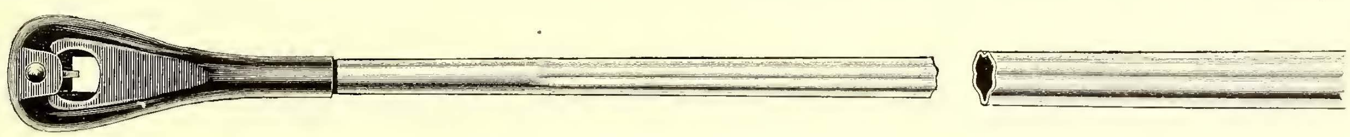
Company, of Chicago. It will be seen that this is a very simple and durable appliance, and it is giving good satisfaction.

Fig. 2 represents the Van Dorn standard No. 7 coupler. This illustration shows how solid these couplings will couple two cars together. They couple automatically within one-sixteenth of an inch. The Van Dorn couplings are well known both throughout this country and abroad, and they have been accepted as standard on a large number of roads. Among the recent companies to adopt this device as standard are both the Brooklyn elevated roads. The Brooklyn Elevated Railroad Company ordered 152 sets of couplings known as the Van Dorn No. 3, to be applied to the Van Dorn improved T rails for draft rigging, that swivels on the body bolster specially built for trail cars. The Van Dorn couplings are also standard on all the elevated roads in Chicago.

The W. T. Van Dorn Company now has nine different sizes of couplings and as many different ways to apply them to different classes of cars, as it constructs them to meet the requirements of different roads. All of these couplings are machine-fitted, and are very complete in every respect. R. W. Blackwell, of London, is the European agent for these appliances.

Corrugated Steel Trolley Poles

The Bibber-White Company, of Boston, Mass., is placing on the market a corrugated steel trolley pole, an illustration of which is shown herewith. The object of the corrugations is to secure greater strength with less weight. That this point is obtained is clearly proven by a series of tests recently made at the Watertown Arsenal, where both transverse and compression tests showed greatly in favor of the corrugation tubing.



CORRUGATED STEEL TROLLEY POLE

This new pole is the invention of H. W. Smith, manager of the electric railway supply department of the Bibber-White Company.

The Chattanooga (Tenn.) Electric Railway Company has a large force of men at work repairing its tracks and otherwise improving the system. When the work is completed this street railway will be one of the best equipped in the country.

The stockholders of the General Electric Company on Aug. 17 voted to scale down the capital stock 60 per cent. The General Electric Company's common stock amounts to $30,460,000 and the preferred stock to $4,250,000. It is stated that the preferred stockholders will contest the reduction of the stock in the courts.

Steam Gages and Valves

The Crosby Steam Gage & Valve Company, of Boston, Mass., for nearly a quarter of a century has been actively engaged in the production of instruments for use on steam boilers and steam engines, which would tend to greater economies in the cost of steam production and to affording security to human life. During this time, modifications of original plans and methods of construction have been made, new inventions and discoveries have been sought, tried and adapted, and this company's line of gages and valves includes everything that can be desired in variety, design, capacity, strength and efficiency.

The Crosby steam engine indicator is designed to meet the requirements of modern high-speed engineering practice. This indicator is very simple in construction, is extremely light, and all the moving parts are very closely adjusted.

The Crosby spring seat valve is made either of brass or of iron. These valves are so designed as to prevent them from jamming when the valve is closed, and yet they are free to accommodate themselves to any variation of temperature. In addition to this, when the valves are partially open, the outrushing steam or fluid does not abrade their surfaces, as sometimes happens with common valves.

The feed-water regulator manufactured by the Crosby Steam Gage & Valve Company comprises a thermostat and a water valve, the latter controlled automatically by the former, and has for its purpose the maintenance of a uniform height of water in a steam boiler under all conditions of use, regardless of any degree of pressure or of the employment of the steam therein. It is equally applicable to and efficient on a single boiler or a battery of boilers.

The Crosby pressure recorder records the pressure of any fluid during a certain period of time. It is designed to supply the constantly increasing demand for a compact and reliable, yet not too costly instrument for recording all the variations of pressure which take place in a steam boiler, or other receptacle.

A New Vestibule Door

Among the many ingenious and valuable inventions relating to the street railway industry which are constantly being brought out, the patent vestibule door recently devised by C. F. Agard is one of the best. This invention very satisfactorily fulfils all the requirements for which it was intended, its object being to facilitate taking on and discharging passengers from a car vestibule. The usual folding doors opening inward, sweep across the standing space of the vestibule, and require the platform to be clear before they can be opened. This is often very awkward and annoying to passengers. The Agard device, which was quite fully described and illustrated in the STREET RAILWAY JOURNAL for January, 1898, does away with this difficulty by substituting a sliding door for the folding doors.

In the new system an overhead track is bent to fit the angle of the vestibule, with a curve at the angle, and from this the door is suspended by swivel hangers, which freely follow the change of direction of the track. A guide rail similarly bent is placed about a foot above the floor, and is grasped by a pair of guide rolls attached to the door to steady the latter at the bottom in intermediate positions. When the door is fully closed the lower corner, which is shod with brass, rests securely in a bell-mouthed socket, while the edge enters a rabbit, which cuts off draughts of air. The door slides close to the side of the vestibule, and does not interfere with the brake staff, controller, etc.

The Hartford Street Railway Company has used the Agard invention on eighty closed cars for over two years, and the general manager of that company states that it is the best thing of its kind that has ever been used on that system. The new door is manufactured by James L. Howard & Company, of Hartford, Conn.

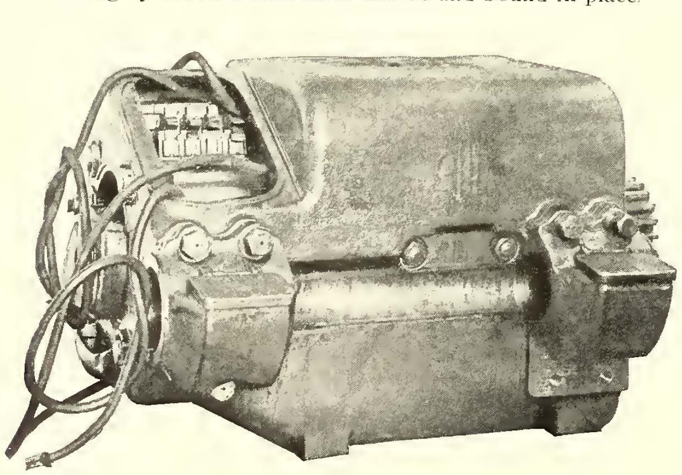
The G E 55 Motor

For elevated and underground railroads, as well as suburban and interurban railways, the General Electric Company has developed the GE-55 motor of 160-h.p. This motor, while differing but slightly in outward appearance from previous GE motors of similar capacity, embodies many important improvements which, it is claimed, render it the only suitable motor for this class of work, presented to the railroads. Reference has already been made on page 540 to the use of this motor on the New York, New Haven & Hartford Railroad, and on page 535, to its employment on the locomotives of the Buffalo & Lockport Railway.

The magnet frame is of soft steel of high magnetic permeability cast in one piece in the form of a cube with well rounded corners. In each end is a bored out opening large enough to allow of the removal of the armature, pole pieces and field coils. Into this opening fits a frame head held in place by four bolts, and carrying the armature shaft bearings. The axle bearing caps are bolted to vertically planed surfaces 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 frame, with the nuts on the outside. The frame has a large opening above the commutator, through which it and the brushes may be inspected and the worn out brushes renewed. The brush holders and insulating supports may also be removed through this opening, which is protected by an easily removable iron cover, securely clamped down by an adjustable cam-locking device. In the bottom of the frame directly under the commutator is a large hand hole protected also by a cover.

The four field coils are wound on metal spools held in place by laminated pole pieces. The winding is of strip copper of ample cross section, thoroughly insulated from the spool and each winding is tested at the works to a potential of 5000 volts.

The armature is of the iron-clad type, with a core built up of soft iron laminæ insulated from each other by coats of japan, and assembled on a composition metal spider securely keyed to the shaft. The slots are so uniformly punched in the sheets that the assembled core has smooth and regular slots in which to place the conductors. The winding is of the series drum barrel type, and is made up of stranded copper conductors thoroughly formed and insulated before insertion in the slots of the core. The insulation placed on these coils is of the highest obtainable quality, and is practically impervious to moisture. The conductors are soldered directly into the ears, which form part of the commutator segments, avoiding the use of connecting leads. Before assembling in the motor the armature is tested to withstand a potential of 2500 volts between the conductors and the core. To prevent carbon dust from finding access to the end windings they are thoroughly covered with stout canvas and bound in place.



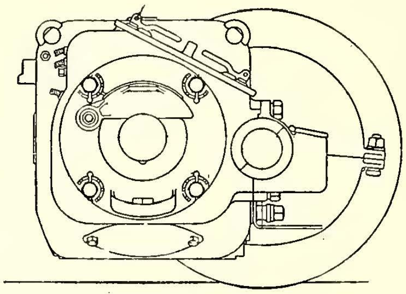
VIEW OF MOTOR

The commutator segments of hard drawn copper are built up and securely clamped on a malleable iron shell, the best quality of mica being used for the insulation.

The cone clamping insulations are of the same high grade mica built up and pressed hard into compact shape, but the mica between the segments is of a somewhat softer quality to allow of even wearing with the segments. Each commutator is subjected to a high potential test of 5000 volts between segments and shell, and 500 volts between each adjacent segment. Under all normal conditions it will run without injurious sparking.

The bearings of the armature are supported in the frame heads, which extend inside the armature and commutator. They are lubricated by oil and waste, put in place through a hand hole, as with the ordinary car-box bearing. The brasses take the form of a sleeve with the sides cut away to expose the shaft to the oily waste. The use of oil makes it easier to keep the motor clean, and oil deflectors are provided to prevent any access of the lubricant to the inside of the machine. Drip cups cast into the frame heads under the armature bearings allow of the removal of used oil. A similar system of lubrication is employed with the axle bearings, as with the armature shaft bearings.

All the leads are brought out through rubber bushed holes in the magnet frame, and are easily removable. The two brush holders are of cast brass, each carrying four carbon brushes, which slide in finished ways and are pressed against the commutator by independent fingers, giving a practically uniform pressure throughout the working range of the brushes. The holders are bolted to guides, which in turn are clamped to a specially designed mica insulated stud. The GE-55 motor is rated at 160 h.p. It weighs approximately 5000 lbs.



SIDE ELEVATION OF MOTOR

Report of the Dublin United Tramways, Limited

At the half yearly meeting of the Dublin (Ireland) United Tramways Company, Limited, the following interesting report upon the company's condition was made. The chairman's address to the stockholders was in part as follows: "In pursuance of the undertaking given at the last meeting of shareholders we have sent you on this occasion the report and statements of account of the companies from which we draw our revenue, namely, the Dublin United Tramways Company and the Dublin Southern District Tramways Company. These documents afford full information of the working of the tramways for the past half year, and give some indications of the progress made in the electrical equipment and the conversion of horse lines to electricity. As stated in the report, we have completed the electrical equipment of the Clontarf line, which was opened for traffic by electric traction to Nelson's Pillar on the 20th of March; the Haddington Road line, which was opened on the 12th of July, and the North Quay, which is expected to open shortly, when we shall popularize the traffic to the Phœnix Park by reducing the fare from O'Connell Bridge to one penny for the whole distance."

The Dublin United Tramways Company is also equipping with electricity the new line from Rathmines to the sea, and also the North Circular road line. A large capital expenditure is going on in carrying out all these works, as well as in relaying some of the older lines with new girder rails and in constructing the central power station on Ringsend Road. Up to the present time a large part of this expenditure has not been producing any returns and some time must yet lapse before the full results of the capital outlay are available.

The new station on Ringsend Road will be one of the finest power stations for traction work in Europe, and was designed by H. F. Parshall. It will be equipped with the very best and most modern machinery.

The chairman further said: "Owing to the transition state of the company's system of traction, comparisons between this year and the last are not of much practicable value, but I might say that during the half year we carried on the cars (horse and electric) of the Dublin United Tramways Company 13,723,442 passengers—an increase of 1,334,826 compared with the corresponding period in 1897, the increase being chiefly in the Clontarf electric section."

The following return of traffic on the Clontarf line from the 21st of March to the 30th of June is of interest as showing the increase of traffic on the introduction of electricity:

	1897, Horse.	1898, Electricity.
Receipts	£4,934	£6,775
Passengers	697,928	1,246,020
Average fare	1.71 d	1.30 d

The figures for the first twenty-four days of July are still more remarkable, being as follows:

	1897, Horse.	1898, Electricity.
Receipts	£1,492	£2,261
Passengers	204,639	390,994
Average fare	1.75 d	1.27 d

It is expected that the earning power of this entire system will be greatly increased by the adoption of several bills now in Parliament, which will enable the company to run its cars on several lines at considerable higher speeds. When these bills are passed, and when the entire system is electrically equipped, both the gross and net receipts should show even a greater increase for the year 1899 over the year 1898 than the 1898 returns show over those for 1897.

A New Storage Battery at Braintree

In Braintree, Mass., there is being operated on the Braintree Division of the Quincy & Boston Street Railway system a storage battery of the Hatch type, which is not only novel and highly ingenious in point of construction, but is apparently doing excellent work in every respect. The battery consists of 260 cells, and has a capacity of 550 amp. hours, the normal discharge rate being about 60 amps. It is delivering current to, and receiving it from, the street railway lines according to the fluctuations of the load, which it has greatly steadied, as well as improving the voltage to such a point that the cars now make time on the principal division, where before they lagged behind schedule, and were losing traffic in consequence.

There are, of course, no new features involved in this particular application of storage batteries to electric railway service, neither are there any new chemical or electrical principles involved in the construction of this storage battery. The improvements are of a purely mechanical nature, and relate to the construction of the element, the general aim being to reduce the weight of the material supporting the lead oxide, which is, in most batteries, lead itself, one of the heaviest of the metals. In constructing the Hatch element a porous plate of unglazed earthenware about 4 ins. square is used, with square receptacles on one side and grooves on the reverse side, as shown in Figs. 1 and 2, respectively. The square receptacles in the face of each plate are filled with the usual active material, lead oxide, to an amount sufficient to bring the surface of the oxide one-eighth of an inch above the surface of the plates. This forms what may be called the "ultimate unit" of the battery and cell.

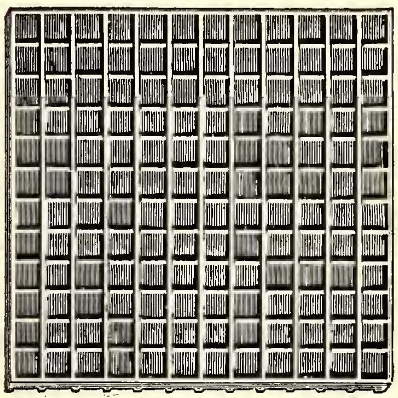


FIG. 1.—FACE OF BATTERY PLATE

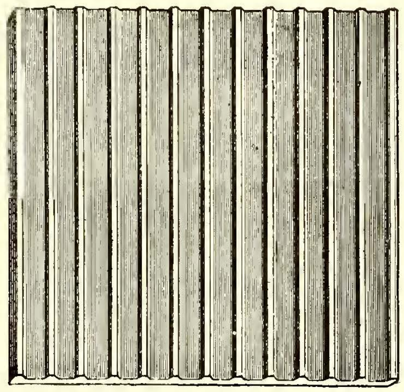


FIG. 2.—BACK OF BATTERY PLATE

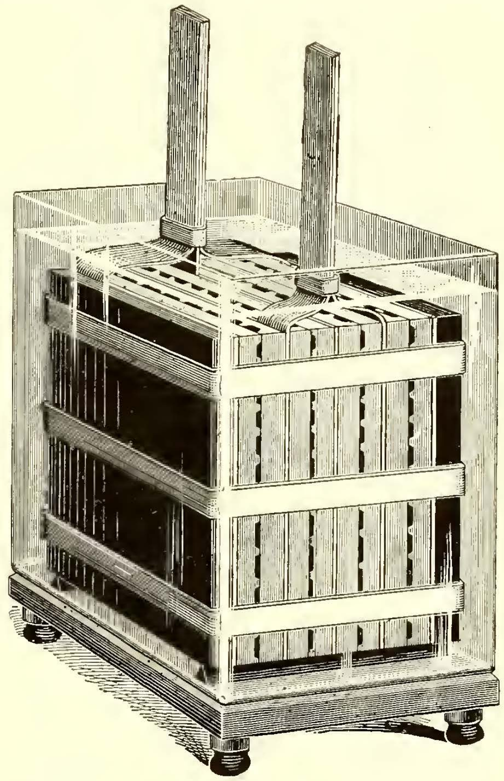


FIG. 3.—COMPLETE BATTERY CELL

These units are obviously of great simplicity, the chief peculiarity of construction being the extreme porosity of the earthenware base, by reason of which the liquids of the cell have an opportunity of instantly reaching all portions of the active material. Nine of these units (in the Braintree battery) are combined together to form a large plate about 11 ins. square. This large plate cannot possibly "buckle" in the way that a solid plate of the same area might do, since it is flexible, and can be bound firmly into a desired position and held there. The units are, of course, too small to buckle individually to any great extent.

Two of these 11-in. battery plates are then placed face to face against a sheet of lead, which serves as a conductor for the electricity passing to and from the lead oxide faces of the units. Both the positive and negative plates of the battery are made up in this way, and are later grouped in cells and "formed" in the usual way by passing a current of electricity through the cells. The lead oxide of one pair of plates thus becomes lead peroxide, and forms the positive electrode of the couple, while the lead oxide of the other pair of plates is reduced to pure lead, thus forming the negative electrode. In the Braintree battery there are two couples in each cell joined in parallel, as shown in Fig. 3, and the superficial area of the active material of the positive plates is nearly 500 sq. ins. The eight plates are bound up together with a sheet of glass at each end of the group of couples, and rubber bands are used for holding the whole together.

Careful provision is made in the mechanical conductor and arrangement of the earthenware plates for perfect circulation of the acids. The grooves in the backs of the earthenware plates are placed at right angles to each other, as shown in Fig. 3, so that the liquids can reach all parts of the plate, and thus penetrate to the active material on the other side.

Terminals are soldered to the positive and negative electrodes, and the cell stands complete, as shown in Fig. 3.

Superintendent Weeks, of the Quincy & Boston Street Railway Company, speaks in highest terms of this battery, stating that so far there has been not the slightest trouble of any kind. It has greatly improved the voltage and speed of the Braintree cars, as above stated. Extensions of the battery service are contemplated for other portions of the Quincy system, where the voltage is low.

This battery is the invention of George E. Hatch, and is manufactured by the Hatch Storage Battery Company, of 53 State Street, Boston, Mass.

A New Book on Street Railway Roadbed

A book on street railway track construction, written by Mason D. Pratt and C. A. Alden, has just been issued from the press of the Street Railway Publishing Company. The experience of the authors in track building and designing insures a thorough, comprehensive and up-to-date treatment of the subject.

The book contains eleven chapters, one each being devoted to early types of rails, the development of the girder rail, what governs the shape of rails, the T rail adapted to street railways, track fastening and joints, special work, guard rails, advantages of spiral curves and tables for same, design of special work, surveys and laying out work, specifications for track construction. The book contains 135 pages, and is supplied with an index. Its price is $2.00, postage prepaid to any part of the world.

The employees of the Metropolitan Street Railway Company, of New York City, have formed a mutual benefit association, to be known as the Metropolitan Street Railway Association. The initiation fee is $1 and the dues fifty cents a month. Members in good standing are permitted to draw $1 a day in case of sickness, and $150 is paid to a member's family at his death. The officials of the Metropolitan Street Railway Company have heartily endorsed the formation of this association.

Large Power Transmission Plant, Mechanicville, N. Y.

The development of the power of St. Anthony's Falls on the Mississippi at Minneapolis, Minn., is followed closely by the utilization of the power of the upper waters of the Hudson River at Mechanicville, N. Y., where an undertaking of no less magnitude has been completed within the past few days. From 5000 to 7000 h.p. is available at the power house, and the use of high tension current permits of its distribution over a wide territory. The site is two miles from Mechanicville, eleven miles from Troy, eighteen miles from Albany, and seventeen miles from Schenectady. The plant is owned by the Hudson River Power Transmission Company, which was organized by R. N. King, president of the Stilwell-Bierce & Smith-Vaile Company, and A. C. Rice, chief engineer of that company, has had entire charge of the hydraulic engineering features of the installation. As the General Electric Company was to purchase the largest amount of power, its advice as to the electrical equipment was naturally closely followed. The result brought about by the harmonious co-operation of both hydraulic and electrical engineers is a power transmission plant in every respect strictly representative of the most modern hydraulic and electrical practice.

At the point chosen for the hydraulic development the physical conditions make the location an ideal place for a dam and power house. The banks and bottom of the river are of rock, as is Bluff Island, immediately adjacent, which divides the Hudson into two channels. During the greater part of the year there is water sufficient to produce from 7000 to 10,000 h.p..

The island is about one-third of the distance across the river from the western bank, the combined width of the two channels being about 1200 ft. The western channel is used for the head and tail races.

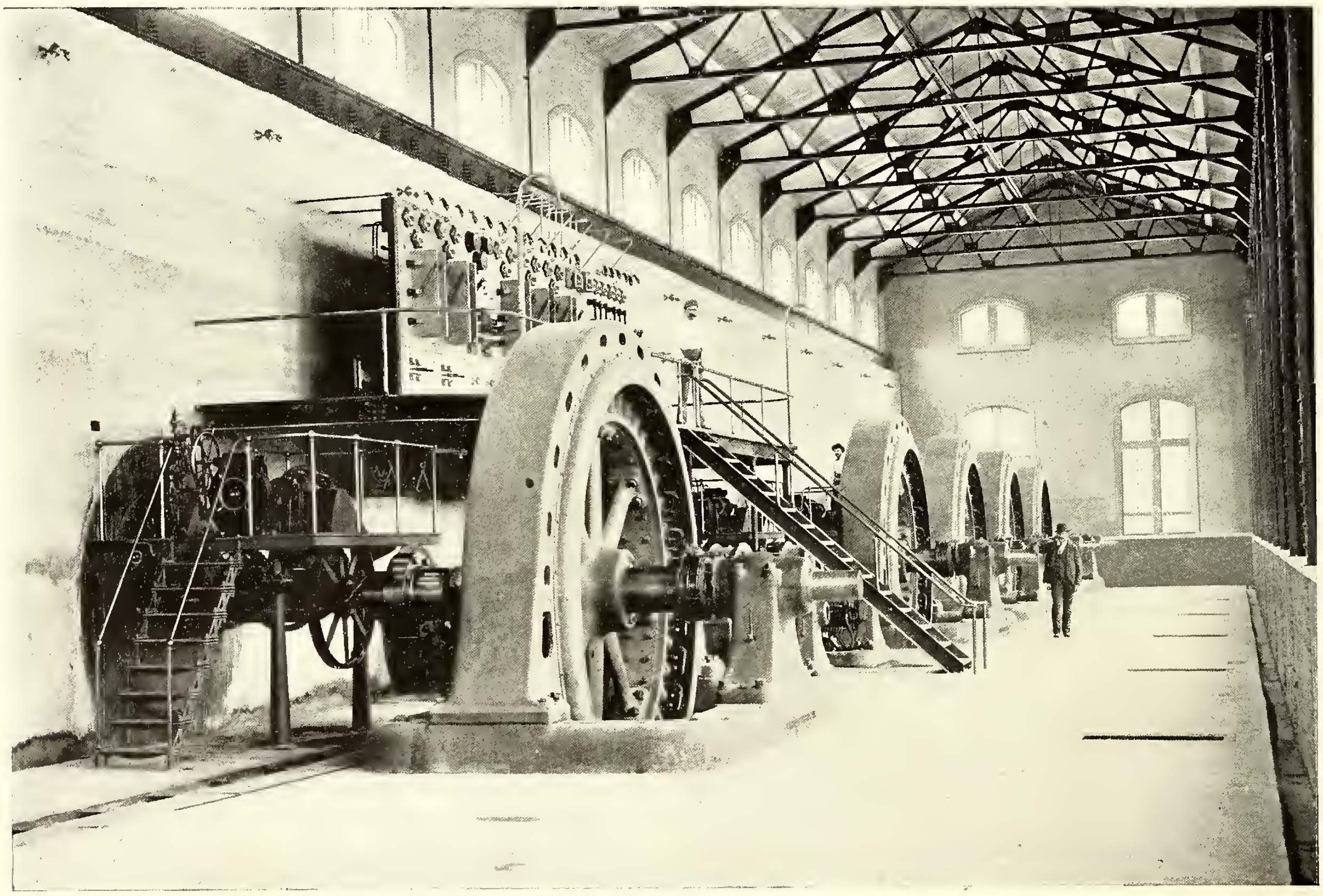
The power house is divided into two parts by a thick head wall. The upstream part contains wheel chambers for seven 1000-h.p. wheels, of which five only are at present occupied. The downstream portion contains the wheel governors and the electrical apparatus. The length of the power house proper is 257 ft. 6 ins. and its total width is 66 ft. 6 ins. Each main wheel chamber is 32 ft. 6 ins. long, 22 ft. wide and 17 ft. 5 ins. high, and is provided with two 6-ft. manholes. Each exciter wheel chamber is 32 ft. 6 ins. long, 17 ft. 5 ins. high and 10 ft. wide. The main wheel plant consists of ten pair of 42-in. horizontal Victor turbines of the latest type, built by the Stilwell-Bierce & Smith-Vaile Company, of Dayton, Ohio. Each main turbine consists of two pair of wheels at the normal speed of 114 r.p.m. Each wheel is rated at 250 h.p. The total power of each set of turbines is therefore 1000 h.p. The head under which the water wheels are operated is 18 ft. The turbines for the exciters consist of three 18-in. Victor cylinder gate wheels, having, at 259 r.p.m., a total of 300 h.p.

The speed of each set of main wheels is regulated by a Geisler electro-mechanical governor, mounted on a platform directly over the turbine shaft, and between the head wall and the generator. The use of electricity renders the mechanism of this governor extremely sensitive and effective, and the gates can be entirely opened or shut, should the full current be thrown on or off, in six seconds.

The governors controlling the exciter wheel gates are improved "Snow" governors, which rapidly bring the speed to normal when changes are neither frequent nor heavy. They are especially adapted to the regulation of water wheels driving exciters, and are provided with adjustable stops, which limit the hoisting action on the gate as soon as the gate is fully open.

The dynamo room is a spacious chamber well lighted by windows on all sides. It is 255 ft. long and 34 ft. 5 ins. in the clear from floor to roof truss, and 22 ft. from floor to crane. The ultimate generator capacity of the station is 7000 h.p. in seven generators, each of 750 k.w. capacity. Five have been installed and are now running. They are unitooth, three phase, forty pole 750-k.w. 114-revolution, alternating current machines, having revolving fields and stationary armatures, and wound to deliver 36 amps. of current at a periodicity of thirty-eight cycles, and a pressure of 12,000 volts to the transmission lines. They are arranged for operation in parallel at constant voltage. By using the revolving-field type of generator and thus securing this pressure directly from the machine the use of step-up transformers to raise the voltage for transmission purposes is avoided. As the current is to operate synchronous and induction motors, to operate lights and to be converted into direct current through rotary converters, the frequency of thirty-eight cycles was selected as most suitable for the different conditions required.

The alternators are similar in their main characteristics to those successfully used in the development of the power of the Lachine Rapids at Montreal. The armature frame, or ring, is of the box type, 15 ft. 4 ins. in diameter and 36 ins. wide. It is bolted to a base 18 ft. 2 ins. long by 10 ft. wide, along which it may be moved



INTERIOR OF POWER STATION

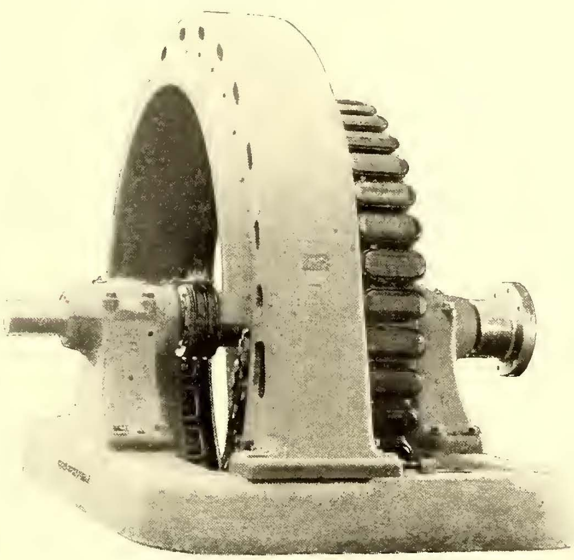
parallel with the shaft, in order that the revolving field spider and poles may be uncovered should occasion arise. The armature winding is protected on each side by iron shields. The pillow blocks are also bolted to the base, and the bearings are of the spherical seated self-oiling type used in all General Electric generators.

The field ring is bolted to the spokes of the spider. It carries forty poles, each securely fastened by two bolts to the ring. The whole revolves on a shaft 15 ins. in diameter provided with a rigid coupling on the turbine side bolted to a similar coupling on the turbine shaft. The dynamo shaft is extended for coupling to a vertical steam engine in case of necessity.

The exciters are placed one on each side of the stairway leading to the switchboard gallery. They are 6-pole 100-k.w. 125-volt standard General Electric machines with ribbed field frame and iron-clad armatures.

The switchboard erected on a gallery on the north wall of the dynamo room is built up of nine highly polished panels of blue Vermont marble, each panel 7 ft. 6 ins. high, 3 ft. wide, and 2 ins. thick. Of these nine panels five are used for the generators and two for the feeders; one is the total output panel, and the last is for the control of the exciters. The generator panels occupy the left side of the board, and room on the gallery is left for two additional panels. The feeder panels are on the right hand side; the total output panel is between these and generator panels, and the exciter panel is the third panel from the left-hand end of the board.

On the front of the output panel are two Thomson recording wattmeters for balanced three-phase circuits, each reading to 300



750 K.W. THREE PHASE ALTERNATOR

amps and 12,000 volts. and twelve triple-pole, single-throw 100-amp. switches with fuses for the lighting circuits. On the back are four potential and two current transformers.

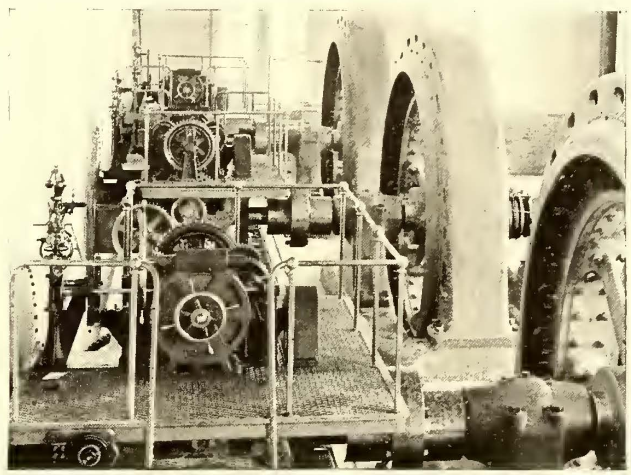
The lightning arresters are of the GE short gap type. Arresters of this type have been installed on nearly all of the most important long-distance transmission lines in this country, and have proved a most satisfactory protection against damage by lightning

The lead-covered leads from the generators are taken out at the base of the machine, and are laid in ducts in the floor. Rubber-covered wire is used for the field connections. The cables rise on a frame from the duct to the floor of the gallery, through which they rise to the board. From the back of the board the line wires rise to supports bolted to the I beam on the north wall, which supports one of the crane runways. The lines run along the north and west walls and pass out to the poles through a blind window over the door of the power house.

The line from Mechanicville to the General Electric Works at

MAIN WHEEL CHAMBER

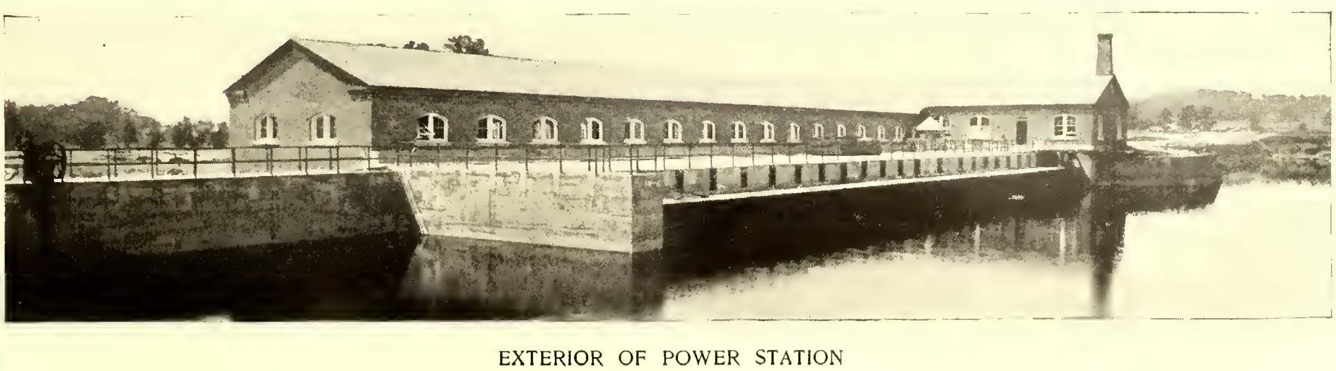
Schenectady is the only one at present laid down. It consists of three No. 000 B. & S. bare wires, this large gage being employed in order to give the line as high a self-induction as possible. This



MAIN WHEEL GOVERNORS

insertion of self-induction in transmission lines is a departure from earlier practice. In cases where synchronizing apparatus is used self-induction is now considered necessary, and is artificially brought into the line in the shape of reactive coils in cases in which the natural self-induction is too small. The circuits are carried on poles of 30 ft. to 60 ft. long, and all 8 ins. in diameter at the top. Each pole carries one cross arm, on one side of which are two porcelain insulators of the petticoated type, a third being on the other side. For lightning protection a barbed wire frequently grounded runs along the top of the pole line.

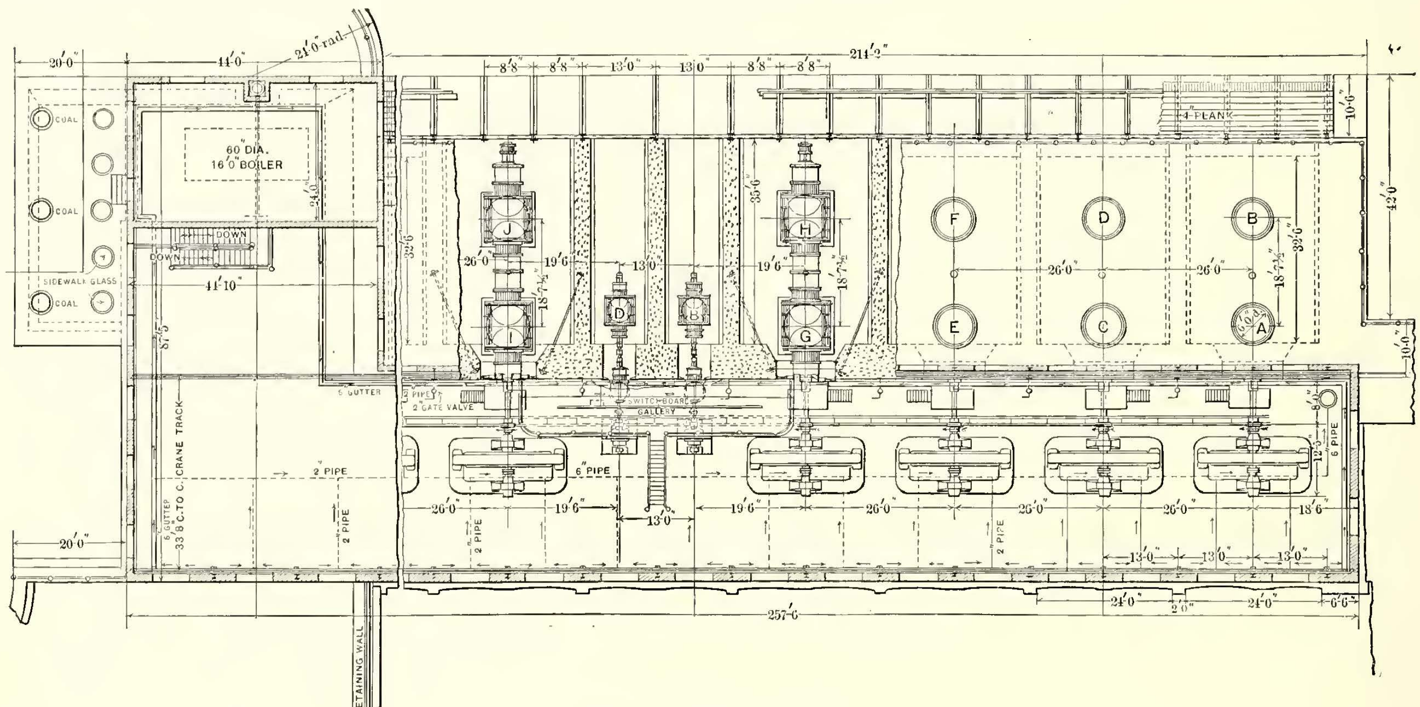
The introduction of this transmitted electrical power into the factory will work a considerable change. At present all the ma-



EXTERIOR OF POWER STATION

chinery is driven by electric motors, while the testing department demands an independent supply of current for the work it carries on. There are at present, therefore, two distinct generating plants. The 550-volt motors in the testing department are supplied from an engine driven multipolar generator of 500-k.w. capacity, while a smaller engine drives a number of exciters which allow of independent control of the excitation of all machines in this department. The factory is operated by a number of 250-volt motors, running on the same circuit as the factory lights. These motors will not be changed, and the steam plant which supplies them will be retained as a reserve in case the power from Mechanicville should fail. The electric power plant superseding the present steam plant at the works will, therefore, consist of two synchronous motors, one of 500 k.w., the other of 100 k.w. and three 400 k.w. rotary converters, the synchronous motors for the testing department, the converters to supply current to the factory motors.

The large engine driving the 500-k.w. multipolar generator is superseded by the 500-k.w. synchronous motors. This is a twelve-pole 400-revolution machine of the revolving field type, wound directly for 10,000 volts. The small engine driving the exciters is replaced by the 100-k.w. synchronous motor and eight-pole, 600-r.p.m. revolving-field machine similarly wound. This disposition renders this department independent of everything but



PLAN OF POWER HOUSE

the speed of the Mechanicville generators, which will be kept as nearly constant as possible.

Electric Heaters

Despite the early predictions of some that electric heaters would never prove an economic success, the electric heater to-day is an established and accepted fact. The history of its development shows that necessity is the mother of invention, and that while it was impossible to get more heat out of a given amount of current, it had been possible to so design the heater that the heat produced is more fully utilized for car purposes. Among the companies which have placed heaters on the market, the Gold Car Heating Company, of New York and Chicago, has attracted much attention from the fact that for a long time it has occupied a very high position as manufacturer of heating apparatus for railway cars. Upon the general adoption of electricity for propelling street cars, the company took up the electric heating problem and devoted its long experience in car heating to the subject. As evidence of its ability to take hold of this subject, it might be said that over 10,000 cars and locomotives in this country are equipped with Gold heaters, not to mention 5000 in England and numberless more in numerous other quarters of the globe. It is not remarkable, therefore, that the Gold Company should manufacture an electric heater which has been widely adopted. In Chicago, for example, the South Side Elevated road has in use 3000 Gold standard electric heaters for cross-seat cars.

Among the features of the Gold electric heater is the wire employed. Wire for such use must be of such composition that it will not crystallize, and the Gold Company has produced a wire that has stood the test of ten years. Instead of being wound on the usual close pitch, the Gold wire is wound on an open pitch, thus freeing it from any unusual strain. The Gold wire has also high resistance—an essential thing in wire for electric heaters, as is readily understood.

The wire is held in the Gold heaters on a steel rod which is covered with enamel burnt on at a heat of 2500 deg. F. The rod is shaped a good deal like the waves of corrugated iron in order that there may be no vibrations of wire against it with consequent noise and possible damage to wire. Considering the degree of heat at which the enamel is burnt on, it is obvious that no degree of heat which the wire would ever attain could possibly damage the insulation.

The peculiar shape of the supporting rod also gives the coils of wire very complete contact with the surrounding air. Free circulation of air in electric heating is very essential, and the Gold heater is well nigh perfection in that respect. It is a fact admitted by all heating engineers that circulation of air is always better than radiation, and that is one thing upon which the principles of the Gold heater are based.

Six Gold heaters equip an ordinary 24-ft. car, and the whole system is equipped with three different series of wires. In this way it is possible to give three degrees of heat from a car equipment as a whole.

It is these features which have made and are making for Gold electric heaters progress where such equipments are desired.

The employees of the Mexico City Tramways have been put in uniform, which makes a very decided difference in the appearance of the force. The cost of these uniforms is $21 (silver), and is met by the employees by a weekly payment of $1. To enable the employees to pay the additional expense, wages have been readjusted in such a way that the income of a faithful employee is increased by at least ten per cent. In the readjustment of the conductor's wages, compensation by the hour, instead of by the day, has been adopted, and drivers working twenty-five full days in the month without incurring any demerit receive a premium of five per cent on the wages earned.

The Hartford Street Railway Company expects to have its new auxiliary power house in running order before the middle of September. This building is being built in a very substantial manner, with solid concrete foundations and brick superstructure. The power house, when completed, will contain one Corliss cross compound engine, which is being built by the Pennsylvania Iron Works Company, of Philadelphia, Pa. It will be of 1200 h.p., and will run at 90 r.p.m. The fly wheel is to be 20 ft. in diameter, and with the shaft and armature will weigh 240,000 lbs. The engine will be direct connected to a General Electric 850-k.w. generator. A Worthington condenser of 1200 h.p. will also be installed. The new power station will be 45 ft. x 67 ft.

EXHIBITS AT THE COMING CONVENTION

Manufacturers and dealers in electrical apparatus are making unusual preparations for the exhibition in connection with the meeting of the American Street Railway Association at Boston, and this feature of the convention promises to be of even greater interest than it has been in previous years. A diagram of the exhibit hall and a full list of the exhibitors is given in another column of this issue. Among the companies which are planning to make extensive displays may be mentioned the following:

The Bemis Car Box Company, of Springfield, Mass., will exhibit its different types of trucks.

The Billings & Spencer Company, of Hartford, Conn., will make an extensive exhibit of commutator bars.

John F. Ohmer, of Dayton, Ohio, will exhibit his registers which have recently been placed on the market.

F. H. Newcomb, of Brooklyn, N. Y., will show a full line of uniform caps for conductors, motormen and railroad men.

The Corning Brake Shoe Company, of Buffalo, N. Y., will make an exhibition of a number of different patterns of brake shoes.

A. Mertes Manufacturing Company, of Allegheny, Pa., will be represented at the convention by its agents, Smith & Wallace.

The Bibber-White Company, of Boston, intends to exhibit a full line of Cutter goods, electric headlights and line material.

The Pettingell-Andrews Company, of Boston, will make an exhibit of electric railway material, feeder cables, digging tools, etc.

The Van Dorn & Dutton Company, of Cleveland, Ohio, will be represented by their secretary and treasurer, W. A. Dutton.

The W. R. Garton Company, of Chicago, will probably be represented at Boston by W. R. Garton, president of the company.

The Leonhardt Wagon Manufacturing Company, of Baltimore, Md., will exhibit its revolving tower wagon and a ladder wagon.

The Fuel Economizer Company, of Matteawan, N. Y., will show models, drawings and blue-prints of some of the work which it has done.

McKee, Fuller & Company, of Catasauqua, Pa., will show a number of their wheels under cars and trucks to be exhibited by the J. G. Brill Company.

The Barney & Smith Car Company, of Dayton, Ohio, expects to show one of its class "G" single trucks, one class "C" bicycle truck and one class "H" double truck.

The McGuire Manufacturing Company, of Chicago, will exhibit one of its combination plows and sweepers, a standerd steel frame motor truck and Columbia car heaters.

The Pearson Jack Company, of Boston, Mass., expects to show at the convention several of the Pearson jacks in different sizes especially adapted for street railway work.

The Samson Cordage Works, of Boston, Mass., will have a show case on exhibition containing coils of their belt cords, signal cords, trolley cords and arc-light cords.

The Partridge Carbon Company, of Sandusky, Ohio, will be represented by its secretary, J. S. Speer. A complete line of the Partridge self-lubricating brushes will be shown.

The Sterling Supply & Manufacturing Company, of New York City, intends to show the Sterling registers, safety brakes, fenders, sandboxes, bronze trimmings and insulating material.

The Springfield Manufacturing Company, of Bridgeport, Conn., is planning to send to the convention one of its car wheel grinders, one of its No. 1 tool grinders, and possibly an armature grinder.

A. O. Norton, of Boston, Mass., will exhibit a full line of track and car jacks, also a new device for replacing cars, which is really a new style of traversing base worked in conjunction with a lifting jack.

The Q. & C. Company, of Chicago, will have representatives at the convention who will show samples of the Q. & C. Company's drills, track and car jacks, rail sawing machines and pneumatic tools.

The R. D. Nuttall Company, of Alleghany, Pa., expects to exhibit its regular line of gears and pinions, bearings and all types of Union Standard trolleys of which this company is the sole licensed manufacturer.

The Laconia Car Company Works, of Boston, expect to exhibit two cars, one complete and one in skeleton, of the type in use by the Boston Elevated Railway Company. This company will also show samples of Gregg's patent steam trap, which it manufactures.

The Taunton Locomotive Manufacturing Company, Taunton, Mass., has been assigned a large space in the convention hall, and will have on exhibition three different snow plows and probably a transfer table. This company also expects to have ready a street railway sprinkler, which will have in addition to the ordinary range given by the discharge of water by gravity a further arrangement consisting of a pump and motor which will throw a spray of water for 20 ft. or more from the side of the car.

The American Brake Shoe Company, of Chicago, will show various samples of the Diamond "S" brake shoe, and it is hoped that all interested in the subject will examine this exhibit and become fully posted in regard to the construction and advantages of these shoes.

The Duquesne Forge Company, of Rankin Station, Pa., will have on exhibition a number of forged steel axle gears, together with forged steel pinions, and extends to all delegates and visitors to the convention a hearty invitation to carefully inspect these products.

John Stephenson Company, Ltd., of New York, will have at the convention a complete model of the New York Broadway car. This model is very highly finished, and is built to a perfect scale. It is the same one that was shown at the recent Electrical Show in New York.

The New York Switch & Crossing Company, of Hoboken, N. J., has reserved a place at the corner of Washington and Boylston Streets, Brookline, Mass., where it will show its electric track switch in actual operation. This corner is convenient to reach from convention hall.

The American Rail-Joint & Manufacturing Company, of Cleveland, Ohio, will make a display of its rail joints, and will give practical illustrations of the manner in which they are driven on and off. The company's interests will be looked after by W. E. Ludlow, general manager.

The Crouse-Hinds Electric Company, of Syracuse, N. Y., expects to have on exhibition its Syracuse changeable electric headlights. These headlights have now come into extensive use, and the company is receiving splendid testimonials regarding the satisfaction which they are giving.

The International Register Company, of Chicago, Ill., will have at the convention a complete line of its well-known registers. These registers are made in various styles and to suit various conditions, and have been adopted as standard by a large number of leading street railway companies.

Barbour-Stockwell Company, of Cambridgeport, Mass., will probably show several styles of special work in girder and T rails, and also minor appliances which it manufactures. This company will also exhibit several "Composite" brake-shoes and a Parmenter fender for which it is the selling agent.

The Allen & Morrison Brake Shoe & Manufacturing Company, of Chicago, will make an extensive display of brake shoes for surface and elevated railway cars. These shoes have been in use for some time on the street railway and elevated lines in Chicago and have shown unusual wearing qualities.

Wendell & MacDuffie, of New York city and Boston, will represent at the convention, as manufacturing agents, the following companies: The American Rail Joint & Manufacturing Company, the Western Gear Company, The Taunton Locomotive Manufacturing Company, and the Rochester Car Wheel Works.

The Buda Foundry & Manufacturing Company, of Chicago, will show samples of its standard Paulus track drill, both light and heavy patterns; the Paulus track drill as arranged for girder rails, and the Wilson track drill which is a drill weighing only 20 lbs., and especially designed for drilling small holes not exceeding ½ in. in diameter for bond wires for signal circuits.

The Consolidated Car Heating Company, of Albany, N. Y., will exhibit at the convention a full line of electric heaters and temperature regulating switches. This company also expects to show some improved types of heaters, and will exhibit the heaters, which are standard on the Metropolitan Street Railway, of New York.

The Watson-Stillman Company, of New York City, intends to show at the convention a line of hydraulic tools, consisting of hydraulic jacks, hydraulic motor lifts, hydraulic rail benders, and hydraulic punches. These tools, to a great extent, are of entirely new designs, and should be carefully examined by all delegates and visitors.

The Westinghouse Electric & Manufacturing Company, of Pittsburgh, Pa., has made extensive preparations for the convention, and will exhibit the following: One 25-k.w. rotary transformer (500 volts, direct current, 7200 alternations, two-phase), 1800 r.p.m.; one 1-h.p. motor generator for exciting the above rotary, comprised of 300 volts, shunt wound, 1800 revolution generator and 200 volt, two-phase 7200 alternation motor; one pedestal upon which will be mounted a pneumatic switch and circuit breaker for railway switchboards; one $2\frac{1}{2}$-h.p. motor, operating rotary pump; six 500-volt series arc lamps; six 110-volt A. C. arc lamps, indoor; six 110-volt A. C. arc lamps, outdoor; one 15-k.w. multipoint outo-converter, for operating the above lamps; six A. C. fan motors; six D. C. fan motors. Besides the above this company will show numerous small details, such as choke coils, lightning arresters, line arresters, railway fuse blocks, tank lightning arresters, canopy switches, rheostats, etc.

The W. T. Van Dorn Company, of Chicago, will be represented as usual by W. T. Van Dorn, and a full line of samples of the different classes and sizes of couplings which his company makes will be shown. Mr. Van Dorn will also have a full line of prints and photographs of the same framed, showing different styles; also a book of prints showing in detail everything this company builds.

The American Stoker Company, of New York City, does not intend to make an exhibit at the convention hall, but this company will be pleased to have all delegates and visitors to the convention visit its Boston office, 439 Exchange Building, where a full sized American stoker is in operation, and where the strong claims made for this device can be fully demonstrated.

The Weber Railway Joint Manufacturing Company, of New York City, will have a representative at Boston, and will exhibit a number of the Weber joints showing the latest practice of this company in street and steam railroad work. To fully illustrate the work which this company is doing it will show a few joints taken from the track after a service of some four or five years.

Wilson, Thomson & Company, of Brooklyn, will have a number of their trolley pole catchers in operation at the convention. Practical test will be made on this device and several will be taken apart so as to show the simple mechanism. This exhibit will be made in conjunction with the New England agent of the company, C. N. Wood. Mr. Wilson and Mr. Thomson, of the Brooklyn office, will both be in attendance.

The J. G. Brill Company's exhibit will consist of a new convertible open and closed car. This car is a novelty, and it is claimed to be entirely different from any convertible car that has yet been brought out. The Brill Company will also show its Eureka maximum traction trucks, its No. 21 E. trucks, its No. 27 and 27 D. trucks, together with light supply material, such as radiating draw bars, pedal alarm gongs, etc.

William Wharton, Jr., & Company, of Philadelphia, Pa., will exhibit several of their various makes of special work, particularly their well-known Manganese steel girder and their Manganese steel T rail work showing some further improvements in the details of construction which this company has made in the past year. The company will have several representatives in Boston, including its Boston agents, Harrington, Robinson & Company.

The Duplex Car Company of New York is making arrangements for showing one of its duplex cars during the convention. This car is built from new designs, and the company is making preparation to thoroughly introduce the "Duplex" car throughout the country. The company's office is in the Postal Telegraph Building, New York. This car is adapted to summer and winter use and can be changed wholly or partially from one to the other in a few minutes.

The New York Car Wheel Works, of Buffalo, N. Y., are planning to show a number of pairs of their "machined" car wheels mounted on special axles, among which will be the standard type in use on the Boston Elevated Railway, which road has been using the wheels of the New York Car Wheel Works for several years past. There will also be shown at this exhibit specimen sections of various styles of wheels, showing character of iron and chill, together with test bars, chill-blocks, etc

The Lap Joint Railway Track Company, of New York City, is preparing to exhibit a full-sized model of its new system of track construction with 67-lb. rail. Sections and drawings of this track will also be shown with a detailed description of all head rails giving the number of parts per mile. A representative from the engineering department of this company will be on hand to make estimates of cost of construction and give any additional information desired regarding the new method of construction.

The Keystone Electrical Instrument Company, of Philadelphia, is making plans to have on exhibition a switchboard in operation on which will be one of each of this company's four different types of switchboard instruments, together with an arc-light voltmeter and ground detector for constant potential circuits. The company will also show a full line of its portable testing instruments consisting of voltmeters, ammeters and wattmeters. This company is also arranging to have on exhibition a railway switchboard, consisting of one generator and ten feeder panels on which will be shown the regular line of Keystone switchboard instruments for street railway plants. This board will be complete in all respects with circuit breakers, switches and all necessary appliances.

The Walker Company, of Cleveland, will exhibit the following Walker apparatus: Section of Walker underground conduit system with car in operation, Walker No. 15 L railway motor in operation, Walker No. 15 L motor open to show construction, Walker No. 33 S motor mounted, Walker No. 33 S motor open, set of 33 S armatures in various stages of construction, set of 33 S motor parts, Walker standard trolley, Walker standard railway switchboard panels with wattmeter, "S" controllers in operation, solenoid partitions open and in operation.

McCardell, West & Co., of Trenton, N. J., expect to show a Trenton trolley wagon of the latest improved pattern. This wagon is the result of several years careful study of the requirements of street railways for all-round service. The fact that all overhead work can be done from the extended platform without interfering with passing cars, that the tower and extension platform can be easily operated and placed in any position by one man, and that any changes in the position of tower and platform can be made in a very short time, makes this wagon a very necessary labor-saving device to any street railway company.

The New Haven Car Register Company, of New Haven, Conn., intends making a complete exhibit of the various styles of its single, double and triple registers, embracing the latest features. Special attention will be called to a double register intended to prevent dishonest conductors from turning in transfers instead of cash fares, also a double register intended for use in cars running over two connecting but independent lines. Each side of the register is complete and perfectly independent of the other side, and each road has its own side of the register, which its conductor securely locks upon leaving the car.

The Johnson Company, of Johnstown, Pa., will send to the convention for exhibition four types of equipments, namely, 30, 35, 45 and 50-h.p. motors, some of which will be mounted on Dupont trucks, which are manufactured by the Johnson Company. This company will also show the latest type of controllers for use with two, three and four-motor equipments. It is stated that the controllers made by the Johnson Company for three and four-motor equipments are the only ones for this class of work on the market. All the parts which constitute a complete equipment will also be shown at the Johnson exhibit.

The Columbia Machine Works, of Brooklyn, N. Y., will have a full line of goods at the exhibition, including assembled segments of the Westinghouse No. 38, 12 A., 12 and 3 machines; General Electric 800 and 1000 machines; W. P. 50 form 7, 1 and 4 machines; Steel motors C and C 3; trolley wheels, trolley harps, trolley poles, gears, pinions, splicing ears, straight ears, straight line ears of several patterns, feed ears, commutator bars of various styles, controller parts, canopy switches, car trimmings, controller handles of various styles, bearings, Babbit metal commutator rings, interchangeable bearings, brush holders, brush springs, etc.

The Standard Underground Cable Company, of Pittsburgh, Pa., intends to show a very handsome large sample board of all its products and a number of samples of street railway feeder cables, overhead and underground, such as it has furnished to many of the leading street railway companies in America, including the Boston Elevated system. This company will be represented at the convention by George L. Wiley, manager of the Eastern sales department, with headquarters at New York; Thomas E. Hughes, manager Southeastern sales department, with headquarters at Philadelphia, and the company's secretary and treasurer, F. A. Rinehart, of Pittsburgh.

The Ohio Brass Company, of Mansfield, Ohio, has secured a large space, prominently located, where it intends to make a very large and attractive exhibit, and if possible to surpass anything which it has ever done at conventions in previous years. The exhibit will be in charge of C. K. King and A. L. Wilkinson, of the Mansfield office. The following is a partial list of devices which this company will show: Wood's adjustable pole bracket, Wood's flexible pole bracket, several types of wire hangers, clamps, ears, splicers, couplers, insulators, rail bonds, axle bearings, motor bearings, etc. The Ohio Brass Company will distribute as usual a very attractive souvenir at the convention.

The Robinson Electric Truck & Supply Company, of Boston, Mass., is intending to place on exhibition a model of its radial truck for electric cars, also a very elaborate model of Robinson's radial palace car truck. This latter truck is adapted for palace cars and composite cars, as well as the heavier type of day coaches for steam roads. This company will also exhibit a model of its 4-in. wheel radial truck. The Robinson truss rail joint, which is said to be a radical departure in rail joints, will be exhibited, and the company also intends to distribute circulars illustrating and describing the new Robinson electric railway system, which it is claimed successfully solves many of the problems which have arisen in heavy electric railroading work.

E. T. Burrowes Company, of Portland, Maine, purposes to show a complete line of Burrowes' patent car curtains and curtain fixtures, as well as curtain material and findings. This company will also exhibit its No. 83 curtain device for box-car curtains. This device is a great improvement, and is giving satisfaction wherever it is used. It may be operated by pressing the handles together. The Burrowes Company will show its Climax open car curtain holding mechanism. It is claimed that with this arrangement the life of the curtain is just doubled. The Oakette car curtain material, which is now in use very extensively throughout the United States, will also be shown in connection with this company's exhibit.

The Taylor Electric Truck Company, of Troy, N. Y., will exhibit one of its latest improved single trucks with 7-ft. wheel base and with 33-in. wheels; one of its latest improved single trucks with extension truss for long open cars; one extra-heavy single truck with 8-ft. wheel base; one set of the Empire State Radial trucks, covering all of the latest improvements. This company will also show a set of new design swing motion double trucks. This last mentioned truck is built very low down and very compact, the idea being to carry long open cars having no wider frame than the ordinary single truck car. With this truck it is also possible to reduce the height of the step, and the truck, it is anticipated, will attract considerable attention from delegates.

The H. W. Johns Manufacturing Company, of New York City, will make an attractive display of its electric materials in a space on the main aisle near the front entrance of the exhibition hall. A large part of this space will be devoted to a display of the various appliances manufactured from "vulcabeston." To illustrate the durability of this material at high temperatures samples of controller arc deflectors will be shown for the first time which have endured a temperature represented by a red heat without injury. The exhibit of moulded mica trolley line insulators will also be complete. The great strength and durability of these supplies are now recognized by street railway managers throughout the country. The Johns Company's all-steel trolley bracket, with flexible attachment to the pole, will be shown and will be of interest to street railroad men, as it is a new device in the way of a flexible or elastic support for the trolley wire. This company has brought out two new styles of electric car heaters during the past year, and these heaters will be shown for the first time at Boston. It is expected that the Johns Company will be represented by the following delegates from its branch houses: H. A. Reeves of the Chicago office, J. W. Perry and possibly D. T. Dickson of Philadelphia, H. C. Spalding of Boston and A. Hall Barry, S. G. Meek, J. E. Meek and W. F. D. Crane of the New York office. The latter will have general charge of the exhibit and J. E. Meek will give his undivided attention to the heaters.

The General Electric Company will be well represented at Boston by engineers and agents, and will have an exhibit at Mechanics' Hall, both interesting and novel. It will establish its headquarters at the Brunswick Hotel, with a reception room on the first floor, to which all delegates are invited and will be made warmly welcome. Advantage will be taken of the fact that Boston is distinctly a General Electric center, where, with the growth of rapid transit, may be seen the actual development of the electric railway, to arrange a series of visits to different stations where General Electric apparatus may be seen in commercial operation. The proximity of the Lynn Works of the company will also afford the delegates an opportunity of visiting them and of appreciating the excellence of the methods employed in the construction of railway apparatus. Much new literature will be published by the General Electric press for distribution at the convention. This will be found by delegates both at Mechanics' Hall and at the company's headquarters. To W. J. Clark, general manager of the railway department, the interests of the General Electric Company will be confided. He will be assisted by the following representatives: C. C. Pierce and C. D. Haskins, of Boston; W. C. Fish, of Lynn; W. B. Potter, F. E. Case, J. R. Lovejoy, H. C. Wirt and W. G. Cary, of Schenectady; R. H. Beach and J. J. Mahoney, of New York; W. G. Bushnell, of New Haven; H. J. Crowley, of Philadelphia, Pa.; A. F. Babson, of Baltimore; P. T. Bailey, of Chicago, Ill.; George D. Rosenthal, of St. Louis, Mo.; F. H. Strieby, of Cincinnati, Ohio; F. F. Barbour, of San Francisco, Cal., and S. W. Trawick, of Atlanta, Ga.

SOME OF THE APPARATUS IN USE IN BOSTON AND VICINITY

The following is a partial list of manufacturers having street railway apparatus and material in use in Boston and vicinity:

The American Stoker Company, of New York, has installed the American stoker in a number of steam plants in Boston.

The Burt Manufacturing Company, of Akron, Ohio, supplied the Cross oil filters which are used in the "Marble Engine Room" in Boston.

The Composite Brake Shoe Company, of Boston, numbers among its customers practically every street railway company in New England.

The Neal Electric Headlight Company, of Boston, Mass., has furnished the Boston Elevated system with a large number of Neal headlights.

Barney & Smith Car Company, of Dayton, Ohio, has forty-eight class "G" single trucks and about 100 closed motor car bodies in operation in the city of Boston

A. O. Norton, of Boston, has sold the Boston Elevated Railway a large number of the Norton jacks, and these jacks are also used on many of the roads near Boston.

The Van Dorn & Dutton Company, of Cleveland, Ohio, number among their customers a large majority of the leading street railway systems in the East, especially those in the vicinity of Boston.

The Crouse-Hinds Electric Company, of Syracuse, N. Y., has received orders for the Syracuse changeable electric headlights from many of the roads running out of Boston and very generally throughout New England.

The Standard Air Brake Company, of New York City, has two equipments of brakes on the Commonwealth Avenue Street Railway, and will have several more in operation on that road before the date of the convention.

The Standard Underground Cable Company, of Pittsburgh, Pa., has large quantities of its 1,000,000 and 500,000 C. M. lead covered feeder cable on the Boston Elevated system. This cable has been in use in Boston for from one to five years.

The Robinson Electric Truck & Supply Company, of Boston, has had a large number of Robinson radial trucks in Boston and other parts of New England since 1890 and 1891.

The New Haven Car Register Company, of New Haven, reports that the New Haven register has been adopted by a very large number of the roads in the vicinity of Boston, and that this register is in use on 70 per cent of the roads throughout New England.

The Columbia Machine Works, of Brooklyn, N. Y., have supplied a number of the street railways centering in Boston with assembled segments, trolley wheels, harps, poles, gears, pinions, ears, commutator bars and various other specialties which they manufacture.

The New York Car Wheel Works, of Buffalo, N. Y., hold contracts to furnish their "machined wheels" and special axles to about 80 per cent of all the important street railway systems east of the Alleghany Mountains, including many of the roads in and near Boston.

E. F. De Witt & Company, of Lansingburgh, N. Y., manufacturers of the "Common Sense" sand boxes, have had sand boxes in use on 175 cars of the Boston Elevated system for the last four years, and they appear to be as good to-day as when first placed upon the cars.

The Phœnix Iron Works, of Meadville, Pa., have a 100 h.p. simple engine directly connected to a Siemens & Halske generator in the building of the Mechanics' Charitable Fair Association. This engine was bought by the association, and all delegates and visitors are invited to examine it.

The Consolidated Car Heating Company, of Albany, N. Y., has equipped 1000 cars belonging to the Boston Elevated system with its standard McElroy heaters. The Lynn & Boston Railroad has about fifty equipments of this type of heaters, and the Commonwealth Avenue Street Railway has four.

The Weber Railway Joint Manufacturing Company, of New York City, has received several duplicate orders for the Weber joints from the Lynn & Boston and the Boston Elevated Railroad. The joints are also in extensive use on the Boston & Maine Railroad and the New York, New Haven & Hartford Railroad.

The Taunton Locomotive Manufacturing Company, of Taunton, Mass., through its selling agents, Wendell & MacDuffie, of New York, has placed a large number of snow plows in operation on the street railways in Massachusetts. Among the roads in the vicinity of Boston using these plows are the Boston Elevated Railway, Commonwealth Avenue Railway, Hanover Street Railway, Hingham Street Railway, Rockland & Abington Street Railway, Wakefield & Stoneham Street Railway, Fitchburg & Leominster Street Railway, Lowell, Lawrence & Haverhill Street Railway, Lowell & Suburban Street Railway, Newton & Boston Street Railway, and many others.

Wilson, Thomson & Company, of Brooklyn, N. Y., have recently sent eighty-nine of their trolley wheel catchers to the Brockton Street Railway Company, and twenty-five to the Lowell, Lawrence & Haverhill Street Railway Company. This device is also being tested by a number of other street railway companies in New England.

The Ohio Brass Company, of Mansfield, Ohio, has a great many regular customers among the street railway companies in Eastern Massachusetts, including the Warren, Brookfield & Spencer, Conway Electric, Fitchburg & Leominster, Holyoke, Leominster & Clinton, Nantasket Beach Electric, Worcester Consolidated, and many others.

The Edward P. Allis Company, of Milwaukee, Wis., writes that all of the street railways in Boston are operated by Allis' engines, with the exception of one small power house. It is stated that the triple engines installed in the Albany Street station by the Allis Company were the first engines of that character ever built for power purposes.

Williamson & Company, of Allegheny, Pa., owners and manufacturers of the Ramsey signal system, have installed this system on the Quincy & Boston Street Railway, the Hingham Street Railway, the Newton & Boston Railway and the Fitchburg & Leominster Street Railway. All of these companies speak very highly of the Ramsey signal.

McCardell, West & Company, of Trenton, N. J., have over 300 of their Trenton trolley wagons now in use. Among the places in the vicinity of Boston where these wagons are used may be mentioned Lowell, West Newton, Worcester, Providence, R. I., Portland, Maine, and Hartford, Conn. The Trenton wagons are also used in the city of Boston.

The Fuel Economizer Company, of Mattewan, N. Y., has the Green economizer in operation at the Harvard Street power station in Boston, and also at the Dorchester and Charleston power station. These economizers are also working at the Chestnut Hill pumping station, Deer Island, East Boston and Old Harbor Point and in a number of mills and factories in and around Boston.

E. T. Burrowes Company, of Portland, Me., reports that the Burrowes' shades are standard on the Boston Elevated Railway, and that company has between 500 and 600 cars equipped with these curtains. The Newton & Boston, Quincy Street and Commonwealth Avenue railway companies, and also a number of suburban lines in and about Boston are using the Burrowes' patent car curtains.

J. A. Grant & Company, of Boston, agents for the McIntosh & Seymour engines, have secured orders for engines from the Lowell, Lawrence & Haverhill Street Railway, Gloucester, Essex & Beverly Street Railway, Wakefield & Stoneham Street Railway, Brockton, Bridgewater & Taunton Street Railway, Conway Street Railway, Norton & Taunton Street Railway, Milford & Hopedale Street Railway.

The Corning Brake Shoe Company, of Buffalo, N. Y., has brake shoes in use on the following roads in the vicinity of Boston: Haverhill & Amesbury Street Railway, Lowell & Suburban Street Railway, Natick & Cochituate Street Railway, Newton & Boston Street Railway, Norfolk Central Street Railway, West Roxbury & Roslindale Street Railway, Wellesley & Boston Street Railway, and Athol & Orange Street Railway.

The Jackson & Sharp Company, of Wilmington, Del., has furnished equipment to the following roads in the vicinity of Boston: Braintree & Weymouth Street Railway, Braintree Street Railway, Commonwealth Avenue Street Railway, Gloucester Street Railway, Gloucester, Essex & Beverly Street Railway, Hanover Street Railway, Hingham Street Railway, Milford & Hopedale Street Railway, South Middlesex Street Railway, and Milford, Holliston & Framingham Street Railway.

The International Register Company, of Chicago, has equipped the East Boston Division of the Boston Elevated Railway with its double registers. The following roads near Boston are using either a partial or entire equipment of the International signal registers: Brockton Street Railway, Lowell, Lawrence & Haverhill Street Railway, Lynn & Boston Railway, Taunton & Brockton Street Railway, Hingham Street Railway, Worcester & Suburban Street Railway, and Worcester & Clinton Street Railway.

The Pearson Jack Company, of Boston, Mass., has sold Pearson jacks to a very large number of street railway companies in Massachusetts, including the Newton Street Railway, Lowell, Lawrence & Haverhill, Holyoke Street Railway, Boston Elevated Railway, Commonwealth Avenue Street Railway, Gardner Electric Railway, Quincy & Boston Street Railway, Hingham Street Railway, and Wakefield & Stoneham Street Railway. The Pearson Jack Company has received a large number of good testimonials from the users of these jacks, stating that the device is giving entire satisfaction.

Harold P. Brown, of New York, writes that the Edison-Brown plastic rail bond has been used by the Hingham Street Railway for the past two years and a half, and reports them as good as new. The plastic bond is also quite generally used throughout New England. Among the cities where it has been installed are Providence, Fall River, New Bedford, Fayville, Framingham, etc., and the Boston Elevated Railway has made very thorough tests of these bonds, and is now using a large number of them.

The Taylor Electric Truck Company, of Troy, N. Y., has a large number of trucks in use in the vicinity of Boston. All of the long open cars on the Lowell & Suburban Street Railway are mounted on Taylor Empire State Radial trucks, also all the long open cars on the Commonwealth Avenue Street Railway, and several of the cars on the Natick & Cochituate Street Railway, and at other places. There are also some specially designed Taylor trucks on the lines of the Brooklyn Elevated Street Railway.

Albert & J. M. Anderson Manufacturing Company, of Boston, Mass., has supplied a great deal of the apparatus in use in the five Edison stations in Boston, including end cell switches, etc., in stations No. 1, 2, 4 and 5, and a switchboard in station 3. Most of this work is heavy. This company has also supplied practically all the overhead insulators used on the Boston Elevated system, also rail bonds. Albert & J. M. Anderson Manufacturing Company has also supplied a very large amount of smaller material in Boston in the way of switchboards, switches, etc.

The Johnson Company, of Johnstown, Pa., has equipped within the past two months two interurban street railways not far from Boston. These are the Worcester & Clinton and Webster & Dudley Street Railways. Twelve cars are operated on the former road, each of which is equipped with Johnson's apparatus throughout. The latter road operates six cars, and these are also equipped with Johnson motors and appliances. The motor controller and other apparatus used on these roads are the latest type manufactured by the Johnson Company, and the owners of the roads are very much pleased with the way the Johnson apparatus works.

The Westinghouse Electric & Manufacturing Company, of Pittsburgh, has furnished the Boston Elevated Railway with about 950 motors, and the Commonwealth Avenue Street Railway with about ninety motors. The following railways are using the Westinghouse equipments in varying numbers according to size of the roads: Randolph Street Railway, Braintree & Weymouth Street Railway, Hanover Street Railway, Norfolk Suburban Street Railway, Milford, Holliston & Framingham Street Railway, Natick & Cochituate Street Railway, Newton & Boston Street Railway, Wakefield & Stoneham Street Railway, Gloucester & Rockport Street Railway, Gloucester, Essex & Beverly Street Railway, Gloucester Street Railway.

The Heine Safety Boiler Company, of St. Louis, has made a number of interesting installations of the Heine boiler in New England. These include the plants of Warren Manufacturing Company, Warren, R. I.; Hartford Street Railway Company, of Hartford, Conn., and Ansonia Brass & Copper Company, of Ansonia, Conn. It is stated that the Warren Manufacturing Company made last year the lowest record in fuel consumption per h.p. hour of any of the New England cotton mills. The Heine Safety Boiler Company's best installations in the city of Boston are the plant of R. H. White & Company, dry goods, and that of the Quincy House. Representatives from the Boston office will be very glad to show any of the delegates to the convention any of these plants. Russell Walker is manager of the Boston office.

The Hazelton Boiler Company, of New York City, has installed five 200 h.p. boilers in the works of the Boston Gas Light Company, and is now erecting three 250 h.p. boilers in the electric department of the Gas Light Company of Allston, Mass., and two additional boilers of 150 h.p. each in the plant of the South Middlesex Street Railway, at South Framingham, Mass. All of these 250 and 150 h.p. boilers are to be equipped with the new Hazelton steel settings with square furnaces and square grate surfaces lined with brick to full height. These boilers will make a very fine appearance, and will occupy very small floor space. An inspection of any of these plants will fully repay any one interested in steam production, and all visitors to the convention are cordially invited to examine them.

The Pennsylvania Steel Company, of Steelton, Pa., has built a number of fine pieces of special work for the Boston Elevated Railway. Among these may be mentioned the special work at the corner of Washington and Summer Streets, Washington and Broadway, Tremont and Columbus Streets, Columbus and Roxbury Streets and at Battery and Commercial Streets this company installed what is claimed to be the only steam railroad crossing made entirely of cast steel with hard steel plates. The Pennsylvania Steel Company has also done considerable structural work in Boston. This includes the train shed for the Union Station, most of the steel work for the Boston Subway train shed for the new Southern Station, the Charlestown bridge, and all the bridges for track elevation work at Readville for the New York, New Haven & Hartford Railroad and the New England Railroad.

Wm. Wharton, Jr., & Company, of Philadelphia, have supplied a very large proportion of the special work in use in and around Boston. Among the layouts which are particularly worthy of mention are the following, all of which were installed by the Wharton Company: Dorchester Avenue and West Fourth Street, Washington, Kneeland and Elliot Streets, Washington and Hanover Streets, Shawmut Avenue and North Hampton Streets, Tremont and Elliot Streets, Tremont and Dartmouth Streets, Milk, Federal and Congress Streets, Bluehill Avenue and Warren Street, and Washington Street and Temple Place. Besides these the Wharton Company has furnished a great number of minor layouts, and there are in the vicinity of Boston nearly 100 of the Wharton unbroken main line crossovers. This company states that all the rails contracted for by the Boston Elevated Railway this year have also been furnished by them. Harrington, Robinson & Company, of Boston, are the New England agents for Wm. Wharton, Jr., & Company.

Personal

MR. W. R. BENSON, of Mt. Vernon, N. Y., has been appointed general manager of the Tarrytown, White Plains & Mamaroneck Electric Railway.

MR. HENRY B. NILES, of the Mexico City Tramways Company, has just made a flying visit to New York and Boston, and returns to Mexico early in September.

MR. CHARLES DAY, of the firm of Cole, Marchant & Morley, engine builders, of Bradford, England, is making a visit in the United States. Mr. Day is investigating the latest American practice in engine building, especially for tramway work.

MR. W. B. KELLOGG, chief engineer of power station of the Syracuse (N. Y.) Rapid Transit Railway Company, has resigned that position. In token of the high esteem in which he is held by his associates, he was presented with a scarf pin and a gold watch charm.

MR. O. A. DALE has accepted a position with the Lewiston (Me.), Brunswick & Bath Street Railway Company as master mechanic and superintendent. Mr. Dale has for the past ten years carried on a very successful business as an independent street car painter, having at the present time contracts for painting cars from twenty-three different roads.

MR. J. H. NEAL, chief clerk of the Boston Elevated Railway Company, has been connected with that system since 1889. Mr. Neal is well known in street railway circles as the inventor of the electric headlight which bears his name. This headlight is now used on many street railway systems throughout the country.

MR. F. E. DRAKE, of the Walker Company, has been selected as electrical adviser to Commissioner General Ferdinand Peck, of the United States, to the Paris Exposition of 1900. Mr. Drake will sail for France with the commissioner general and party on the steamer "La Touraine" from New York on Sept. 3. He expects to return to this country about the middle of October, and will then resume his duties with the Walker Company.

MR. WILLIAM J. WILCOX, of Rochester, N. Y., has been appointed general manager of the Irondequoit Park Railroad Company, of Rochester, better known as the Glen Haven Electric Road. Mr. Wilcox was last year excursion and entertainment manager of this road. He has had years of experience with the excursion and traveling public, and has made the subject of creating pleasure traffic a special study. Since Mr. Wilcox has been connected with the Glen Haven Electric Railroad the summer business on that line has greatly increased, owing to several changes and new methods which he has introduced.

MR. F. E. HUNTRESS, of Boston, is well and favorably known in the street railway field. He was born in Biddeford, Maine, and graduated from Harvard College in 1889, entering the street railway business in 1890. He acted as selling agent for the Wrought Iron Casting Company, of Boston, until 1893, when he established the firm of F. E. Huntress & Company, manufacturers and agents of iron and steel. He has also acted as the Eastern representative of the Barney & Smith Car Company, of Dayton, Ohio. In 1895 Mr. Huntress became the owner of the Neal electric headlight, which, through his persistent efforts, has become one of the best-known street railway devices ever placed on the market. He was nominated for City Council of Somerville, Mass., on an independent ticket and elected after a spirited campaign; he was re-elected by a very large majority. In 1896 he was nominated for the Massachusetts Legislature on an independent ticket, defeating the regular Republican candidate in a district having a usual Republican majority of over 1500. In 1897 he was nominated unanimously by the Republican party and elected by an overwhelming vote.

MR. JAMES CLIFTON ROBINSON, C. E., is the managing director and engineer of the Middlesborough, Stockton & Thornaby Electric Tramway, of Middlesborough, England, which was recently opened for operation, and it is to Mr. Robinson's foresight and engineering skill that this enterprise has been carried through so successfully. Mr. Robinson is very well known both in Europe and in America among street railway men, and has been actively engaged in the construction of many important street railway systems in both hemispheres. He was a member of the engineering staff of the first tramway built in Europe, which was constructed at Birkenhead, and in 1872 he was appointed general manager of the tramways in Cork, Ireland. In 1875 he became manager of the Bristol Tramways, then in process of construction. In 1882 he was picked out from nearly fifty candidates for the important position of general manager of the Edinburgh Street Tramways. In 1887 he visited America, and was engaged by the owners of the Los Angeles (Cal.) Cable Railway Company to reorganize, extend and manage the affairs of that company, which he did with great credit to himself. While in America he presented a paper before the American Street Railway Association on the "Progress of Motive Power." Since returning to England he has been managing director and engineer of the Imperial Tramways Company and of the London United Tramways Company.

Obituary

MR. CHARLES W. GERKE, assistant secretary and treasurer of the Fort Wayne (Ind.) Consolidated Street Railway Company, died on Aug. 7, at Fort Wayne. Mr. Gerke was born in Fayette County, Iowa, Nov. 8, 1869.

MR. CHARLES B. REAVIS, auditor of the Augusta (Ga.) Railway & Electric Company, and ex-vice-president of the American Street Railway Accountants' Association, died suddenly at the Augusta City Hospital, on Aug. 2, of Bright's disease. Mr. Reavis was born at Warrensburg, Mo., in 1864, and was associated with Col. D. B. Dyer in Kansas City, Mo., for a number of years, afterward moving to Augusta to take the position with the Augusta Railway & Electric Company which he held up to the time of his death. He took an active interest in the affairs of the American Street Railway Accountants' Association, and was one of its most earnest supporters.

AMONG THE MANUFACTURERS

THE WASHBURN & MOEN MANUFACTURING COMPANY has recently brought out as a souvenir a handsome miniature, tastefully framed, which is bound to be most popular.

THE DEARBORN DRUG & CHEMICAL WORKS, of Chicago, Ill., have recently analyzed fourteen boiler feed waters and shipped two car loads of suitable scale solvents to large sugar concerns in the Hawaiian Islands.

THE WILLIAMS TRUSS RAIL-JOINT COMPANY, of Chicago, reports that its business is rapidly increasing; inquiries are being received from all over the country, and present sales and prospects for future ones are very encouraging.

THE CHRISTENSEN ENGINEERING COMPANY, of Milwaukee, has recently published a catalogue showing views of the different cars equipped with Christensen air brakes. The pamphlet gives a very good idea of the extent of the use of these brakes.

C. TOWNSEND BLAKE, of Philadelphia, Pa., has just been successful in placing an issue of bonds for the Mason City & Clear

Lake Railway Company, of Mason City, Ia. The bond issue is for $100,000, and the bonds are first mortgage 6 per cent. The mortgage was placed in Boston.

THE AMERICAN RATTAN & REED MANUFACTURING COMPANY, of Brooklyn, N. Y., reports a good demand for its rattan car seating. This seating is well adapted to the uses for which it is intended, and the company is receiving splendid testimonials from its customers everywhere.

THE CREAGHEAD ENGINEERING COMPANY, of Cincinnati, Ohio, supplied the flexible brackets which were used in the construction of the Mt. Tom Electric Railway at Holyoke, which was described in the August issue of the Street Railway Journal. These brackets are very strong and durable, and are unusually neat and pleasing in appearance.

THE BETHLEHEM IRON COMPANY, of South Bethlehem, Pa., has been asked to bid on the bronze for the engine and shafting of a torpedo boat to be built in Japan for the Imperial Japanese navy. The line of shafts, including the thrust and crank-shafts, are to be hollow. It is stated that the Bethlehem Iron Company is the only concern in America that has been asked to bid on this work.

THE CONSOLIDATED CAR FENDER COMPANY, of Providence, R. I., is sending to its friends and customers a very neat little " reminder " in the way of a little book of oiled papers for carrying stamps. The stamp book is attached to a folder briefly calling attention to the fact that Providence car fenders have proven themselves to be positive preventives of serious accidents and consequent suits for heavy damages.

THE BEMIS CAR BOX COMPANY, of Springfield, Mass., is receiving a number of good orders for the Bemis trucks. The new Bemis double trucks are giving excellent satisfaction, and the company has received a letter from the Newton & Boston Street Railway stating that the public waits for cars that are equipped with the Bemis truck in preference to riding on any others.

THE WAGNER ELECTRIC MANUFACTURING COMPANY, of St. Louis, Mo., are manufacturers of alternating-current power motors, ammeters, voltmeters and wattmeters for alternating currents, electric fans, transformers of every description, high potential and other types of switchboards, switches, etc. This company is also building a very successful line of direct-current motors and dynamos.

J. A. FAY & COMPANY, of Cincinnati, Ohio, manufacturers of all kinds of improved woodwork machinery, have recently furnished the entire equipment of woodworking machinery for the new shops of the Consolidated Street Railway Company, of Cincinnati. These shops are among the best equipped in the country, and they have been fitted out according to the latest ideas for both making and repairing cars.

THE J. G. BRILL COMPANY, of Philadelphia, has issued a pamphlet describing and illustrating the Brill snow sweepers, snow plows and track scrapers. The Brill standard snow sweepers are operated by three electric motors, two being used for propulsion and one for driving the brooms. The latter is placed inside the cab in a diagonal position parallel with the brooms, which are driven from it by sprocket wheels and chains.

THE PANTASOTE COMPANY, of New York City, reports that "Pantasote" is coming to be recognized by street railway managers everywhere throughout the country as one of the best materials for car curtains, car wheels, etc., upon the market. The manufacturers claim for " Pantasote " a number of very strong features, the principal ones being that it does not crack, peel or rot, and retains its original surface under all conditions of climate and temperature.

THE NEW YORK ELECTRICAL WORKS, of Brooklyn, N. Y., designers and makers of trolley fittings, have published a new catalogue and price list describing the different kinds of insulators, suspensions, trolley wire crossings, strain ears, splicers, etc., which it supplies. The company's aim has always been not only to supply the best insulations for railroad purposes, but also to insure to its customers a line of appliances of the highest grade in every particular.

THE WASHBURN & MOEN MANUFACTURING COMPANY, of Worcester, Mass., through its Houston, Tex., office is sending to friends and customers a very neat paper weight. This company's well known "Crown" rubber covered wire is especially adapted for use behind the decorations in residences, churches, office buildings, etc. The company claims that the use of this wire insures the best possible transmission of electricity and the greatest protection against fire resulting from electrical causes. The Washburn & Moen Manufacturing Company, in addition to making the "Crown" rubber covered wire, manufacture wire for every possible use.

THE ELECTRICITATS-GESELLSCHAFT, FELIX SINGER & COMPANY, ACT., GESELLSCHAFT, has recently been given an order by the Società Romana Tramways Omnibus, at Rome, for the electric equipment of thirty motor cars, consisting of two Walker motors for each car, and it is particularly noteworthy that this order has been given to the above company after a thorough trial had been made of the Walker material by the Roman tramway company.

THE AMERICAN HARD FIBRE COMPANY, of Newark, Del., has recently entered the railway field. This company has a high reputation for the value of its products, and its hard and flexible fibre has had extended use for electrical and mechanical purposes. The company has appointed H. M. Grant, who is well known in the electrical trade, its New York manager, with headquarters at 14 Dey Street. The company has also a European office at Deichstrasse 7, Hamburg, Germany.

THE BIBBER-WHITE COMPANY, of Boston, Mass., is now introducing several new designs in line material, that is, this company now finishes its line material in four different ways—in black, bronze, galvanized and agatized. This last process is entirely new, and furnishes a perfect insulator. It is not necessary with agatized material to use globe strained insulators. The Bibber-White Company reports a large sale in material during the past year, and prospects for business during the coming months are very excellent.

THE CORNING BRAKE SHOE COMPANY, of Buffalo, N. Y., has supplied the Corning brake shoes to the Brooklyn Heights Railway Company, the Nassau Electric Railway, the Coney Island & Brooklyn Street Railway and the Union Street Railway, of New York. These shoes are coming into very extensive use, during the month of July orders for 9000 being booked from New York City alone. The Joshua Hendy Machine Works, of San Francisco, have been appointed representatives for the Corning Brake Shoe Company on the Pacific coast.

THE GENERAL ELECTRIC COMPANY has received an order from the Government of Victoria, Australia, for six Thomson recording watt meters of varying capacities. These will be deposited in the electrical bureau of the home office of Victoria, and will be used as the official standards, by which all electricity meters used in the colony will be tested. It is stated that in future no meters measuring electrical energy will be allowed to go into service in Victoria unless they agree with those just ordered, and receive the final sanction of the Victoria Government.

THE TAUNTON LOCOMOTIVE MANUFACTURING COMPANY, of Taunton, Mass., has published a neat catalogue showing the standard nose plow, the heavy nose plow and the double track share plow, which it manufactures. This company has given special attention to the subject of snow plows for several years, and its well-known apparatus is now in use on a large number of the leading roads of the country. Both in design and workmanship these plows are all that can be desired. Wendell & MacDuffie, of New York City, are selling agents for the Taunton snow plows.

THE AMERICAN IMPULSE WHEEL COMPANY, of New York City, is sending out a very comprehensive catalogue descriptive of the "Cazin" impulse wheel, which it manufactures. It is claimed that this wheel has several points of superiority over any other wheel of its kind, principally in configuration of bucket, which is designed to receive the impinging jet with the smallest possible disturbance by means of a projecting knife-edge lip. It first receives the jet, guiding it into the bucket, where almost complete reversal occurs in all of the various positions taken by the bucket while in contact with the jet.

THE SARGENT COMPANY, of Chicago, reports that its open-hearth steel plant has been running for the past few months at its fullest capacity on several large contracts, among which may be mentioned the castings for 10-in. gun carriages for the United States Government. The Sargent Company has been very successful in this class of work, readily meeting the physical tests prescribed by the Government, as well as the short delivery which is demanded in most cases. The good record that it has been making is taken as an indication that it will obtain a full quota of this class of work in the awarding of future contracts.

THE CHRISTENSEN ENGINEERING COMPANY, of Milwaukee, Wis., has recently had a very efficient demonstration of the efficiency of its system of air brakes. Two cars, one of which was equipped with the Christensen system, met in a head-on collision recently on the Lowell line of the Lowell, Lawrence & Haverhill Street Railway. The cars were on a single track near a sharp turn, and the motormen within a few feet of each other before either knew of the other's presence. The car that was equipped with air brakes was brought to a standstill before the accident occurred, but the other car could not be brought under control in time to prevent a collision.

BROOMELL, SCHMIDT & COMPANY, LIMITED, of York, Pa., manufacturers of the American fuel economizer for heating and purifying feed water for steam boilers, has issued a very neat and attractive catalogue, describing this economizer. The American economizer is a sectional multiple water heater, consisting of a large number of vertical cast iron tubes built up into sections of various widths, which are set up in a flue or passage leading from the boilers to the chimney. The economizer is so arranged that the feed water for the boiler is pumped into it at the end furtherest from the boiler and is discharged at the opposite or hot end of the economizer and delivered into the boiler very hot, from 225 to 350 degs.

THE PENNSYLVANIA CAR WHEEL COMPANY, of Pittsburgh, has been manufacturing car wheels for about three months, and in this brief time has secured contracts for present and future delivery amounting to a grand total of over 20,000 wheels, many of these orders coming from the larger street railway companies. This company's wheels have been accepted to be used under cars carrying from 100,000 to 120,000 lbs. This company's designs for street car wheels have also been well received throughout the country, and one shipment has been made to England. On account of this phenomenal growth this company has already been compelled to increase its facilities, and extensive additions to its plant are under way.

THE WESTINGHOUSE MACHINE COMPANY, of Pittsburgh, has already commenced to reap some benefit from the recent brilliant successes of American arms in Cuba. It has recently secured through its New York office the initial order for a complete steam plant, involving a 100-h.p. Westinghouse engine and Westinghouse generator, together with boiler, pump, piping, etc., this plant to be installed in Santiago de Cuba. The Westinghouse Machine Company, of Pittsburgh, is also building ten 3000-h.p. engines, to be direct connected to 2000 h.p. dynamos built by the Westinghouse Electric & Manufacturing Company, for the Metropolitan Electric Light & Supply Company, of London.

THE SPRINGFIELD MANUFACTURING COMPANY, of Bridgeport, Conn., is meeting with excellent success in introducing its car wheel grinders. These machines are in use in a number of the street railway shops in the United States, and they are demonstrating the claim made for them that they will very soon pay for themselves in the saving effected in the longer life of the car wheels. Among the large systems where these wheel grinders are used are the Union Traction Company, of Philadelphia; The Consolidated Traction Company, of Jersey City; the Metropolitan Railway Company, of Washington; the Consolidated Traction Company, of Baltimore, and the London Tramways Company, of London, England.

CHARLES N. WOOD, of Boston, is one of the best-known men in the electric railway supply business in New England. Mr. Wood's acquaintance with the electric railway business dates back to about 1890, when he was connected with the railway department of the Thomson-Houston Company. Later on he branched out for himself, handling the Nuttall goods and second-hand machinery. At the present time Mr. Wood has pleasant offices in the new Worthington Building, 31 State Street, and is the exclusive Northeastern agent for the Nuttall Company, International Register Company, Van Wagoner & Williams, Wilson, Thomson & Company, American Electric Heating Corporation, and for the track scrapers manufactured by the Monarch Stove & Manufacturing Company.

HARRINGTON, ROBINSON & COMPANY, of Boston, New England agents of Wm. Wharton, Jr., & Company, Incorp., supplied practically every foot of track and every piece of special work in use on the railway systems in Springfield and Holyoke, Mass., described in the last issue of the STREET RAILWAY JOURNAL. Both of these companies have track construction which is properly a subject of pride and credit, and for it due credit should be given Harrington, Robinson & Company, through whom the material was secured. In Springfield and Holyoke all of the special work installed during the last three years is of the Wharton-Manganese type, including the special work in the new car house in Springfield, illustrations of which were published last month. Visitors to the convention who have an opportunity of spending a few additional hours on the way from New York or Albany to Boston or on their return will find much to interest them if they can stop off at Springfield and examine the character of construction on this line. Holyoke is but eight miles away, and is easily reached both by frequent electric car service and steam trains. Here a trip to the top of Mt. Tom, described in our last issue, will never be regretted if the weather be propitious.

THE FILER & STOWELL COMPANY, has just started at the power station of the Bluff City Street Railway Company, at Fort Sheridan, Ill., a 400-h.p. tandem compound engine direct connected to generator furnished by the General Electric Company. This engine has 17 ins. and 30 ins. x 36 ins. cylinders, and runs 125 revolutions. Another tandem compound engine of about 300-h.p. has just been started by the Filer & Stowell Company at the plant of the Warren Electrical Light Company, Warren, Pa. This engine furnishes power for electric light and street railway work. Two single cylinder engines furnished by the Filer & Stowell Company are now being put in the new power station of the Worcester & Clinton Street Railway Company at West Berlin, Mass. All of these engines are of heavy duty type.

THE BERLIN IRON BRIDGE COMPANY, of East Berlin, Conn., has secured the contract for erecting the new boiler house in connection with the electric plant of the People's Light & Power Company, of Jersey City. The building is a modern structure in every respect. It is 60 ft. wide and about 90 ft. long, contains ample space for large upright boilers, and has an arrangement for the storage of coal in the steel bunker inside the building, so that the fuel can be easily taken direct to the boilers. The tracks are so arranged that railroad cars will run into the building and discharge the coal directly into the bunker. It is of fireproof construction throughout, with steel frame, brick side walls and iron roof covering, well lighted and ventilated. The steel work is being furnished and erected by the Berlin Iron Bridge Company.

ROBERT W. F. OGILVIE is one of the well-known attorneys and patent lawyers in Washington, D. C. He is a graduate of Princeton with the degrees of A. B. and A. M., and the Columbia University with the degrees of L.L. B. and L.L. M., and also of the University of Virginia. He is a practitioner at the bar of the Supreme Court of the United States and of the Supreme Court of the District of Columbia. Mr. Ogilvie is personally interested as attorney for legal interest in railroad matters in Washington and a trustee for the bondholders of the Anacostia & Potomac River Railway Company, of Washington. He makes a specialty of patents relating to electric and railroad matters, and anyone desiring the services of a patent lawyer will find Mr. Ogilvie fully competent to look after their interest.

E. F. DE WITT & COMPANY, of Lansingburgh, N. Y., have their sand boxes in use on a large number of railways in the East, including, among many others, the Winchester Avenue Railroad, of New Haven, whose superintendent reports that this box is considered the best of any in the market; the Portland (Maine) Railroad; the Falls Road Electric Railway, of Baltimore, which has given several orders; and the Glens Falls, Sandy Hill & Fort Edward Street Railway Company, which states that it "has yet to hear the first report of the box failing to work when sand is wanted." Among the Western roads using this box may be mentioned the Chicago General Railway Company, whose superintendent says that "it is giving better service than any sand box I know," and the Butte (Mont.) Consolidated Railway Company, which gives an equally satisfactory report.

THE OHIO BRASS COMPANY, of Mansfield, Ohio, should have reason to congratulate itself on the progress which it has made and the work accomplished this year. It has manufactured and sold more goods from the first of the year to the present time than during the same period in any previous year, and this has been done with the attending difficulties of moving its entire plant into new and more commodious quarters. The factory which it now occupies is thoroughly equipped in every respect to turn out promptly and to the best advantage the lines of materials which it is making, no expense having been spared to make this plant complete and up to date in every detail; the opportunity afforded by the change making it possible to introduce many improvements. With the increased facilities thus afforded this company's business will undoubtedly greatly increase.

THE ELECTRIC STORAGE BATTERY COMPANY, of Philadelphia, has closed a contract recently with the South Side Elevated Railroad Company, of Chicago, for two storage batteries, each of 700-h.p. capacity, one to be installed on the premises at Twelfth Street, and the other at Sixty-first Street. Each battery will be installed with tanks and bus bars sufficiently large to permit of an increase of 100 per cent in their capacity. The batteries will be placed in parallel with the line, and will be used to take care of the fluctuations and to maintain practically a constant potential at extreme points on the line. This will be the largest storage battery installation that has been made for feeder regulation. The batteries are expected to be in operation Sept. 15. The Electric Storage Battery Company has recently issued its circular No. 43, describing the installation of chloride accumulators in the Niagara Street station of the Buffalo Street Railway Company.

THE ST. LOUIS CAR WHEEL COMPANY, of St. Louis, Mo., has made a very simple and practical improvement in the construction of street car wheels. Double brackets are now used on the inside of the spokes of this company's wheels. It is found that by this the wheels are not only materially strengthened without much additional weight of metal, but a much higher chill can be used, greatly adding to the life of the wheel. The best possible demonstration of the value of this improvement is the fact that in the large number of these wheels which are now in use, many of them having covered more than 100,000 miles, not one has failed to fulfil the guarantee. The St. Louis Car Wheel Company has recently found it necessary to increase its foundry by adding a new foundry room.

THE CENTRAL UNION BRASS COMPANY, of St. Louis, has its catalogue No. 2 ready for distribution. This catalogue is distinct from this company's catalogue of car trimmings and other brass goods. It illustrates "The Gem" line material, which is new in design and exceedingly strong and durable. A large number of orders have been received for this material, which is evidence that it is well liked. This company also makes Wood's improved trailer connector and flexible trolley ear, and its engineer is the designer of the "Emergency" trolley clamp, which has been adopted as standard by a great many roads. This company desires its catalogues in the hands of all interested in line material, and will take pleasure in mailing them to anyone not already supplied. The Central Union Brass Company is represented in Chicago by the W. R. Garton Company.

THE MICA INSULATOR COMPANY, of New York and Chicago, is sending to all interested its new catalogue containing information of value to electrical engineers, manufacturers and street railway men. The catalogue contains an account of mica mining in India, which is very interesting and instructive. The primitive state of affairs there is practically the same as a thousand years ago, forming a striking contrast with the advanced method of producing micanite. A number of tables are published in the work giving data of all kinds for some twenty-five different insulating materials, also a number of tables referring to commutators. The Mica Insulating Company manufactures a large number of specialties, including oiled papers and cloths, micanite plates, cloth, rings, insulations, etc., and carries in stock complete insulations for fifty-one different types of street railway motor commutators.

THE McGUIRE MANUFACTURING COMPANY, of Chicago, writes that the Chicago City Railway Company has reconsidered the truck question, and has ordered the McGuire solid steel "Columbian" truck for the 100 cars now being built by the John Stephenson Company, of New York City. The McGuire Manufacturing Company is constantly receiving excellent testimonials regarding its trucks, and also its sweepers. The following letter received from the general manager of the Chicago Electric Traction Company shows the good work that the McGuire sweepers are doing: "In reply to your inquiry as to the efficiency, etc., of our sweeper, I am glad to be able to say that it did very satisfactory work, indeed, during the severe storms of last winter. We have but one sweeper for twenty-six miles of track, but we were not tied up for more than an hour or two during the winter. In one storm we were obliged to cut our way through 7 ft. of snow for a distance of several hundred feet. I understand that ours was the only sweeper you have built which is operated by a storage battery system, and we have not been obliged to make hardly a single change in its construction, and I think you are to be congratulated very highly on its success."

New Publications

"Through the Garden of Kennedy." 32 pages. Illustrated. Published by the Hamilton, Grimsby & Beamsville Electric Railway Company, of Hamilton, Ont.

This pamphlet is very fully illustrated, and describes the principal points of interest and beauty along the line of the Hamilton, Grimsby & Beamsville Electric Railway.

Souvenir of Binghamton, N. Y. 52 pages. Illustrated. Published by the Binghamton Railway Company.

This is a large and very handsomely arranged pamphlet containing a history of the Binghamton Railroad Company, together with a description of the many points of interest reached by its lines in Binghamton and the vicinity.

Electrical Engineers' Central Station Directory. Price, 3s., 6d. Published by Messrs. Biggs & Son, Salisbury Court, Fleet Street, London, E. C., England.

This is a most complete and valuable manual, and contains information about various central stations in operation and under construction, with tabular statements of provisional orders and license in existence; of stations belonging to municipal authorities and to companies; and of the financial working of various stations; to which is added a list of electrical tramways.

Stromvertheilung für Elektrische Bahnen. By Louis Bell, Ph.D. Authorized German edition. Translated by Dr. Gustav Rasch. 262 pages. Illustrated. Published by Julius Springer, Berlin. Price 8 M.

This is a translation of Dr. Bell's "Power Distribution for Electric Railroads," and contains all of the American edition. The dimensions, values, etc., a e also converted to the metric system and German currency, to help the German reader. The book is well printed and bound.

La Traction Electrique Sur Voies Ferrées. By André Blondel and F. Paul-Dubois. Published by Baudry & Cie, Paris. 2 vols. 1700 pages and 1014 engravings. Price, 50 francs.

This is the largest, most comprehensive and best book which has yet been published on electric railway practice. The authors have shown a most praiseworthy effort in collecting data from all sources, and have compiled them in a very readable and systematic manner. What is even more noteworthy in a work of this size, and on a subject in which types and methods are changing so rapidly as in electric railroading, they have brought the discussion of each subject seemingly up to a recent date, and where there has been a large number of types of apparatus of any kind on the market have shown good discrimination in their selection of those forms to describe. Two chapters are devoted to track, and here we think a little more space could have been given to advantage in describing the best forms of mechanical joints in use. The fourth and fifth chapters are given up to motors, the sixth to cars, the seventh to electric locomotives, the eighth to special appliances, ninth to electrical characteristics of continuous current motors, tenth to speed regulation, eleventh to alternating current motors, twelfth to care and maintenance of the rolling stock, thirteenth to an analytical discussion of traction resistances, fourteenth to power consumed in operation and selection of apparatus, fifteenth to brakes. In the appendices are: a bibliography of the subject, a discussion on cost of construction and operation, rules for conductors and motormen, method of designing a 50-h.p. continuous current motor, etc., etc. The chapter on motors gives the weights and a number of the dimensions of all the principal motors in use, that on cars the weights of a large number of types of car bodies, trucks, etc., and throughout there is evidence of an effort to give facts and avoid discursive and general statements.

Trade Catalogues

The American Fuel Economizer. Published by Broomell, Schmidt & Company, of York, Pa. 56 pages. Illustrated.

Catalogue and price list. Published by the New York Electrical Works, of New York City. 23 pages. Illustrated.

The Taunton Snow Plow. Published by the Taunton Locomotive Manufacturing Company, of Taunton, Mass. 16 pages. Illustrated.

Installation of Chloride Accumulators. Published by the Electric Storage Battery Company, of Philadelphia. 4 pages. Illustrated.

Water Wheels. Published by the American Impulse Wheel Company, of New York City. 36 pages. Illustrated.

Snow Sweepers, Snow Plows, Track Scrapers. Published by J. G. Brill Company, of Philadelphia. Illustrated.

One-quarter of a Million Horse Power. Published by the Westinghouse Electric & Manufacturing Company, of Pittsburgh, Pa. 24 pages. Illustrated.

Catalogue. Published by the Mica Insulator Company, of New York. 46 pages. Illustrated.