Street Railway Journal

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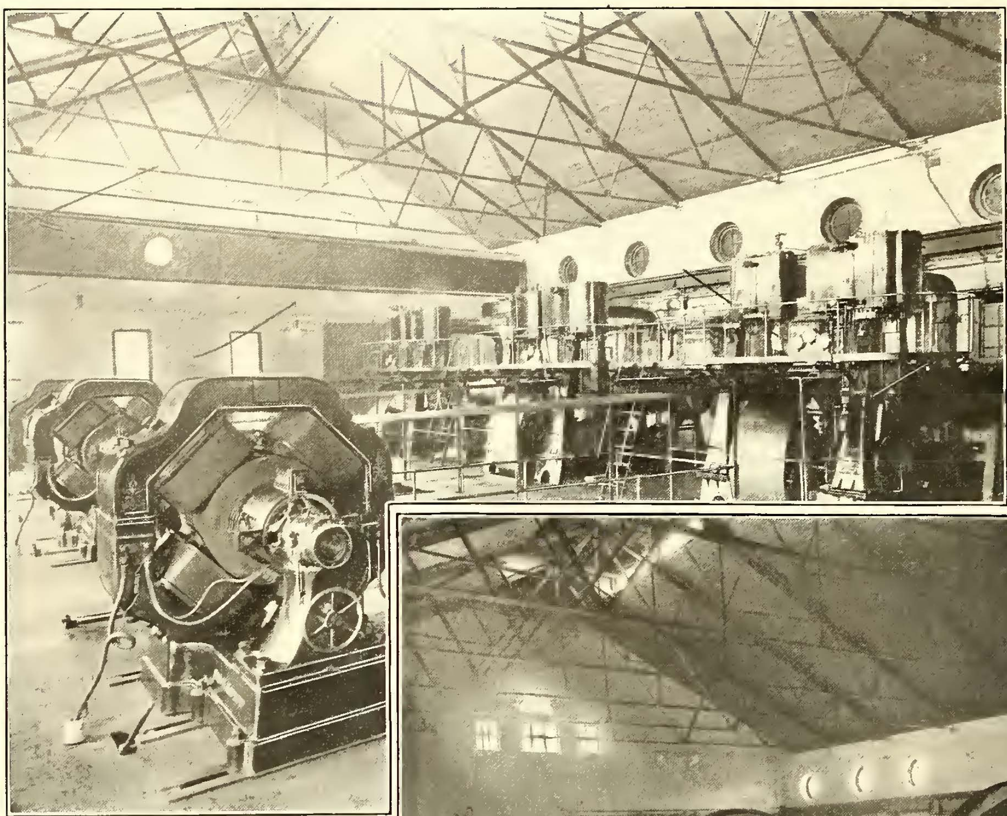
THE STREET RAILWAY SYSTEM OF SYRACUSE, N. Y.

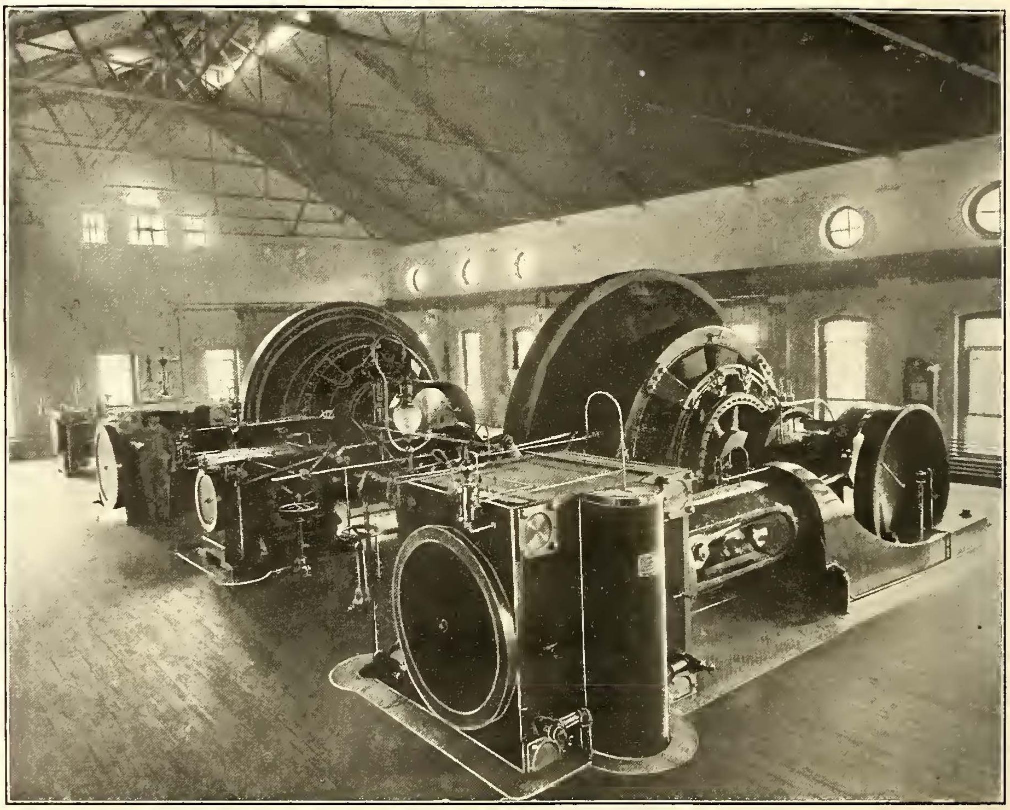
The street railways of Syracuse, N. Y., present a most notable example of the improvement which can be made in both the financial and physical condition of a system by the introduction of up-to-date methods in management. Without expending any great sum of money, and with but little addition to the equipment of a few years ago, the operation of this road has been placed on a very satisfactory basis, not only by the introduction of modern devices and machinery in the repair shops and power stations, but by so organizing the schedule that the public is induced to co-operate more harmoniously with the railway. Some interesting figures are given at the end of this article showing the conditions affecting the income of the road at the time General Manager E. G. Connette took control and at the present time. While, therefore, there is little about the system which is radically novel, the manner in which the details of every department have been carefully worked out, with a slight improvement in the mechanical department here and a more advantageous arrangement of the schedule there, makes the road of peculiar interest, and many of the features brought out in the following description will be found of value as indicating what it is possible to do with apparatus on hand and without large drafts on the capital or maintenance accounts.

RAILWAY COMPANY'S OFFICES, CORNER SALINA AND EAST GENESEE STREETS

POWER STATION

The power station is situated on the Erie Canal, a short distance from the center of the system. Direct current only is used for distribution. The generator equipment has recently been increased by the addition of a 500-kw direct-connected unit which has been erected in the center of the building and which enables the company to feel that it has a surplus of power at all times. This generator was purchased through the firm of Rossiter, MacGovern & Company, of New York, and is practically as good as new, although it had been in use for some years previous to its installation at Syracuse. The total capacity of the power station is now 3000 rated horsepower, with a large allowable percentage of overload, and under no circumstances, with the present traffic conditions, does the load require the running of all the machines. The power station is divided by the new unit into two distinct parts, the front of which contains two 1250-hp compound Reynolds-Corliss engines made by the E. P. Allis Company, each of which is direct-connected to an 800-kw 12-pole generator. The speed of these units is 80 r. p. m. At the rear of the power station are three vertical engines of 500 hp each belted to three General Electric 4-mp, 300-kw generators. These generators run at 400 r. p. m. The engines are from the works of the Cleveland Ship Building Company, of Cleveland, Ohio. The new engine is of the vertical compound type, made by the Lake Erie Engine Works, and is rated at 1000-hp capacity when running at 125 r. p. m. The generator is a General Electric 10-pole, 500-kw machine. The location of the power station rendered the building of the foundation for this large unit somewhat difficult. The size of the foundation was 28 ft. x 22 ft., and it was decided to use piles for the work. Eighty piles were driven, the tops of them being 18 ft. below the proposed position of the engine bed, and this space was filled with concrete, in which was distributed a liberal quantity of old I-beams and rails, bonding the whole mass of concrete together into a thoroughly substantial foundation. The height of the engine prevents the operation of a traveling crane through the entire length of the building, as was previously permissible, so that a new crane was purchased from Maris Brothers, of Philadelphia. The erection of the engine, therefore, was made by the aid of cranes on both sides, which worked very satisfactorily. All the engines are run condensing. Three Wheeler surface condensers with Worthington pumps are used for the three smaller vertical engines and a Conover condenser with the Lake Erie engine. The E. P. Allis engines are each provided with a Reynolds jet condenser placed in pits at the side of the engine room. The boiler equipment consists of six 250-hp Stirling boilers, two 300-hp boilers of the B. & W. type made by the Aultman-Taylor Company and one 500-hp Abendroth & Root boiler. There are two Snow duplex feed-pumps, each 12 in. x 6 in. x 10 in., and a Wheeler feed-water heater. The steam loop and Holly gravity return system is used on the boilers. The steam pressure of the plant is 160 lbs.

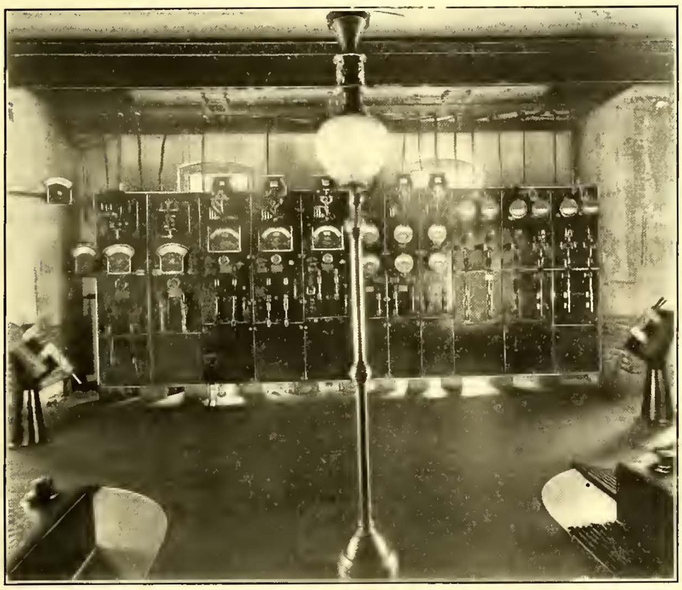




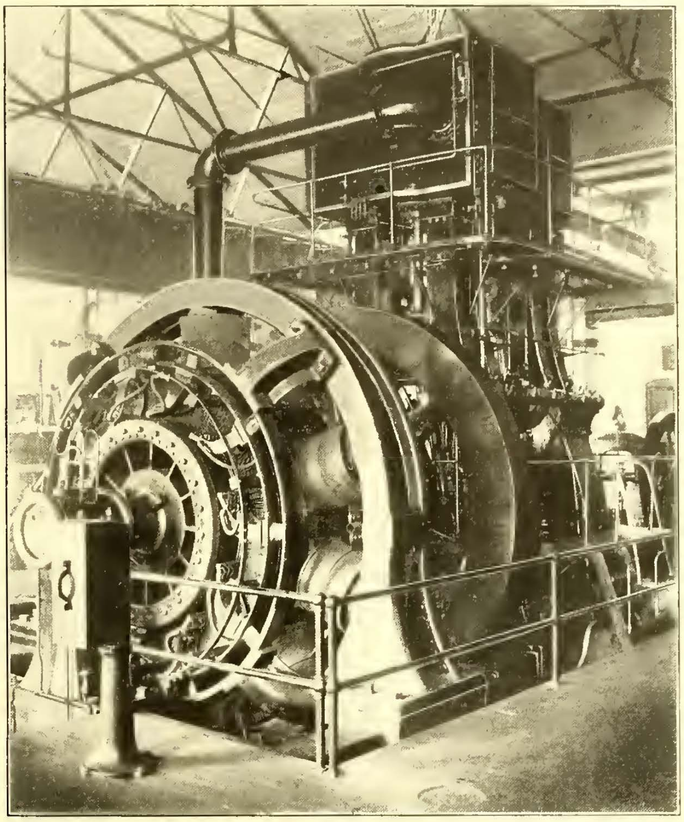
TWO VIEWS IN POWER STATION

The oiling of the engines is done by a gravity oiling system, pressure being supplied by a storage tank on the roof. This tank has a capacity of 250 gallons, allowing a large quantity of oil to be used if necessity requires it. A steam air pump made by the Crane Company, Chicago, which gives a pressure of 80 lbs., is used to supply compressed air for cleansing the dynamos, and has been found to be a most economical investment, as by its use the dynamos can be thoroughly dusted with but little labor. The switchboard is near the center of the building. Since the photograph from which the accompanying engraving was taken an extra panel has been added at the left to accommodate the leads from the new generator and a Thompson integrating wattmeter has been placed near the center of the board. Extra large and well-ventilated rheostats are used in the shunt field circuits of the generators, sufficient space being left between the back of the switchboard and the wall for their reception.

The water from the Erie Canal, adjoining the power station, is used for both condensing and boiler-feeding purposes. It is very unsatisfactory for the latter purpose, and the company is contemplating the erection of a cooling tower, so that the quality of the feed-water can be improved. Various boiler compounds and water-softening processes have been tried, but none have given beneficial results for any length of time, as analysis of the canal water shows that its composition changes greatly from week to week, and a constant watch would be necessary, therefore, to provide the correct remedies. The large amount of scale which forms in the boiler tubes is removed most successfully by mechanical boiler tube cleaners made by the Lagonda Manufacturing Company, of Springfield, Ohio. One of these cleaners holds the record of having gone through a 4-in. tube 20 ft. long in seven minutes, the tube being practically plugged full of scale before the operation.



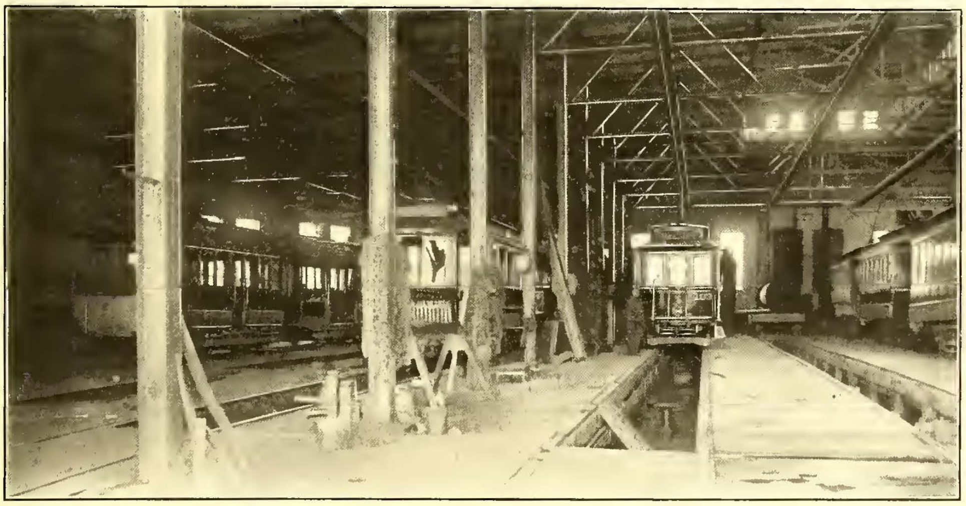
SWITCHBOARD IN POWER STATION



NEW 500-KW GENERATOR

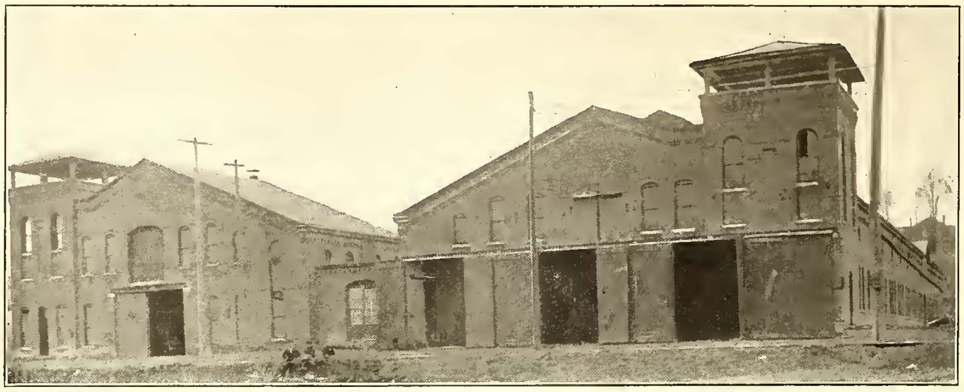
CAR HOUSES AND SHOPS

There are two car houses, one at each end of the system. The one at Wolf Street, the exterior of which is illustrated, is by far the larger, and the turrets on each of the front corners give it quite an imposing appearance. This building is used for storing the cars not in service and contains the paint shop and the wood-working shop. Nearly all repairs upon the car bodies are therefore made at Wolf Street. The machine shop and armature-winding room are at the other end of the system, at the Tallman Street car house, of which the interior is shown. Here are made the repairs to the trucks and motors. The policy of the company is to keep the repair account as low as possible, and not only has everything been done to expedite by mechanical means and convenience of arrangement the work of repairing motor and truck parts, but a thorough inspection system has been instituted which prevents the development of faults wherever steps can be taken to repair them at their commencement. There are no means provided for grinding out flats on wheels, and the company has found that the practice of discarding wheels when they get too much worn for successful service has worked very well, although it is now making a trial of wheel-turning brake-shoes. An armature rack has been constructed between two of the car pits, so that new armatures are always ready for placing between the fields of the motors should a car come in requiring it. This not only utilizes consid-



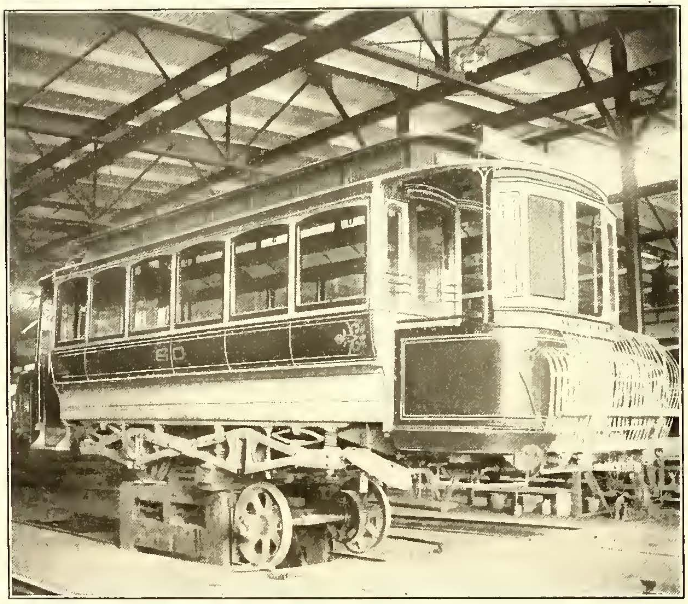
INTERIOR OF TALLMAN STREET CAR HOUSE

erable waste space, but saves the time necessary for carrying the new armature from the winding room out into the car house.



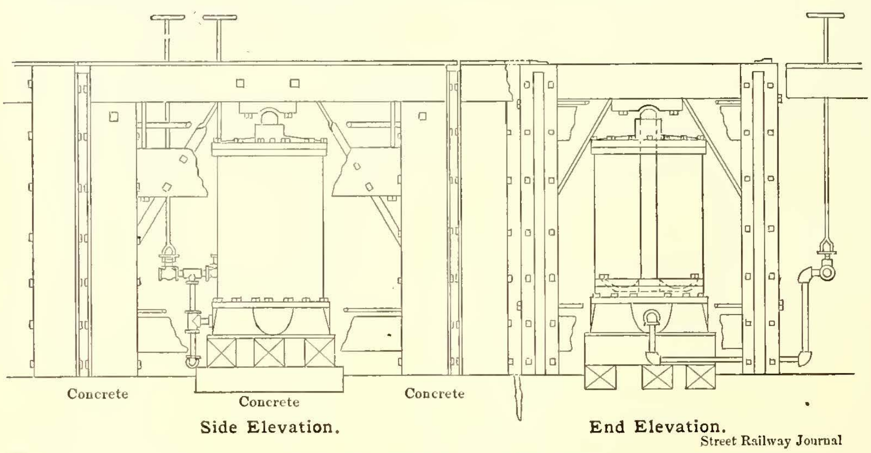
WOLF STREET CAR HOUSE

The master mechanic of the road, Fred DuBois, has perfected a most ingenious hydraulic hoist for removing wheels or trucks from cars. The details of this hoist are



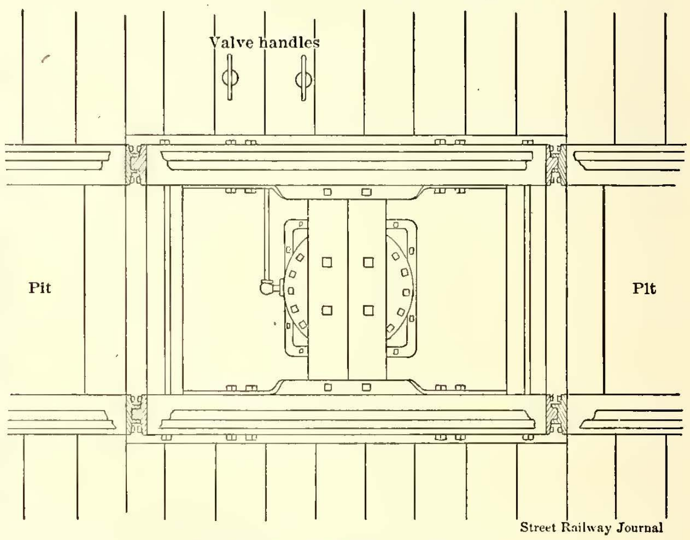
REMOVING A PAIR OF WHEELS BY HYDRAULIC LIFT

shown in the accompanying drawings. This apparatus is made from an old steam engine cylinder 24 ins. in internal



DETAILS OF HYDRAULIC LIFT

diameter and with a possible lift of 46 ins., although 30 ins. is quite sufficient in ordinary use. The water for supplying the cylinder is taken from the city mains at a pressure of about 90 lbs. per square inch, giving a lifting force of over 20 tons. The valves, which are in the supply pipe and exhaust pipe of the cylinder, are operated by long handles which pass through holes in the floor. When not using the hoist, the ends of these handles are taken out of the valve wheel and allowed to drop to their tops, so that they are entirely out of the way. The movable rails attached to the hoist are 7 ft. 8 in. long, being quite sufficient to take the entire length of one of the standard single-truck wheel bases. The operation of the hoist in removing a pair of wheels from a single-truck car is shown in the half-tone illustration. Its other uses, such as removing the entire truck of either single or double-truck cars, will be readily appreciated by street railway men. Where a truck entire is to be removed, the car body, with truck, is, of course, lifted by means of the hoist, the body then jacked up and the truck allowed to return with the hoist. A short time ago a pair of wheels was changed by means of this apparatus in twenty-eight minutes from the time the car came into the car house until it went out. Another ingenious device is



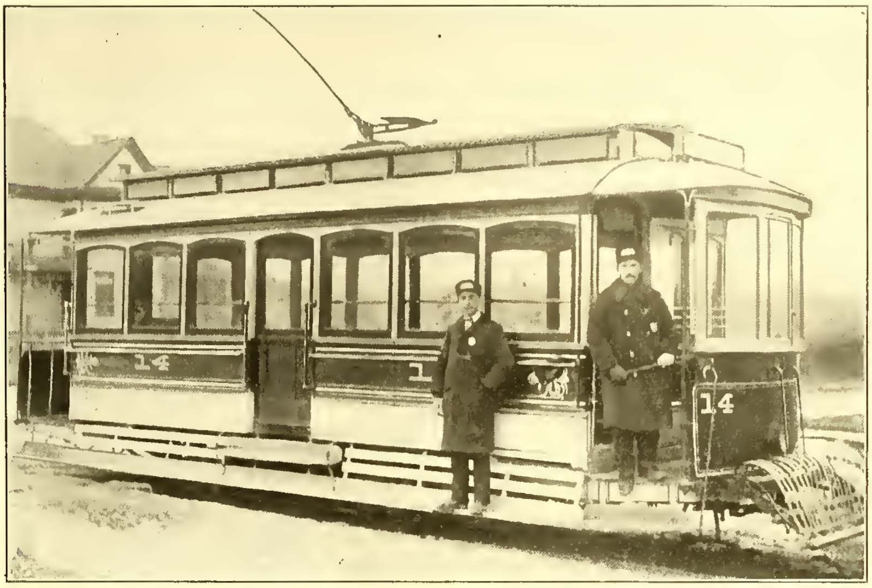
PLAN OF HYDRAULIC LIFT

a controller handle which can be adjusted to fit tightly over any controller spindle no matter how much the latter has been worn. A part of the controllers in use have seen considerable hard service, and it was found that when a controller handle became lost it was difficult to buy a new one which would fit the worn spindle, and a controller handle containing a screw clamp was devised. This handle will fit perfectly the worn spindle when once adjusted, and the screw allows of its being readily changed from one piece of apparatus to another.

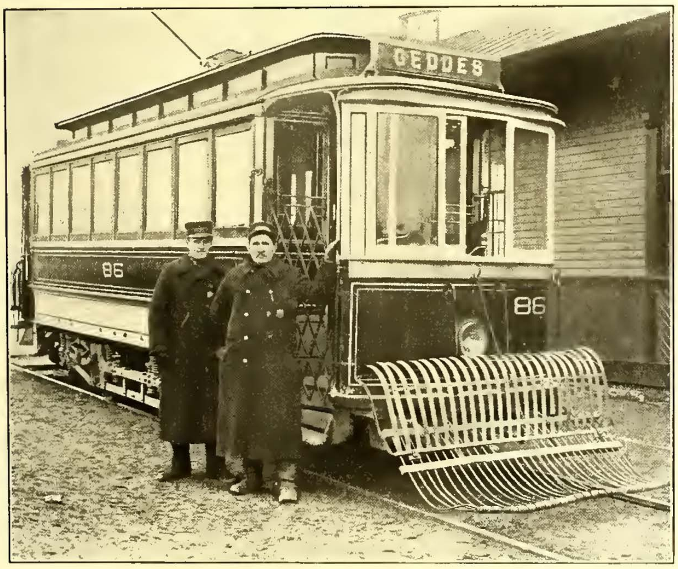
ROLLING STOCK

There is a great variety in the types of cars used on the Syracuse system, but the long double-truck car shown in one of the illustrations presented herewith has been adopted as standard and will probably be adhered to very closely in future orders. There are now seven of these cars. They were made by the St. Louis Car Company, of St. Louis Mo., and are equipped with St. Louis Car Company's trucks made on the standard master car builders' design. These cars have four G. E.-54 motors and are furnished with air brakes, the company fully realizing that it is impossible to operate such long cars without power brakes. The air brakes are supplied by a motor compressor in a box under the car, the braking equipment being manufactured by the Christensen Engineering Company, of Milwaukee, Wis. The seats, which were made by the St. Louis Car Company, are of the walkover pattern, and under each seat is placed a round electric heater made by the Consolidated Car Heating Company. The seating capacity of these cars is forty-four. The company allows smoking in the vestibule and on the rear platforms of other cars.

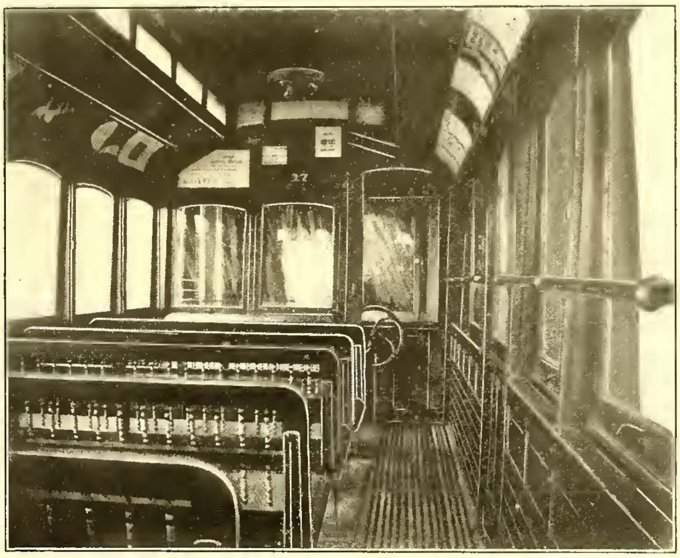
There are included in the Syracuse equipment thirty-five of what are probably the most unique cars in the country. These cars were made by the J. G. Brill Company a number of years ago, and while they are but 31 ft. over all can carry between 100 and 125 people easily, although they seat but twenty-six passengers. Both the interior and exterior of these cars are shown. The seats are arranged with a side aisle, and, with the exception of the end seats, hold five passengers each. The cars are mounted on Brill trucks, and the electrical equipment consists of two G. E.-800 motors and K.-2 controllers. The most peculiar features of the car are the running board along the outside and the center door. A grab rail is provided at a convenient height above the running board, and very few accidents have occurred to passengers while riding on this part of the car. Considerable annoyance, however, is experienced by the jumping on and off of small boys, it being very difficult to prevent such persons from stealing a ride "just for fun," and most of the accidents on this type of car have been due to this cause. The central door, which is only used during crowded periods, is operated from the back platform by means of a handle running back under the hood.



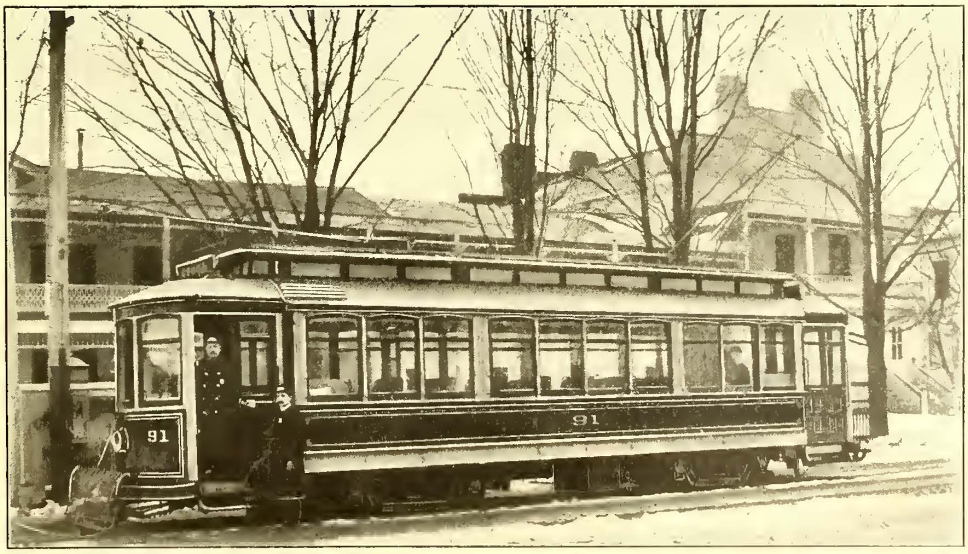
CLOSED CAR WITH OUTSIDE RUNNING BOARD



STANDARD SINGLE-TRUCK CAR



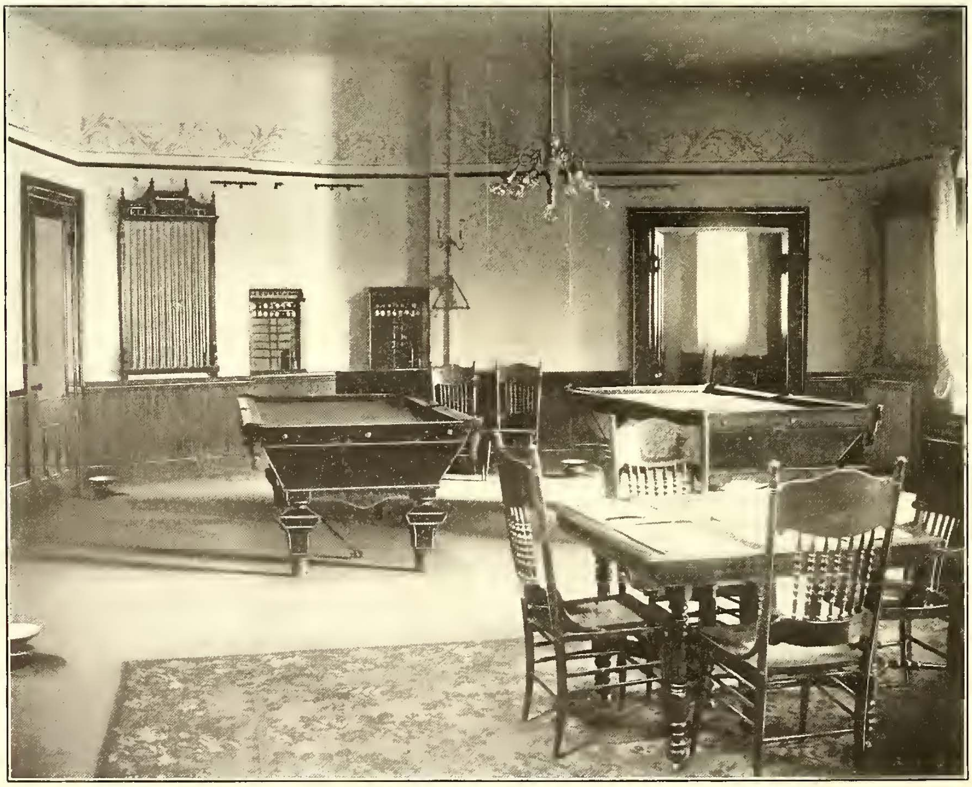
INTERIOR OF CAR ILLUSTRATED ABOVE



STANDARD DOUBLE-TRUCK CAR

The Barney & Smith Manufacturing Company, of Dayton, Ohio, has supplied thirty closed cars, seating twenty-four passengers. These cars have longitudinal seats. The trucks are from the Diamond Truck & Car Gear Company, and are equipped with two G. E.-1000 motors. There are also six closed cars from the Gilbert Car Manufacturing Company having single Peckham trucks and G. E.-800 motors and eight cars from the American Car Company, also equipped with Peckham trucks. These last types of car have longitudinal seats with panel heaters made by the Consolidated Car Heating Company.

The open-car equipment consists of ten 9-bench single-truck cars from the Gilbert Car Manufacturing Company, equipped with Peckham trucks; ten 10-bench single-truck cars from J. M. Jones & Son, equipped with Brill 21-B trucks, and two 15-bench double-truck cars from the latter manufacturers. One of these long cars is equipped with Peckham trucks and the other with Brill maximum traction trucks. Besides these are ten Lewis & Fowler cars which have been completely rebuilt by the Syracuse Company and equipped with new Peckham single trucks. These cars were originally 8-bench cars with plain platforms. The platforms have been considerably lengthened, new bumpers, hood and dash made and two extra seats added, making a very serviceable 10-bench car. Five old cars made by the American Car Company, of St. Louis, have also been rebuilt. Besides the above service equipment the company owns a handsome parlor car which was built in its own shops.



CLUB ROOM OF BENEFIT ASSOCIATION

On account of the great number of routes operated by the Syracuse Rapid Transit Railway it was necessary to adopt some form of changeable sign, and after investigating the matter quite thoroughly a sign was selected by means of which it was possible to operate any car over any line. This sign is of the well-known style made by the Hunter Illuminated Car Sign Company, of Cincinnati, Ohio, and contains a roll of linen upon which are printed the various routes. The sign is placed immediately above the motorman's head, on top of the hood, and a handle comes through the hood so as to facilitate the changing of the reading. The roll of linen is placed within a tin case which contains two incandescent lamps, so that at night the sign is brightly illuminated and can be read at a long distance. The cars are supplied with registers made by the New Haven Car Register Company, of New Haven, Conn.

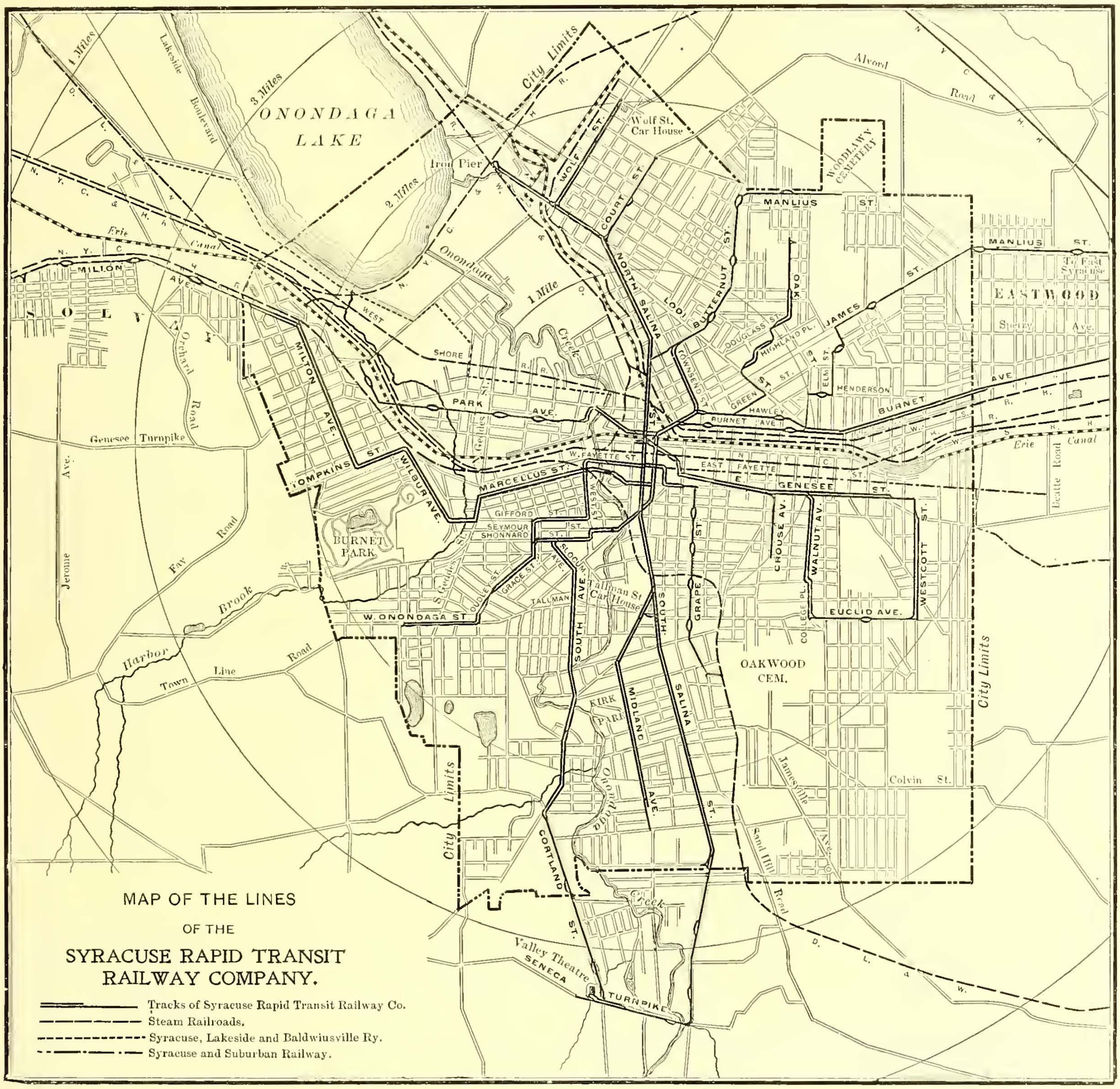
ONE OF THE HOME-MADE SNOW PLOWS

The company has five snow-plows, which it has manufactured itself from old box cars. These plows have wide wings, which are stepped, and give most efficient service in keeping the road open. Besides these plows, a sweeper, made by the Maguire Manufacturing Company, has been of great service during the past winter where the snow had not had time to fall to any great depth. The company also owns a large snow-plow made by the Taunton Locomotive Manufacturing Company, of Taunton, Mass., and five plows made by Smith & Wallace, of Woburn, Mass.

TRACK AND OVERHEAD WORK

In the central part of the city the railway company is obliged to pave between its tracks and for two feet on each side, but it has the right to determine what the paving of the streets shall be. The track is ballasted almost entirely with stone and the rails laid on ties 6 in. x 8 in. x 8 ft. A large part of the outlying districts are laid with 85-lb. T-rail, A. S. C. E. section, but within the city the rail is either grooved or plain tram head, about one-third of it being of the former section and weighing 90 lbs. to the yard. The guard rails weigh 117 lbs. to the yard, and many of these

the country. This theater since its opening has proved a source of considerable revenue to the company. It is situated at the extremity of one of the company's lines, as is shown in the accompanying map, and it is intended this summer to open a large park at the other end of the town, thus distributing the pleasure traffic and preventing congestion at any one portion of the system. The plans for this new park have not been completely worked out as yet, but General Manager Connette has made satisfactory ar-



MAP OF SYRACUSE RAILWAY LINES

are placed in positions where they are subject to extreme conditions of wear, as the town contains a large number of hills with curves at both top and bottom. The overhead work is partly of side-pole construction, with brackets made by the Ohio Brass Company, of Mansfield, Ohio, but with the exception of about 5 miles span wires are used. A large number of iron poles are employed for this work. The company built the two bridges over the Erie Canal shown in the illustrations.

PARKS AND PLEASURE RESORTS

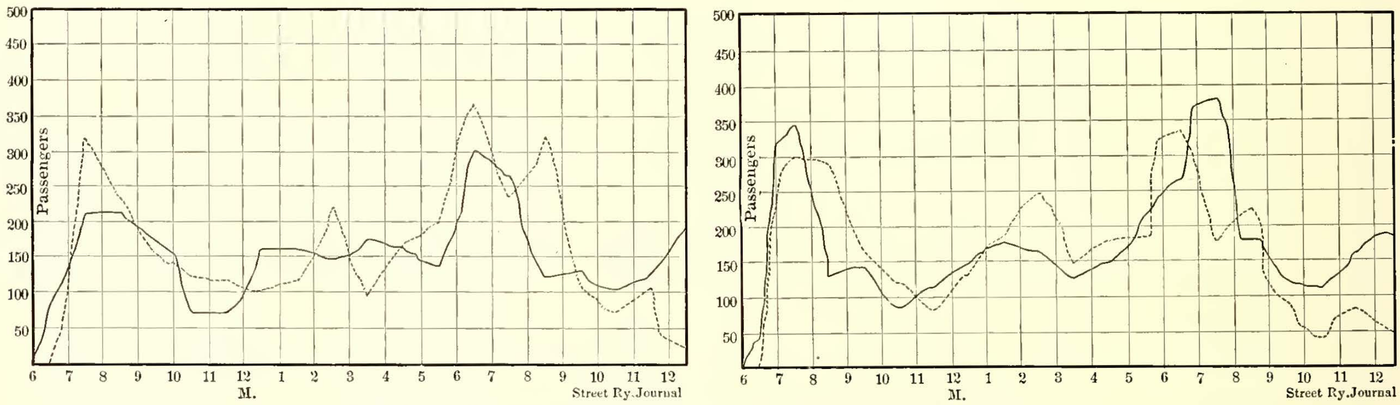
The Syracuse Rapid Transit Railway Company has one of the handsomest theaters operated by street railways in

rangements with M. S. Robinson, the manager of "The Bastable," one of the local theaters, for running this new pleasure resort. It is intended to utilize the space around the Iron Pier, which has always been more or less of an attractive spot for pleasure-seekers, and to build up a model "Coney Island," with chutes, merry-go-rounds, electric fountains, etc.

The expense of running the theater averages about $900 a week for salaries, including attendants, performers and musicians, and the company charges twenty-five cents for admission, including a free ride from any part of the city and back. All conductors on the system are provided with books of coupon tickets, which they sell to passengers for twenty-five cents. These tickets are made by the Globe

LAYING A HANDSOME PIECE OF SPECIAL WORK

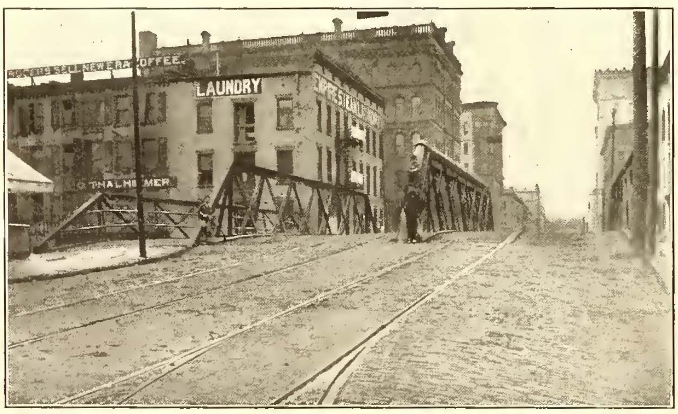
Ticket Company, of Philadelphia, and consist of three coupons and a stub. The first coupon is good for a ride



Solid Line: West-Bound Passengers; Dotted Line, East-Bound Passengers.

TRAFFIC CURVES OF TWO SUCCESSIVE WEEK DAYS—SOLVAY DIVISION

and transfer, if necessary, to get to the theater; the second is an admission ticket to the theater, and the third is good for a ride and transfer home. The tickets are good on any line, so that it is not necessary to return by the same route. In addition to this revenue, one-third of the seats in the theater are reserved, an extra charge of twenty-five cents being made for them on account of their more desirable location. Last year the rule was to have a performance every week-day evening, with two matinees, and the same programme will probably be carried out this season.



TWO BRIDGES CONSTRUCTED BY THE RAILWAY COMPANY ACROSS THE ERIE CANAL

BENEFIT ASSOCIATION

A room on the top floor of the building containing the company's offices has been handsomely fitted up for the accommodation of the benefit association. The railway company has taken considerable pains to make this association as advantageous to its members as any in the country, and the manner in which the men have responded to the efforts of their employers to form a co-operative body with the best interests of the railway at heart has been most flattering to the management. The club rooms contain pool tables, daily and monthly papers and magazines, and are in charge of a janitor, who keeps them at all times in the most perfect condition. A separate room, seen through the door in the illustration, is set aside for the use of committees, and here the business of the organization is transacted. The secretary of the association is an employee of the road, who is allowed two days a week on full pay to attend to this special work. His duties include not only the keeping of the records and accounts and other clerical work, but the visiting of men on the sick list and a general supervision of all such outside service. The dues of the association are fifty cents a month, which provides $150 death benefit and $1 a day in case of illness, with a maximum of $90 for the latter. The association has at present 300 members out of a total of 425 employees.

OPERATION

The following table gives an interesting comparison of what has been done during the last two years on the financial side of the road. This not only shows an increase in gross earnings of 28 per cent, but every item of the statement also shows marked improvement:

PARTIAL FINANCIAL STATEMENT FOR YEARS ENDING JUNE 30, 1899 AND 1901

	1899	1901	Increase
Gross earnings	$485,401.93	$621,299.04	$135,897.11
Net income from all sources	$7,398.47	$56,550 40	$49,151.93
Earnings per car mile	.1747	.1804	....
Earnings per car per day	25.37	27.90	... .
Operating cost per cent of earnings	59.60	55 4	....
Operating cost per car mile	10 41 cents	10 cents	....
Passengers carried, including transfers	12,202,511	15,433,650	3,231,139
Transfers	1,976,386	2,735,278	758,892
Revenue passengers carried	10,226,125	12,698,372	2,472,247
Revenue passengers per car mile	3.71	3.72	....

Nearly all the lines of the company have either loops or Y's at the end. This is made necessary on account of the large number of single-ended cars which are operated and which are used on many of the lines indiscriminately. The Solvay division is one of the most heavily and erratically loaded of the system, and load diagrams of two successive week-days are shown herewith. A large number of the employees in the Solvay potash works live in Syracuse or on the line of the railway. The opening of this division was of great benefit to the New York Central & Hudson River Railroad, which formerly was obliged to run a local train at a considerable loss for the benefit of these employees. Since the street railway company has assumed this traffic the New York Central has been relieved in this regard very satisfactorily to all concerned. Another point where the street railway is of advantage to the steam road is at the freight yards in East Syracuse, where cars are run all night for the benefit of the employees of the New York Central itself. Four trips are run on this division each night after midnight, and the steam road guarantees the street railway at least $5 per night, accounts being rendered monthly and the steam railroad paying the difference if traffic has been too light to come up to the guarantee.

Considerable revenue is obtained by the operation of private cars. A scale of fixed prices has been adopted by the company, as follows:

RATES FOR SPECIAL CARS

Single-truck box car, round trip over any two divisions of the rapid transit system, excepting East Syracuse	$6.00
Single-truck open car, round trip, etc	7.00
One way	6.00
Double-truck open car, round trip, etc	10.00
One way	8.00
Parlor Car—Evening	10.00
Afternoon and evening	15.00
All day	15.00
All day and evening	25.00

Round trips under the above rates must not consume more than four hours. Additional time to be charged at the rate of $1 per hour.

On East Syracuse division, add $2 to above rates.

After 12:30 midnight $2 per hour additional to above rates will be charged.

No open cars to be rented on Sundays or holidays without permission from the general manager.

The city of Syracuse has been built up directly around the New York Central's tracks and the trains run through the center of the city. This gives a large number of grade crossings, at which in numerous instances flagmen have been detailed. At all other places the conductor leaves the car and runs ahead to see if the track is clear. The speed of the railroad trains through the city is governed by ordinance to a maximum of eight miles per hour. As an illustration of the density of the traffic at some of these crossings, it might be mentioned that at Salina and Washington Streets ninety electric cars pass per hour. This crossing suffered considerably last year on account of the heavy traffic over the New York Central resulting from the Pan-American Exposition, and has just been relaid. The speed of the street cars is fixed by the city authorities. The city has been divided by a series of imaginary circles, with the City Hall as the common centre. Within the half-mile circle the speed is confined to eight miles an hour; between this circle and the three-quarter-mile circle twelve miles per hour is allowable, and without the latter limit fifteen miles per hour is attained.

ORGANIZATION

The president of the road, William P. Gannon, confines his attention almost entirely to the legal side of the company's business, leaving the operation to Vice-President and General Manager E. G. Connette. Mr. Connette has under him Superintendent John E. Duffy, who is in charge of both the schedules and operation of the cars and also the repair departments, where he is ably assisted by the master mechanic, Fred DuBois. The secretary and treasurer, T. H. Conderman, resides in Philadelphia. The other officers of the road are: John L. Luckenbach, auditor; M. F. Connette, a brother of E. G. Connette, road master; L. E. Barnes, claim agent, and Charles F. Steirly, superintendent of power house.

Rapid Transit in New York

Remedies for the conditions of congestion which are now prevalent on all the surface and elevated lines of the various boroughs of New York City are in sight, and within a year or two New York will be one of the best-equipped cities, from a rapid transit standpoint, of any metropolis in the world. Work on the new East River Bridge is progressing at a very rapid rate, the conditions of the New York terminal of the Brooklyn Bridge are under investigation, with every prospect of immediate improvement, and the work of the New York Rapid Transit Subway Construction Company, which is building the underground railway from City Hall up the west side of the borough of Manhattan, is being rushed at every point. At a recent meeting of the Rapid Transit Commission the question of the advisability of having an East Side extension to the present plans was proposed, and the scheme met with the unanimous aproval of the board. The estimated cost of this East Side subway is roughly estimated at $15,000,000, which the present condition of the city's finances renders prohibitive for the time being, but it was shown by the reports of the tax office that an increase could be reasonably expected in the debt limit of $7,500,000 per annum. Thus the natural increase of the city's resources will provide for the building of the proposed line in two years. It was claimed, in showing the necessity for the East Side extension, that the present route was circuitous and would not afford true rapid transit to the borough of the Bronx, which is situated north of the Harlem River. The company which has been formed with the intention of operating the rapid transit subway when completed has submitted its formal articles of incorporation. This company will be known as the "Interborough Rapid Transit Railway Company," and the articles of incorporation show that it is to be capitalized at $25,000,000.

New Repair Shops at Providence

The Rhode Island Suburban Railroad Company, one of the most prosperous electric railway companies in the country, recently occupied its new repair shops. The general plans of the work, as prepared by Chief Engineer George B. Francis, were published in these pages last year. The building, covering a large area just outside of Providence, is situated in the town of Cranston, R. I., and is, perhaps, the most carefully equipped of modern electric car repair shops. About 160 men are regularly employed.

While the shops were built by the Rhode Island Suburban Railway, this is only one of four organizations which go to make up the street railway system of Providence and for which repairs will be made. The other three are: The Pawtucket Street Railway Company, Interstate Consolidated Street Railway Company and Union Railroad Company. All four companies are controlled by the United Traction & Electric Company, of New Jersey.

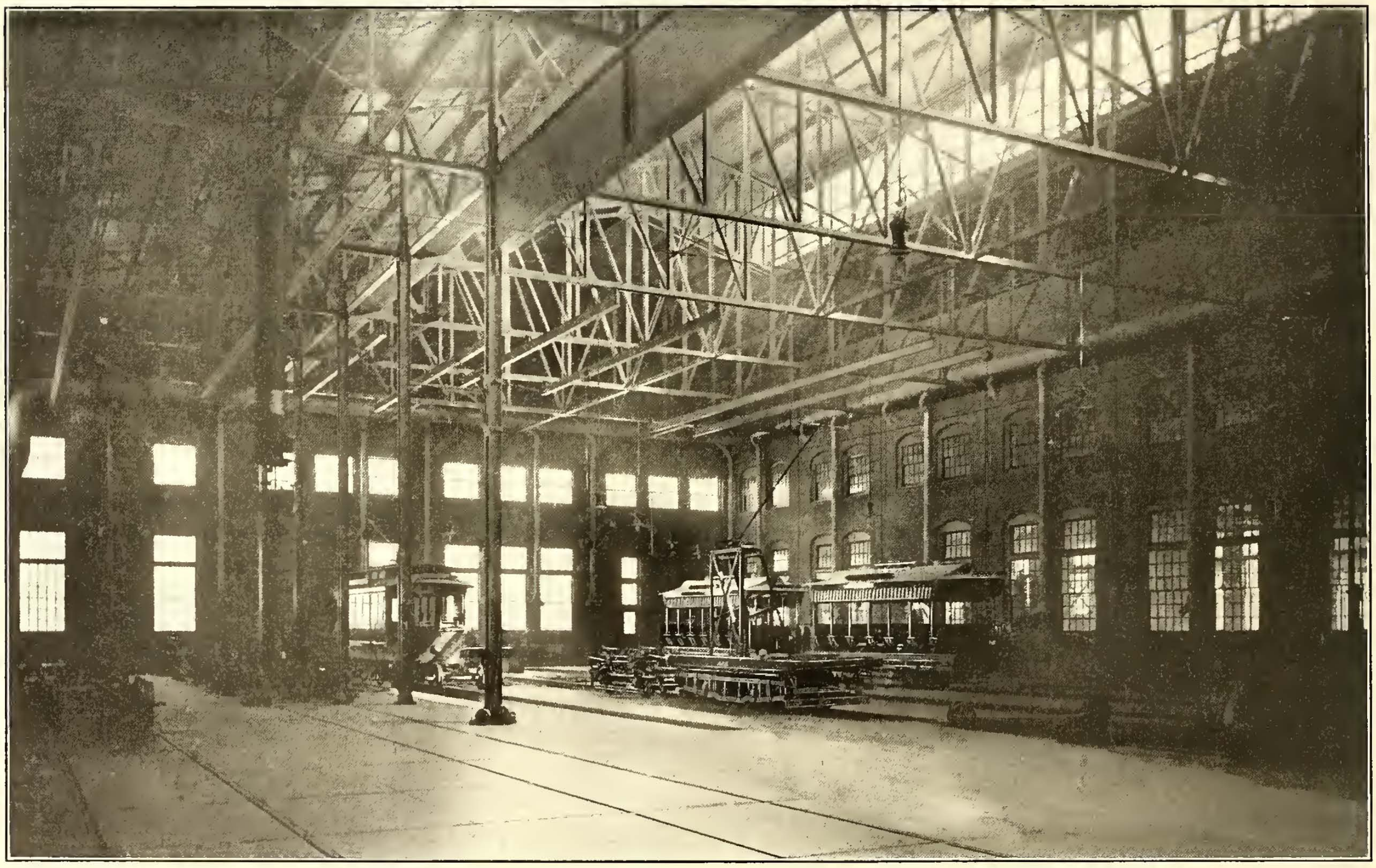
MAIN REPAIR ROOM

The pit rooms are in the southeast part of the building and have access to the street through two large doors. Six tracks run the entire length of the room and connect with the painting department. In this room repairs to the electrical equipment are made, controllers replaced, cables mended or the wiring changed. There are six pits, three for the wiremen and three for truck and wheel work.

An admirable arrangement for removing and replacing wheels and motors is the new hydraulic pit hoist. This machine was built for the company by the Whittier Machine Company, of Boston. It is fitted with an automatic cut-out, shutting off the pressure at 110 lbs. The electric pump from which the pressure is derived is placed underneath one of the platforms between the pits, and the machine, therefore, does not take up otherwise useful room. An electric transfer table with S. R. G. motor and R-17 controller runs across the center of this room. The table is built to accommodate a 40-ft. car. Two air hoists are provided for carrying wheels and other heavy parts. These work with a 100-lb. air pressure supplied from an electrically driven air compressor. By means of one of these hoists a pair of wheels can be picked out of any portion of a number of wheels, lifted up and carried to the open tracks.

WINDING ROOM

The winding room runs a third of the length of the front of the shop and is perhaps the busiest part of the shop. Here expert armature winders rewind, build and repair armatures and fields. A space at the west end of the room is devoted to small electrical repairs, controllers, testing instruments and also cash registers. This is separate from the winding room works proper.



GENERAL VIEW OF MAIN SHOP

A bench runs nearly the entire length of the winding room, with magneto-bells distributed at intervals for the purpose of testing grounds and poor connections. These bells are connected with a power magneto. Armature stands are provided for twenty workmen. At the eastern end of the room two binders have been placed, one for armatures, and one arranged for both armatures and fields. A field winder, a lathe and a grindstone, together with the two armature binders, are connected to a 5-hp motor.

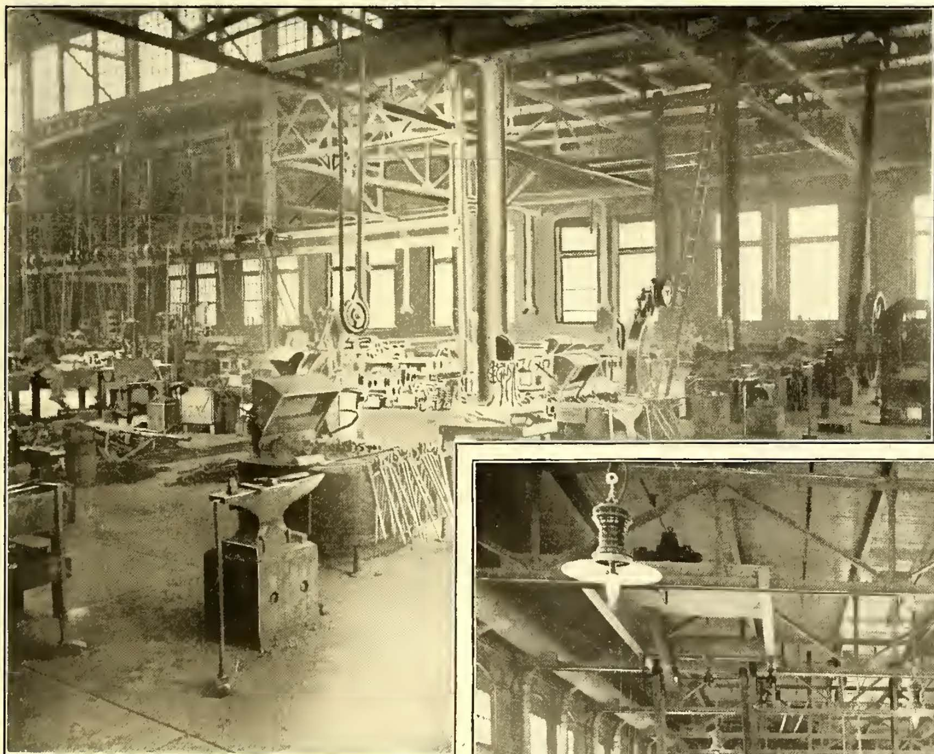
A machine for shrinking armature rings on to shafts is in process of construction, and when this is completed all work pertaining to armatures will be done in this room. A small office for the foreman is also in the eastern end of the room and is provided with telephone communication with the main offices. A small stock room contains the material in every-day use. A Watson-Stillman pump with a capacity of 50 tons, run by a 2-hp motor, supplies pressure to a hydraulic press in the main room for forcing on and off pinions, rings and commutators. This machine is operated by opening and closing certain valves, a decided advantage, it is found by those in charge, over the old style of hand lever. At the opposite end of the room a drill and a lathe driven by a 1-hp motor, made by the Holtzer-Cabot Company, of Boston, is used in making small equipment repairs. The most notable features of the winding room, however, are the three drying ovens shown in the engraving. These are built of brick, each being about 6 ft. x 4 ft. x 4 ft. 9 ins. Two are arranged for armatures and the third for fields. Five armatures each is the capacity of the ovens, three suspended and two on trucks. An outlet pipe is provided to carry off the damp air. Overhead cranes and pneumatic hoists carry the armatures from any portion of the room to the ovens. The ovens are heated electrically, heaters made by the Simplex Electrical Company, Cambridgeport, Mass., being used. These are so wired as to give three graduations of heat. Thermometer readings taken from these ovens show 150 degs., 180 degs. and 210 degs. F. After they have reached a stationary temperature, sliding iron doors and locks fasten the ovens securely. Shelves are arranged in the third oven for fields. A dipping vat is to be placed next to the ovens, where fields will be covered with their final coating of paint and then placed on racks to dry in the air. A large table or bench for making fields, with drawers containing all materials for their construction, is now provided.

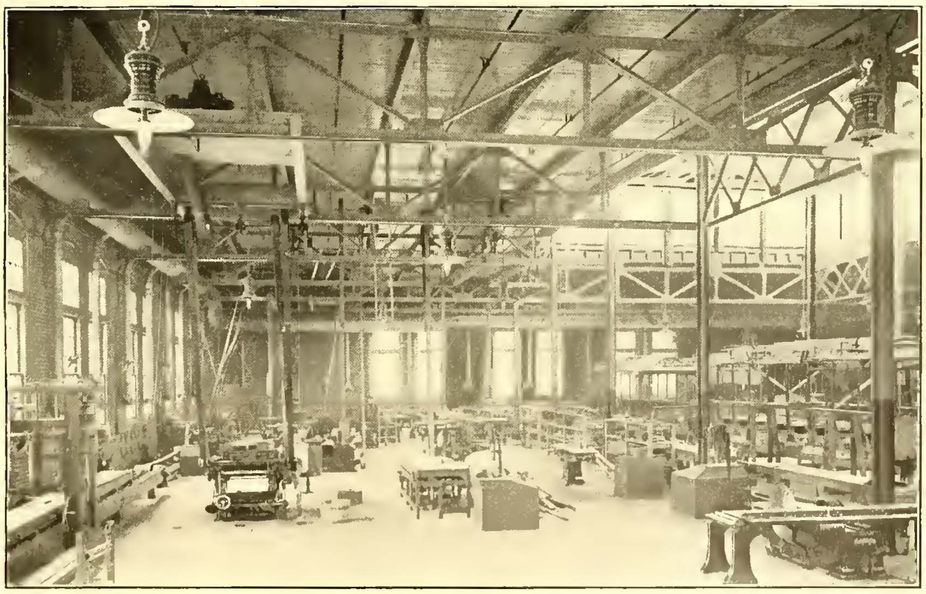
Next to the main offices, which are on the ground floor, are the stock rooms. Here a large stock of equipment is kept not only for use in the repair shop proper, but also for the several car houses of the system. Stock for the winding room, blacksmith, woodworking and machine shops and pit rooms require the ground-floor space and also a second floor above that.

PAINT SHOP

PAINT SHOP

Special attention has been given to the equipment of this department, and many ingenious devices are here in use for facilitating the operations of the workmen. The paint shop itself is large and roomy and has a special entrance of its own, although it is connected with the front part of the shops. The paint room, where the mixing of the paint is done, is a model of cleanliness. Benches are placed against the walls, under which are barrels containing materials in bulk, and in the center of the room are four large mixers made by the Kent Machine Works, of Brooklyn, N. Y. The blades within these four mixers are kept in motion by the motor-driven shaft shown in the illustration, and the paint is in perfect condition for use at all times. The barrels containing the raw materials are on iron rollers and





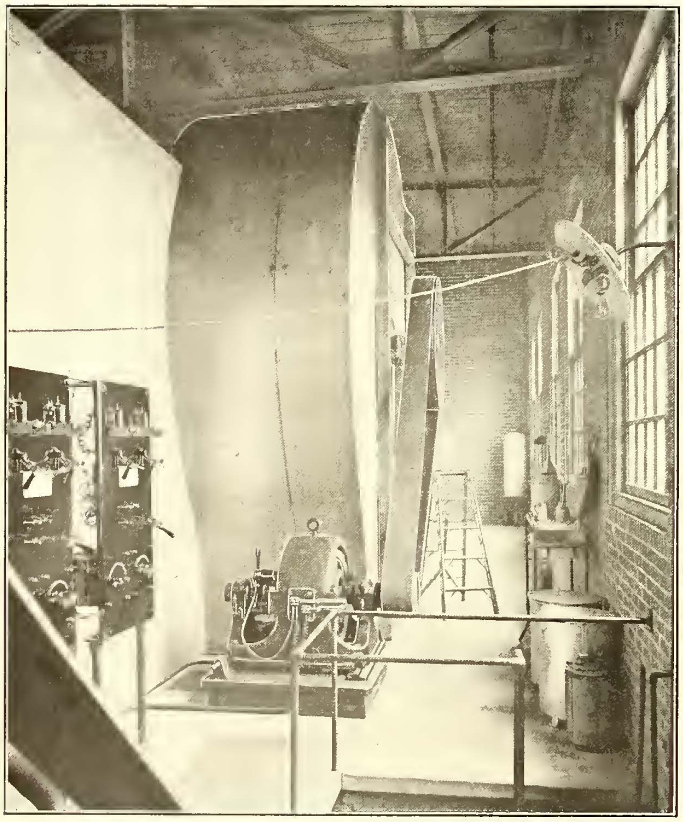
BLACKSMITH AND WOODWORKING SHOPS

have a handle at the side so that they can readily be rolled out from under the benches. Three sinks are provided in this room for keeping brushes in good condition when not in use. The brushes are held in racks with the bristles under water, which can be readily changed from time to time. The glazing department is in a room nearby, and racks are provided for a large number of sash, so that broken windows can be replaced with the greatest expedition.

The portable paint bench shown in the illustration was designed by the foreman of this department and is one of the most useful devices employed in the shop.

THE WOODWORKING MILL

Spur tracks are laid in this room leading from the street through the paint shop. A main track also enters through the west wall, making direct access to the yard and thence to the street possible. Tracks are extended from the carpenter shop across an areaway into the blacksmith shop.



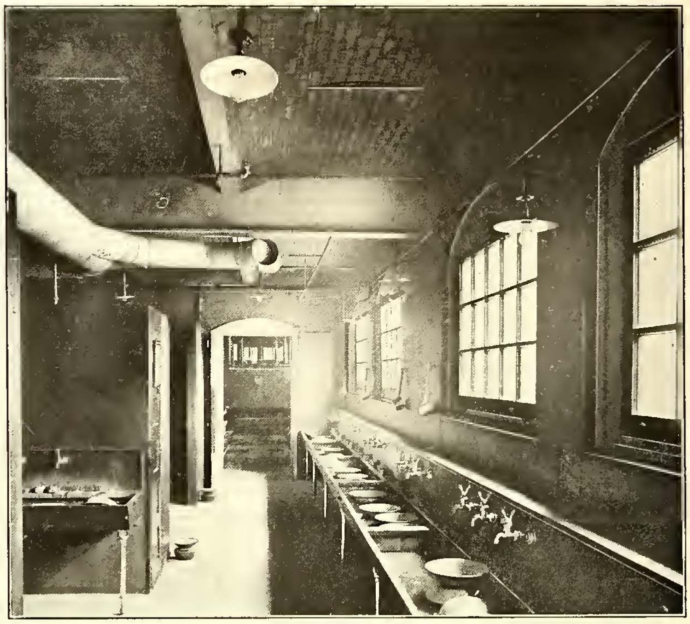
VENTILATING APPARATUS

The woodworking shop was equipped almost entirely by the S. A. Woods Machine Company, South Boston, Mass., and contains a double-surface planer, a buzz-planer, a railway cut-off saw, a small double cut-off and rip saw, a band saw and a jig saw, an outside molder, a mortising machine, a tenoner, a rabbeting machine, a single surfacer, an irregular molder, a lathe and a polishing machine or wheel. Two emery grinders and a grindstone complete this well-appointed department. The tools are run by individual motors, which are placed at the machines, switches being conveniently located. Each motor is protected by a wooden case.

Adjoining the main room is a small room containing five tanks, one for cold water, the others for hot water, lacquer, acid and potash. These are used in finishing and cleansing brass and other metals and woodwork. In connection with the woodworking shop, but situated in the basement, a 20-ft. tank is used for steaming rims and warping panels. Lumber and stock are kept in the basement, as well as a room for kiln-drying the wood. An outside brick building separate from the main building proved necessary for an auxiliary lumber store room, with tracks connecting it with the main building. A sawdust conveyor will soon be set up to carry the sawdust from the shop to the boiler room in the basement. This conveyor will be installed by the Sterling Blower Company, Hartford, Conn., and it is expected that the apparatus will automatically separate the sawdust from the shavings and thus greatly improve this material as fuel. The boilers supply steam for heating the shops.

UPHOLSTERY DEPARTMENT

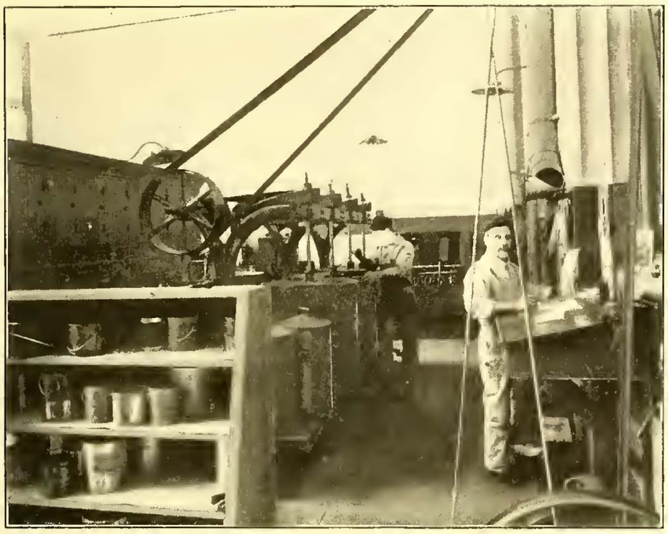
The upholstering shop adjoins the woodworking shop This department, though small, is of considerable importance, as the Rhode Island Suburban Railroad Company prides itself upon the neatness and cleanliness of its rolling stock. New cushions for box cars, curtains for open cars, bell cords, register cords, car straps and step treads are made in this room. There are two Wheeler & Wilson sewing machines connected to $\frac{1}{4}$-hp motors. One is for plain sewing, the other for binding. A bench along the north wall and another along the south wall with a large cutting table in the center of the floor complete the furnishings. Shelves on two sides of the room are filled with cloth in rolls and made up into curtains. The foreman's office adjoins the main room, with shelves on two sides for storage purposes, and a door opens into an area or court in the center of the building. At present cushions and mats are cleaned in this area by hand, but a 100-lb. pressure compressed-air apparatus, with suitable connections and hose, will soon be used for this purpose.



EMPLOYEES' ROOM

BLACKSMITH AND MACHINE SHOPS

These are combined in one room. There are ten down-draft forges made by the Buffalo Forge Company. Following is a list of the equipment of this portion of the repair department: One 350-lb. and one 100-lb. Beaudry power hammer, a Beaudry shearing punch; one 5-hp motor and one 3-hp motor are placed overhead to run these machines. In the machine shop are a Morgan bolt cutter, a Bullard 28-in. boring mill, a speed lathe and three upright drills, four engine lathes, including one McCabe double spindle lathe, a Brown & Sharpe milling machine No. 2, a Potter & Johnson shaper, a Bullard 42-in. boring mill, a Brown & Sharpe key-seating machine, two wheel presses, a Brown & Sharpe cutter grinder, a Diamond Machine Company wet tool grinder and a dry grinder and a twist drill grinder, a 24-in. Putnam planer, a 42-in. wheel borer and a turret lathe. Three motors, one $7\frac{1}{2}$ hp and two 5 hp, are required in the machine department. There are also a small planer and a straightening machine. The switchboard for the lights and power throughout the entire building is set in the foreman's office.



PAINT STORAGE AND MIXING ROOM

UPHOLSTERY DEPARTMENT

GENERAL REMARKS

An important feature of the repair shops is the excellent accommodations for workmen provided by the company. The lavatory and wash rooms, together with the lockers for clothing, are all of the best. Open plumbing, nickeled, with slate partitions, with plenty of room in each locker, make this part of the equipment very acceptable. Over the wash room and reached by an iron ladder are the motor fans used in the heating system.

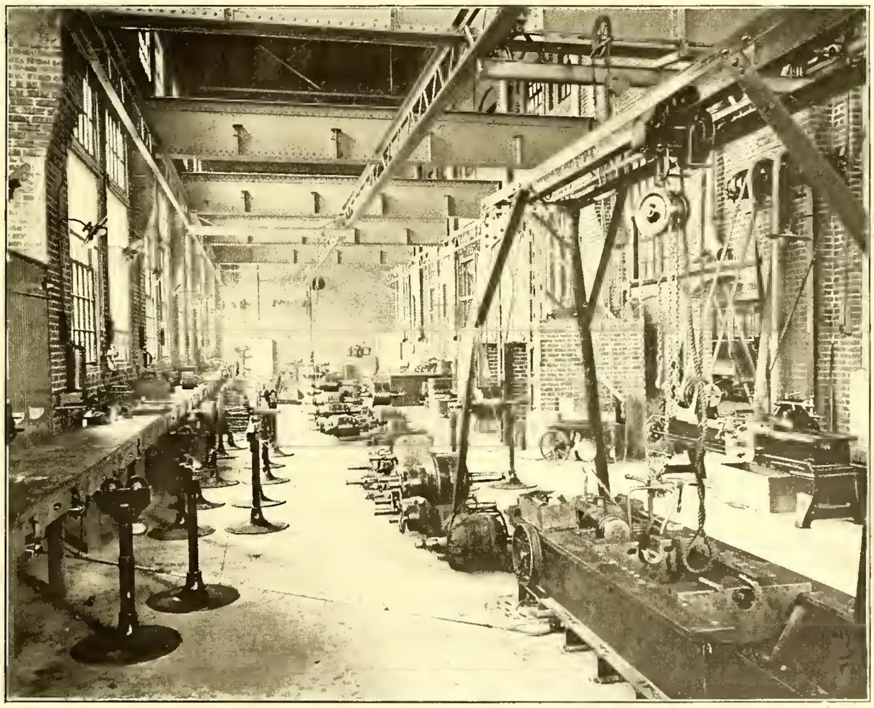
Time clocks are placed in every department, and electric gongs connected to a clock in the timekeeper's office announce the opening and closing of working hours.

Grinnell automatic sprinklers and "Underwriters" fire extinguishers provide for accidental fires. The superintendent's office is on the second floor, with tables for the draftsmen. Windows overlook the pit rooms and machine shop. The area in the center of the building forms room for the storage of wheels, while an electric flat car is provided for transporting heavy material.

The machines throughout the shop are in general belt-driven, electric motors supplying all the power used. The motors are all from the Holtzer-Cabot Company, Boston, Mass. They are twenty-six in number and include machines from 1-3 hp to 15 hp. For the power and lighting, two 500,000-cm wires run direct to the Eddy Street power station and are connected to a distributing board. The switchboards and starting boards were made by the Albert & J. M. Anderson Manufacturing Company, of Boston.

The power is the regular railway 550-volt service. D. & W. enclosed fuses are used throughout for protection, and the switchboard equipment includes Weston measuring instruments and Bristol recording gages. For lighting, 100 enclosed arc lamps and about 1400 16-cp incandescent lamps are used, the latter, with the exception of the wash room, being arranged in five-light clusters. No wires are visible, all being enclosed in steel tubing, which greatly reduces the fire risk.

The blast at the forges and the smoke draft are operated by a 15-hp motor situated in the basement. The shops are heated and ventilated by a very complete hot air system. Fans are placed in a convenient location on the second floor and force air, heated by steam pipes from the boiler plant in the basement, through large ducts to all parts of the building. The system was installed by Westinghouse, Church, Kerr & Company, of New York. A private automatic telephone system connects the various departments, there being eight or nine instruments on the line.



ARMATURE AND FIELD ROOM

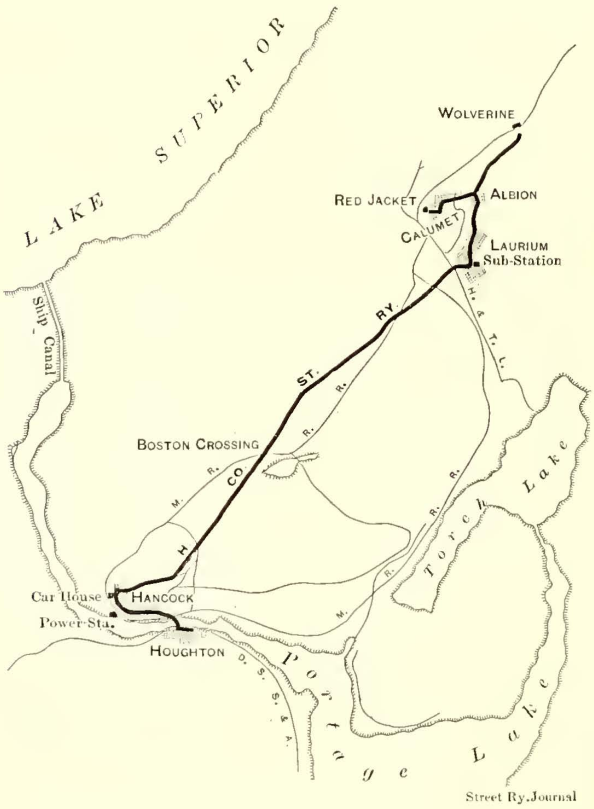
The shops are in charge of W. D. Wright, the chief electrician and master mechanic of the company. Mr. Wright is most fortunate in having associated with him men in charge of his various departments who not only are thoroughly posted in the line of work which they superintend, but who take a personal pride in the welfare of the company.

Houghton County Street Railway

BY W. R. PARKER

Located on the peninsula which projects into Lake Superior, midway of its southern shore, the Houghton County Street Railway successfully meets the demand for adequate passenger service in the Michigan copper region. The steam roads on the peninsula are engaged almost entirely in the transportation of ore, and little provision is made for the accommodation of local passengers. Travel over the highways is unpleasant in summer because of the circuitous routes, numerous hills and poor condition of the roads, and in winter the huge drifts which collect in every favorable spot make communication between towns very difficult. The average snowfall for the past ten years is 11 ft. As the snow is very dry and there is generally a strong wind blowing from Lake Superior, it is necessary to build high snow fences in many places for protection from the drifts.

When the settlements in this section were only rough mining camps the need of improving the situation was not very evident, but as the camps developed into villages and later into thriving towns the demand for better facilities



MAP OF HOUGHTON COUNTY STREET RAILWAY SYSTEM

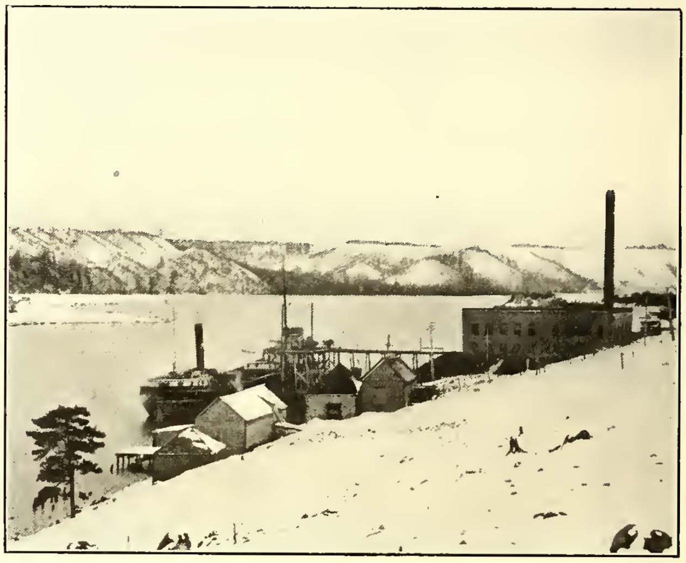
steadily increased. The agitation for an electric road began several years before the culmination was reached in the spring of 1900, when the construction of the present road was begun. The chief opposition was raised by some of the mining companies, and not, as would naturally be expected, by the steam railroad. The latter recognized the certainty of an electric line being built by some company in the near future and assisted the projectors of the new line instead of opposing them.

Except in the towns, nearly all the land is in the possession of various well-known mining companies, and as the Michigan statutes do not give street railways the right to condemn land, considerable difficulty was experienced in obtaining locations on some of the mining properties. The present route was finally decided upon, and considers the present and future needs of the situation better than any other route that could have been selected. Locations from the municipalities were granted for a period of thirty years under the general street railway laws of the State, and the rights of way over private property are practically perpetual.

The populations of the towns and districts served by the electric road are as follows:

	Population	Miles from Houghton
Houghton	5,000	
Hancock	6,000	1
Franklin and Quincy	3,000	4
Boston	1,000	7
Osceola Road	2,000	12
Laurium	8,000	13
Calumet	15,000	14
Red Jacket	6,000	16
Centennial	1,000	17
Wolverine and Kearsarge	4,000	18
Total	51,000	

Starting at Houghton, the county seat, the track crosses Portage Lake on the county bridge, which is about 2100



POWER STATION AT HANCOCK

ft. in length, to Hancock, on the northern shore of the lake. The electric road and the highway are carried on the upper deck of the bridge, while the tracks of the steam road are laid on the lower. Hancock, like Houghton, is built on a side hill which rises abruptly from the lake to an elevation of about 600 ft., and the only practicable route to the table land above was by a circuitous ascent 3 miles in length having in one place a grade of 7½ per cent for a distance of 1000 ft. From the top of this grade the road traverses rolling country, crossed by many deep ravines—running toward the lake.

Until Boston Crossing is reached the road parallels the highway and then passes by a direct route with moderate grades over the holdings of well-known copper companies, including the Franklin, Osceola, Torch Lake and other properties, to Laurium, which, with the adjacent settlement of Calumet, the location of the famous Calumet and Hecla mines, has a population of 23,000. From this point the road passes through the village of Albion to Red Jacket, which is the northern terminus. The total length of the main line is 16.5 miles. From Albion a branch about 1½ miles long runs to Wolverine, serving a population of 5000. The road is single track with turnouts located about 2 miles apart. In the various towns there is considerable double track. There are 22 miles of single track, including turnouts and second track.

In the two groups of terminal towns a fifteen-minute schedule is in force, the cars running from 7 in the morning to 10 at night. The through traffic is accommodated by a half-hour schedule from 6 a. m. to 11 p. m.

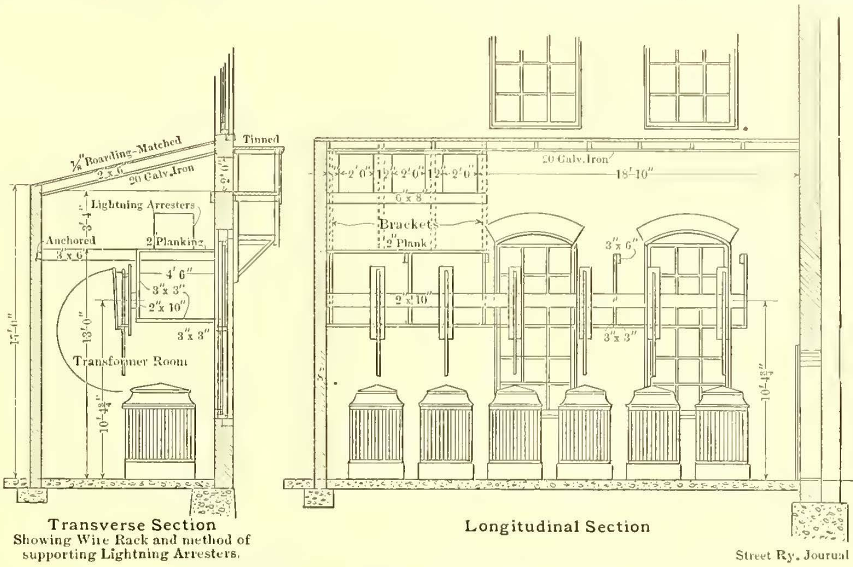
A ship canal connecting the northern end of Portage Lake with Lake Superior provides a direct route between Duluth and Superior and eastern points via Portage Lake and Keeweenaw Bay. From the breaking up of the ice in May until the latter part of November a large amount of shipping travels this route every day, passing directly by the power house. Incidentally, the opening of the draw in the county bridge to permit these vessels to pass causes a serious derangement of the car schedule very frequently.

BUILDINGS

The power house occupies a well-chosen site on the outskirts of Hancock, about 1¼ miles from the southern end of the road. The lot has a frontage of 300 ft. on Portage Lake and a depth of 400 ft. The building is 85 ft. x 95 ft. 8 ins., and is substantially built of brick with a six-ply tar and gravel roof. The roof trusses are ten in number, those in the engine room having a span of 50

HANCOCK CAR HOUSE

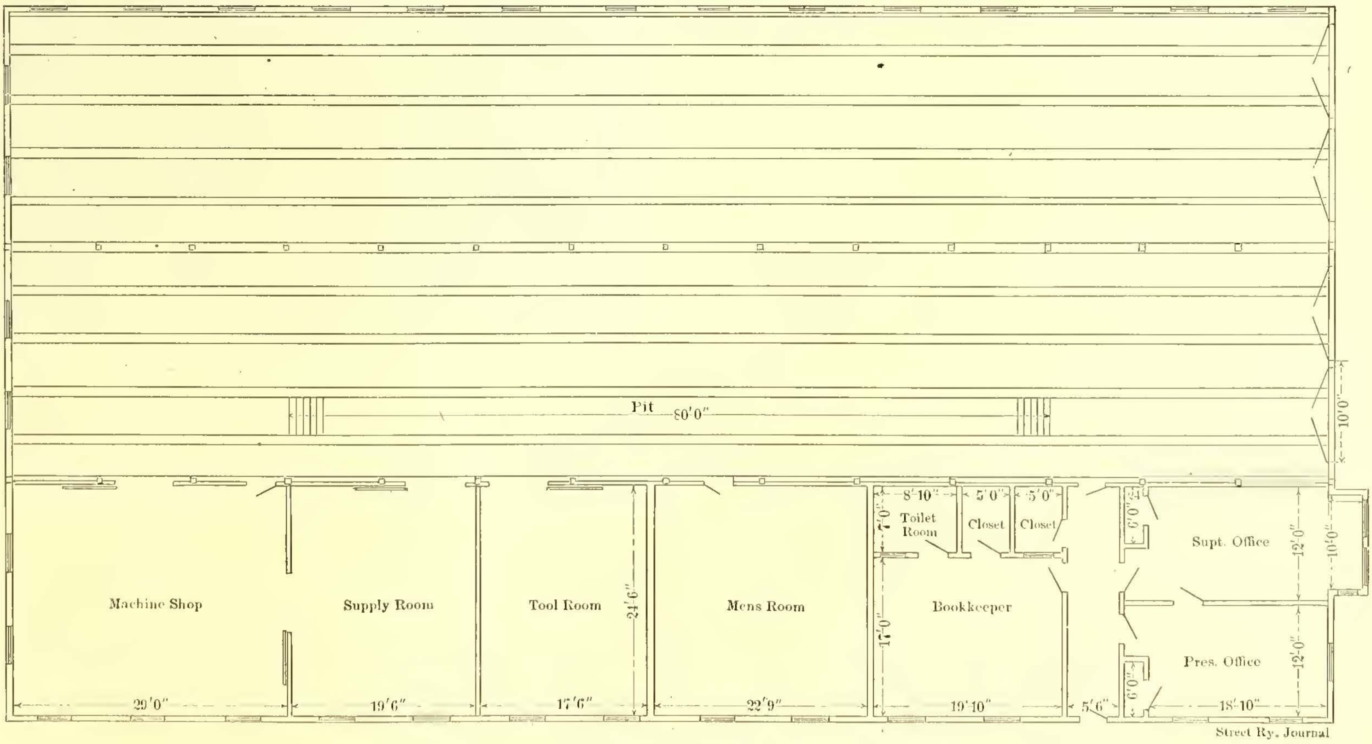
ft. and those in the boiler room a span of 40 ft. They were designed with a factor of safety of four against a total load for wind and snow of 50 lbs. per square foot of horizontal covered area, exclusive of the roof itself. The boiler house trusses are designed for an addi-



TRANSFORMER ROOM IN POWER STATION

tional load of 10,000 lbs. applied at any point of the bottom chord. All trusses rest on cast-iron plates built into the walls. The anchor-bolts project through the plates, slots being left in the shoes at the ends of the trusses to allow for adjustment and expansion. Washers 6 ins. square were provided for the base of each anchor-bolt. Each truss has a bearing surface on the walls of at least 8 ins. The Union Foundry Company furnished and erected the trusses, purlins, monitor bracing, crane runways, and so forth. The Whiting Foundry Equipment Company, of Harvey, Ill., built the 20-ton hand-power traveling crane used in the engine room.

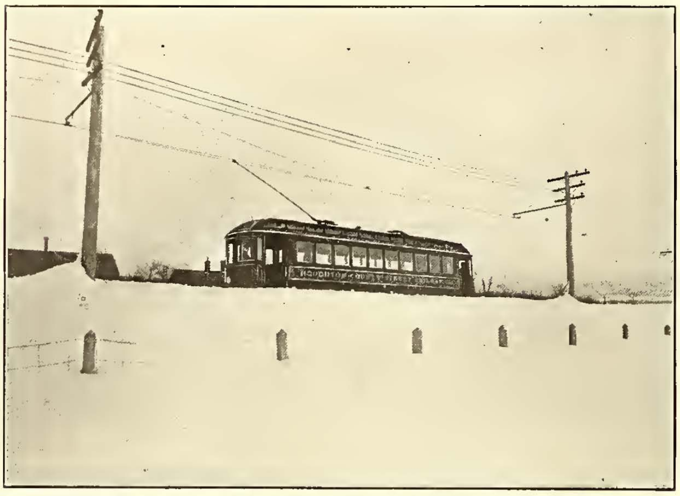
A brick wall 16 ins. thick divides the building into a boiler room, the inside dimensions of which are 40 ft. x 82 ft. 4 in., with a height to the bottom chord of the roof trusses of 26 ft., and an engine room measuring 50 ft. x 82 ft. 4 ins. and 26 ft. high. The engine room basement is 12 ft. high. A partition, also of brick, sets aside from the boiler room a space 10 ft. x 27 ft. 6 ins., which contains



PLAN OF CAR HOUSE

the step-up transformers. The ceiling of this room is sheathed with galvanized iron, and the single door, which communicates with the office, is fire-proofed with the same material. At the west end of the boiler room and outside the station is a guyed steel stack 110 ft. high with a diameter of 7 ft.

Coal is delivered at the company's dock and is carried on a trestle 24 ft. high and about 160 ft. long to the coal



STANDARD CAR AND OVERHEAD CONSTRUCTION

pile at the east side of the power house. The dock is built of piling filled with stone, and compares favorably with any in the vicinity.

A compact, well-built, brick sub-station 20 ft. 10 ins. x 32 ft. 10 ins. was erected in Laurium, about 12 miles from the main station, in the summer of 1901. The entrance is closed by double sliding doors, and the building is well lighted by four windows in each side wall. The pitch roof is covered with galvanized iron laid with standing seams.

In Hancock, about 2¼ miles from the Houghton terminal, is the car house, a well-equipped wooden structure with shingled roof and stone foundation. On account of the exposed location and the strong winds which prevail during the winter season the construction of the building was made extra heavy throughout. When the road was extended and the rolling stock was increased an addition to the car house became necessary. As the building now stands, two of its three bays are occupied by the four tracks and cover a space about 50 ft. x 245 ft. There is a pit under each track. The third bay, approximately 25 ft. x 145 ft., contains several well-furnished offices, including those of the president and general manager, and the employees' room, machine shop and store room. In the monitor is a large tank which supplies all parts of the building with excellent water, which is pumped from a spring in the basement. Provision is made in the basement for the stabling of the company's horses. The building is provided with a steam heating plant.

On the sub-station lot in Laurium there is a small two-track wooden car house used for storage purposes.

BOILERS

Steam is furnished by a battery of five horizontal return tubular boilers, each 72 ins. in diameter and containing 112 tubes 3 ins. in diameter and 16 ft. long. The boilers have overhanging fronts and are guaranteed for a working pressure of 150 lbs. The shells and heads are made of the best open-hearth steel, which met the following requirements:

Tensile strength, 55,000-65,000 lbs.
Elastic limit, at least, 33,000 lbs.
Elongation in 8 inches, not less than 25 per cent.

The shell plates are ½ in. thick and the heads are 9-16 in. flanged steel. The tubes are made of best quality of steel spaced vertically and horizontally 1 in. apart, with a center vertical space 2 ins. wide. The heads are stayed above and below the tubes by means of through braces. Each boiler has two cast-iron nozzles 6 ins. in diameter, one in the middle sheet for steam connection and the other in the front sheet, having riveted to it a special casting which carries two inspector lock-up pop safety valves. To prevent priming, a dry pipe runs nearly the whole length of the boiler over the tubes, being screwed into a steam-box which is fastened to the nozzle with a steam-tight joint. The upper surface of this pipe is perforated with ½-in. holes aggregating an area equal to that of the steam nozzle, and the under side has two ¼-in. holes for draining. The blow-off pipe and fittings are extra heavy. Each boiler is provided with a 12-in. brass steam gage, a combination water column and a 2-in. internal brass feed pipe, which runs back within 3 ft. of the rear end and then turns down 6 ins. below the water line. The feed pipes and the water column connections are brass. All piping and fittings where subjected to boiler pressure are extra heavy and correspond to the Walworth Manufacturing Company standard. Each boiler is suspended by six cast-iron brackets. Each has two manholes, one 11 ins. x 15 ins. in the top of the rear sheet and the other 10 ins. x 15 ins. in the front head below the tubes.

The fronts are cast iron with two fire doors. The grates were made by W. W. Tupper & Company and have ⅝-in. air spaces, ½-in. bars and an area of 36 sq. ft. The uptakes are cast iron, air-tight and fitted with hand dampers to be operated from the floor. A sheet-iron flue with cross section 4 ft. x 10 ft. connects the uptakes with the stack. Boilers, flue and all accessories were made by Edward Kendall & Sons, of Cambridgeport, Mass. Each boiler is equipped with a low-water alarm made by the Ashcroft Manufacturing Company. Two 6-in. x 4-in. x 6-in. Stilwell-

TRACK CONSTRUCTION THROUGH RECLAIMED SWAMP

Bierce & Smith-Vaile duplex boiler feed pumps and a Wainwright even-flow supplementary horizontal feed-water heater are installed at the west end of the battery. The heater contains 400 sq. ft. of heating surface and was made by the Taunton Locomotive Manufacturing Company.

PIPING

All steam and water pipes subjected to boiler pressure are of best grade lap-welded steel tubing. All work above 2½ ins. is flanged. The flanges are extra heavy, provided with raised face and calking recess. All flanged fittings are of extra heavy long-turn pattern made from the best grade of cast iron.

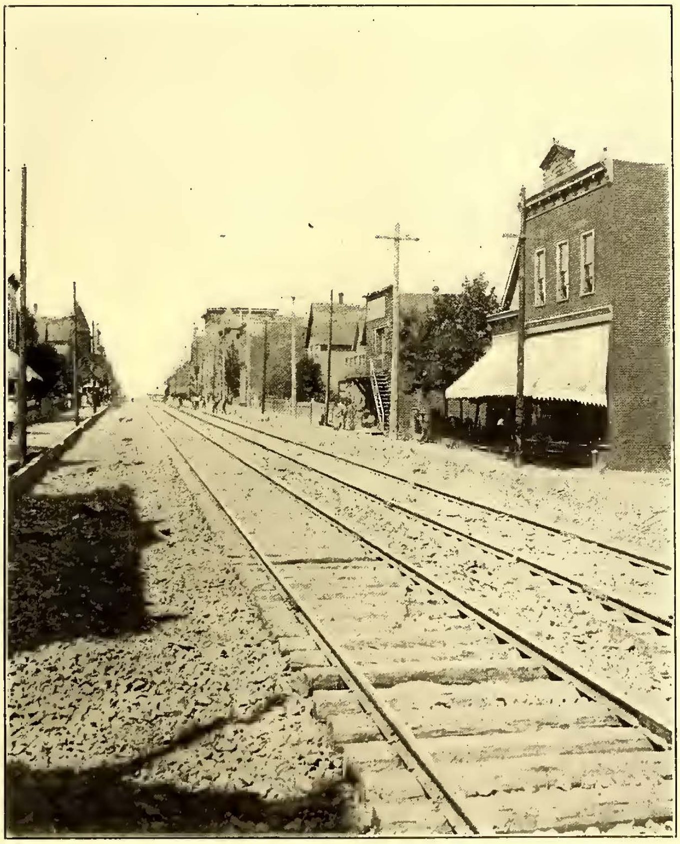
The low-pressure piping is chiefly of lap-welded iron, all work above 4 ins. being flanged. Flanged cast iron piping is used between the exhaust nozzles of the engines and condensers and the automatic relief valves, for suction pipes of the pumps and condensers, and for the discharge pipes from the condensers.

The valves are of the Chapman Valve Manufacturing Company's make and are extra heavy where subjected to boiler pressure. These valves have flanged iron bodies with bronze seats arranged with outside screw and yoke. By-passes are provided for all high-pressure valves above 6 ins. Such valves have ribbed bodies.

Heaters, tops of boilers, all steam supply pipes, drips from heater, all feed pipes carrying hot water (except the brass connections in front of the boilers) and exhaust pipes, including all valves and fittings, are covered with Keasbey & Mattison's magnesia covering. Sectional covering is used wherever feasible and plastic elsewhere. On heaters and tops of boilers the plastic covering is 2 ins. thick. Water for boiler feed and condensing purposes is drawn from the lake. For use in emergencies there is a 4-in. connection to the town water supply, the waterworks being only a few hundred feet west of the power station.

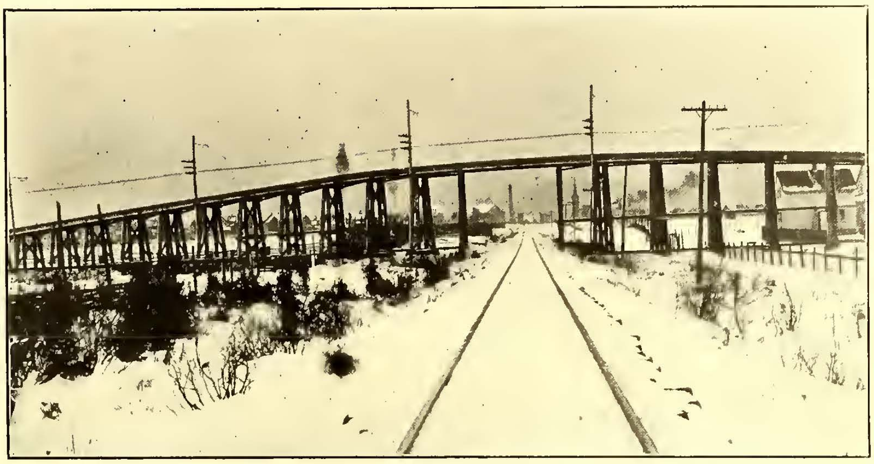
RAILWAY UNIT

The engine room contains two 500-kw direct-connected units, one for railway work and the other for supplying



HECLA STREET, LAURIUM, READY FOR CRUSHED STONE

power to the three-phase transmission line. The railway unit was installed in 1900, and consists of a 750-hp horizontal cross-compound condensing St. Louis-Corliss engine built by the St. Louis Iron & Machine Works, and a Westinghouse 10-pole, 500-kw, 550-volt railway generator. The unit occupies a floor space 25 ft. x 36 ft. The cylinders of this engine are 22 ins. and 38 ins. in diameter, with a common stroke of 42 ins. The working pressure is 125 lbs. and the speed 90 r. p. m. The piston rods are open-hearth steel, the high-pressure rod having a diameter of 3 15-16 ins. and the low-pressure 4 7-16 ins. The material of the



TRESTLE OVER HECLA AND TORCH LAKE RAILWAY

connecting rods is selected forged iron. The cross-head pins and crank pins are made of best hammered crucible steel, the size of the former being $5\frac{1}{2}$ ins. x 6 ins. and of the latter $6\frac{1}{2}$ ins. x $6\frac{1}{2}$ ins. The main shaft is selected forged iron 15 ins. x 28 ins. in the journals and 28 ins. in diameter at the wheel seat. There is a reheating receiver between the cylinders. At full load and with a vacuum of 25 ins. at the exhaust the steam consumption is guaranteed not to exceed 15 lbs. ihp per hour. The segmental fly-wheel is 18 ft. in diameter and weighs 60,000 lbs. Its arms have an I-beam section. The total weight of the engine is 209,000 lbs.

The generator is rated at 910 amps. and 550 volts at full load, and is guaranteed to stand an overload of 50 per cent for one hour and 75 per cent temporarily without injurious heating or undue sparking at the commutator. Its efficiency at full load is 94 per cent. The armature is of the slotted-drum type with multiple winding. The insulation of the armature and field coils is guaranteed to stand a test with alternating current at a pressure of 3500 volts.

TRANSMISSION UNIT

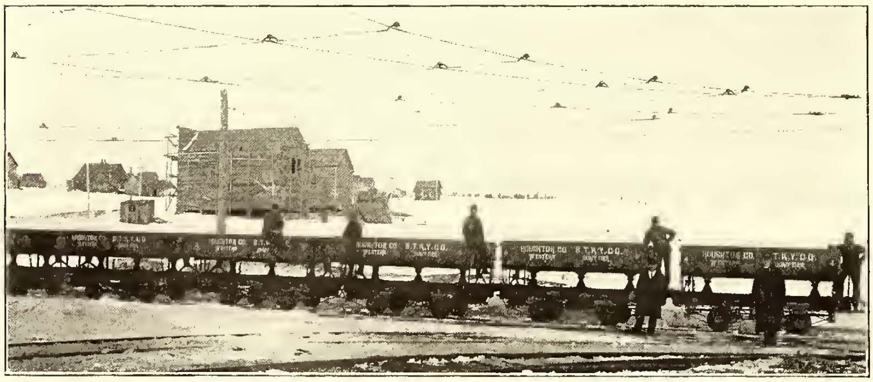
The transmission unit, installed in 1901, comprises a 750-hp horizontal cross-compound condensing engine built by C. H. Brown & Company, of Fitchburg, Mass., and a Westinghouse three-phase, 25-cycle, 500-kw separately excited generator running at 100 r. p. m. The floor space occupied by this unit is about 26 ft. x 35 ft.

A brief description of the engine is as follows: Cylinders, 22 ins. and 40 ins.; stroke, 48 ins.; speed, 100 r. p. m.; pressure at throttle, 125 lbs.; diameter of steam supply, 8 ins.; diameter of exhaust, 16 ins.; gridiron valves with cut-off varying from zero to three-quarters stroke; clearance, high pressure, $\frac{1}{4}$ in.; low pressure, $\frac{3}{8}$ in.; high-pressure port areas, 36.17 sq. ins. and 46.26 sq. ins.; low-pressure port areas, 97.45 sq. ins. and 131.62 sq. ins.; piston rods, open-hearth steel, high pressure 4 ins. diameter, low pressure $4\frac{1}{2}$ ins. diameter; connecting rods, wrought iron, 144 ins long, large and small sections 33.18 sq. ins. and 21.64 sq. ins.; cross-head pins and crank pins, open-hearth steel, the former 6 ins. x 6 ins. and the latter 7 ins. x 7 ins.; shaft, Bethlehem steel, 16 ins. x 28 ins. in the journals and 20 ins. in diameter in the fly-wheel; weight fly-wheel, which was cast in two pieces, 60,000 lbs.; section of fly-wheel arms, oval; total weight of engine, 195,000 lbs.

There is a reheating receiver between the cylinders with capacity of 56,984 cu. ins. The engine is guaranteed for an overload of 50 per cent for two hours. The steam consumption, when running under full load at normal speed and pressure, with a vacuum at the exhaust of 26 ins., is guaranteed not to exceed 14 lbs. per ihp per hour. A Monarch safety stop was furnished with the engine and operates if the speed exceeds 110 r. p. m.

The generator has a revolving armature, and is guaranteed to develop 500 kw continuously at 380 volts, with an efficiency of 94 per cent, and 750 kw for two hours with an efficiency of 94.5 per cent. The full-load current is 750 amps. per phase. The regulation of the generator is 8 per cent when the power factor is 100 per cent and the speed constant. For continuous running with power factor of 90 to 100 per cent the temperature rise is guaranteed not to exceed 40 degs. C. above a room temperature of 25 degs. C. The weight of the armature is 21,000 lbs., and of the complete machine 74,000 lbs. The exciter for this machine is driven by belt from a countershaft in the basement, which is in turn driven from the main shaft of the engine.

The exhaust steam from each of the above engines passes into a 7½ in. x 15 in. x 20 in. x 15 in. jet condenser with vertical cross-compound air pump. Both of these condensers were furnished by the W. H. Blake Steam Pump Company, of Fitchburg, Mass.



CONSTRUCTION CARS

For the purpose of lighting the power house, and also the car house when the railway unit is out of service, there was installed in the power house a small direct-connected set consisting of a 30-kw, 500-550 volt Holtzer-Cabot generator and a 10 in. x 10 in. McEwen engine.

ROTARY CONVERTER

In a corner of the engine room is located a 250-kw, three-phase, 25-cycle Westinghouse synchronous converter, rated at 420 amps. at 600 volts on the direct-current side. Its starting motor is mounted on the same shaft. When driven from the alternating-current side the converter is self-exciting; when driven from the direct-current side it is separately excited by a 2.6 kw Westinghouse belted machine. This converter and those in the sub-station have a full-load efficiency of 93 per cent, and were designed to stand an overload of 50 per cent for two hours without injurious heating. During a continuous run the temperature is guaranteed not to exceed 40 degs. C. rise above a room temperature of 25 degs. C. The total weight of each rotary is about 18,000 lbs.

STEP-UP TRANSFORMERS

The transformer room contains six 100-kw, 25-cycle Westinghouse oil-cooled, step-up transformers, the primary of each being wound for three-phase current at 380 volts and the secondary for three-phase current at 11,000 volts. Each converter has a full-load efficiency of 96.7 per cent and a voltage regulation of 2.2 per cent when the power factor is 100 per cent. Each transformer weighs 2100 lbs. without case or oil and occupies a floor space 51 ins. x 38 ins. Directly over the transformers are six "wooden pole" circuit breakers, rated at 6000 volts to 15,000 volts and 100 amps. and mounted on marble bases attached to wooden framing. The type R 11,000-volt lightning arresters are placed on a shelf of 2-in. planking opposite an opening communicating with a wire shelter on the outside of the building. This shelter contains line insulators supported on a slate slab.

SWITCHBOARD

The entire switchboard and equipment was also furnished by the Westinghouse Company, and is made up of white marble panels 65 ins. high, with sub-bases 25 ins. high supported by an iron frame. The direct-current board is of the standard railway type 5 construction, and includes one type B generator panel of 1200 amps. capacity, two type F feeder panels, each of 600 amps. capacity, and one type C rheostat panel, added to which is a panel for the lighting unit. With this board was also furnished a 1200-amp tank lightning arrester.

The transmission section of the switchboard matches the earlier railway board and comprises the following panels: One generator panel containing three 1200-amp., 380-volt, single-pole, single-throw, washer type main switches; one ammeter with 1200-amp. scale; two voltmeters on swinging bracket, integrating wattmeter, circuit breaker, etc.; one exciter panel, one alternating-current rotary converter panel with one 600-amp., 380-volt, washer type main switch, phasing lamps, switches for starting motor and necessary connections; one direct-current rotary converter panel on which are mounted one main quick-break, two-pole, 600-amp., 600-volt switch, one ammeter with 1000-amp. scale, integrating wattmeter, circuit breaker, and other apparatus and connections. The high-voltage switches and lightning arresters are located in the transformer room.

TRANSMISSION LINE

The wire used in the three-phase transmission line is No. 1 bare copper carried on Locke No. 3 brown porcelain insulators. These insulators are of the triple-petticoat type and are guaranteed for a working pressure of 15,000 volts, with a factor of safety of at least two. For nearly the entire distance, about 12 miles, the wires are strung on the railway pole line. The upper cross-arm carries two of the transmission wires and the middle arm carries the neutral wire, while on the third arm are the feeders. All of these wires are strung on the outer side of the poles. On the trestles the arms are bracketed low enough on the poles to avoid a material change in the grade of the line.

SUB-STATION EQUIPMENT

The entire equipment installed in the sub-station is of Westinghouse manufacture. Six 100-kw, 25-cycle, oil-cooled step-down transformers, with three-phase primaries and secondaries transforming from 11,000 volts to 380 volts, occupy one side of the station. These transformers are similar to those installed in the power house. The high-tension circuit breakers are supported on a frame above the transformers. At the opposite side of the room are two 250-kw, three-phase, 25-cycle rotary converters which deliver current to the feeder system at a pressure of 600 volts. These rotaries are similar in all respects to that in the main station and have the same overload and heating guarantees.

At the rear of the room is a white marble switchboard of five panels, as follows: Two alternating-current synchronous converter panels, each containing one three-pole, single-throw main switch, ammeter with 900-amp. scale, switch for starting motor, voltmeter on swinging bracket and other necessary apparatus and connections; two direct-current synchronous converter panels, on each side of which are mounted one 600-amp., 600-volt, two-pole switch; one 1000-amp. ammeter, integrating wattmeter, circuit breaker, etc., with the two 600-volt voltmeters mounted on a swinging bracket; and finally one direct-current feeder panel containing two 600-amp., 600-volt, single-pole, single-throw switches, two ammeters with 800-amp. scales, circuit breakers, lightning arresters and two 600-amp. feeders controlled by each panel.

ROADBED AND TRACK

Between Hancock and Laurium, and on the Wolverine branch, the road runs over a private right of way, which is enclosed by a wire fence. The construction is of the steam railroad type except that cuts are avoided, the ties being laid on an embankment which is in no place less than 3 ft. above the level of the surrounding country. As the character of the surface is rolling, many moderate grades are introduced which could otherwise have been avoided, but it is now seen that the road would have been unable to operate between towns during some of the heavy snowstorms if cuts had been made. These would have invited the collection of large drifts which could have been removed with difficulty; but it is a comparatively easy matter to clear the raised tracks. In many places the wind sweeps the rails clean.

In building the embankment there were used 115,342 cu. yds. of earth, 68,000 cu. yds. of earth and gravel and 38,196 cu. yds. of broken rock. Between Boston Crossing and the sub-station two large swamps were encountered which necessitated a large amount of rock filling and ditching, and in many places the right of way was cut through the virgin forest.

The Michigan Railroad Commissioners have no power to grant crossings with main lines of steam roads except on highways, and then not at grade, which caused a change in the original plans of the company, which provided for grade crossings. In compliance with the law, five wooden trestles clearing the steam railroad tracks by 23 ft. were built where main lines were to be crossed, thus introducing several short 8 per cent grades. The Portage Lake bridge and several of the township bridges had to be strengthened in order to bear the additional weight of the cars.

Except on the county bridge, where girder rails were used on account of the planking, the road was laid throughout with 30-ft. 60-lb. T-rails with A. S. C. E. section. The spikes used are 5½ ins. x 9-16 ins. The angle-bars are extra heavy, 24 ins. in length, with four bolts. The Pennsylvania and Illinois steel companies furnished the track materials. The rails were laid on native cedar ties spaced 2 ft. on centers. In the towns 6-in. x 6-in. x 7-ft. ties were used, and in the interurban sections 6 in. x 6 in. x 8-ft. The first portion of the track to be laid was bonded with American Steel & Wire Company concealed bonds, but on the later work the Clark bond, furnished by the Chase-Shawmut Company, of Boston, was used.

OVERHEAD CONSTRUCTION

The overhead construction is of the top-guy flexible bracket type, strung with No. 00 trolley wire throughout. The only portion of the line where double trolley wire was installed is on the 3-mile grade in Hancock. The well-known West End hangers with soldered ears were used. The wooden poles are native cedar 35 ft. high with 8-in. top and carry three cross-arms for the transmission and feed wires. In the various towns where double track is laid the span wires are carried on iron poles, about 300 of which were erected. All of the bare copper wire used by the road was made by a local firm, the Tamarack-Osceola Copper Manufacturing Company. The feeder installation consists of about 35 miles of No. 0000 triple-braided copper wire.

ROLLING STOCK AND EQUIPMENT

The company operates sixteen closed cars, all of which have straight sides and vestibules with folding doors, and the majority of which have "steam car" roof with the monitor extending over the platform. As the summer season is of short duration open cars are little needed. The windows of the closed cars are extra wide and low, and by lowering both sashes the advantages of open cars are obtained without additional expense. The long cars are equipped with two trolley poles.

Of the eight 30-ft. cars built by the Laconia Car Company Works, two have longitudinal seats and six are of the cross-seat, center-aisle type. All of them are mounted on Peckham double trucks and are equipped with the American Electric Heating Corporation's heaters.

The other cars are of Brill manufacture. Four of these have bodies 29 ft. 4⅝ ins. long, measure 38 ft. 8⅝ ins. over vestibules and are mounted on Brill 27-G trucks. Twenty No. 42 Wheeler seats, upholstered with rattan, provide for the seating of forty passengers. The remaining four cars measure 20 ft. 8 ins. over the corner posts and 30 ft. over the vestibules, and are mounted on Brill 21-E single trucks. The seats in these cars run lengthwise and are upholstered with cane. The Brill cars have Simplex heaters.

The motors are G. E.-67, the four-motor equipments having K-6 controllers and the double equipments K-10 controllers. At 500 volts these motors develop 38 hp, the output being based on the G. E. standard rating. The weight of the complete motor is 2385 lbs and of the gear and case 285 lbs.

All cars are provided with the Standard Traction Brake Company's air brake equipments, designed for a maximum speed of 30 m. p. h. and an average speed of 20 m. p. h. The compressors of four of these equipments are of the independent motor-driven type, while the remainder are axle-driven.

The company's rolling stock also includes one Ruggles rotary snowplow, three Taunton heavy nose plows, three two-wheel "walkaway" snow scrapers and eight construction cars of the Western side-dumping type. The trouble department has at its disposal two one-horse Trenton folding tower wagons.

The road was completed as far as Boston in October, 1900, and operation of this section was begun early in November. The following summer the line was completed and the transmission plant installed, the operation of the entire system beginning in September, 1901. The company's business has been excellent, and in order to handle the summer travel it is probable that some of the rolling stock will be equipped with a multiple-control system so that two-car trains can be run.

The officers of the Houghton County Street Railway Company are as follows: F. J. Bawden, president; W. O. Chapman, vice-president; H. B. Sawyer, treasurer; A. H. Warren, assistant treasurer; E. Wadsworth, secretary; J. H. Oakley, manager and superintendent. The general managers of the road are Stone and Webster, of Boston, Mass.

STREET RAILWAY ACCOUNTING

CONDUCTED BY J. F. CALDERWOOD, COMPTROLLER TWIN CITY RAPID TRANSIT COMPANY AND MEMBER INSTITUTE OF SECRETARIES OF LONDON

"There is not a science or class of men on whom the business of the world is more dependent than the science of accounts and accounting."—Andrew Carnegie.

The Accounting Department

The writer was requested, not only by street railway accountants, but by managers, to induce someone to fill a want in the field of journalism by establishing a journal devoted exclusively to street railway accounts and accounting.

Believing that such an object could, for the present, at least, be best served by securing the co-operation of one of our leading journals devoted to the interests of street railways in general, the writer took the matter up with the STREET RAILWAY JOURNAL, and a satisfactory arrangement has been made to set aside the needed space to be devoted exclusively to matters pertaining to street railway accounts and accounting.

The writer has secured the co-operation of such leading accountants as C. N. Duffy, of the Chicago City Railway; H. L. Wilson, of the Boston Elevated Railway; W. F. Ham, of the Washington Traction Company; W. G. Ross, of the Montreal Street Railway Company; F. E. Smith, of the Union Traction Company; H. C. Mackay, of the Milwaukee Railway, Light & Power Company and president of the Street Railway Accountants Association of America; W. B. Brockway, of the New Orleans & Carrollton Railway, secretary and treasurer of the Street Railway Accountants' Association of America, and many others who will, in these columns, contribute on matters of interest in connection with accounting in general and street railway accounting in particular.

The writer would be glad to receive inquiries from anyone on any subject pertaining to street railway accounting.

The writer will, with each issue, publish the methods of handling the details of the different departments of the company with which he is connected. This is not done with the idea that our system is any better than many others, but with the thought that such a course will suggest points for discussion, and thereby bring out the most progressive ideas.

Inquiries from managers are especially invited. They are the ones who are continually meeting new conditions. The question as to how they can best meet these questions they can best answer, but it is for the accountants to say which can be done with the least expense; for in the end the wisdom of every new idea or change in policy must meet and stand the test of economy. J. F. CALDERWOOD.

The fundamental principles of accounting are comparatively simple. The art lies: First, in the adaptation of the principles to the varied classes of business, and to such an understanding of the business that the diversified interest will clearly and accurately set forth the real facts; second to the preparation of statistical information that the true condition of the business may be presented in a clear and concise manner.

The Modern Accountant

BY J. F. CALDERWOOD

In the world of accounts there abide these four—the clerk, the bookkeeper, the auditor, the accountant—but the greatest of these is the accountant.

The clerk transcribes; the bookkeeper produces balances; the auditor sees that the books agree with the facts; the accountant produces from the books and from a study of the business factors behind them, a foundation for profitable investment and successful management.

The clerk is a copyist; the bookkeeper is a routine compiler of records; the auditor is an inspector of books and a verifier of the records with the facts; the accountant deals with the facts themselves that are booked and audited. He is, first, an analyst of records, and second, a synthesist of the facts and factors of production and distribution.

The clerk may be more than a mere copyist; he may be a bookkeeper. The latter may be more than a keeper of records; he may have an intelligent knowledge of the business of which the books are the photographic history. The auditor may be more than a supervisor and verifier, indeed he is often the accountant with initiative genius, the financial adviser, the "Napoleon of finance." In each of these giving service beyond the routine sphere assigned to him is a candidate for deserved promotion.

As an analyst of records, the accountant may begin his work where the clerk, bookkeeper and auditor left off. As a synthesist of business facts and factors, the accountant may have antedated both bookkeeper and auditor; indeed, he may have been on the ground before there were books, or plant, or investment. His examination may have been the foundation of all. His judgment may have originated the bookkeeping system which the bookkeeper kept and the auditor verified. His advice may have been responsible for the system of management which produced the business facts afterward booked and audited.

After the bookkeeper and auditor have compiled and verified their records, the accountant's work begins again. He may use their work as a foundation upon which to erect the coming year's business, or, he may proceed to knock and tear to pieces the product of their workmanship. Again, he may find that the facts not contained in the books are of more vital business import than the facts that are booked. He may read between the lines; he may see facts that are concealed. He must familiarize himself with facts that cannot be booked—the physical condition of the plant, the adaptability of the plant to the requirements; the character of the management, the personnel of the working force, the system and methods of management, bookkeeping and financiering.

The accountant may arrive at a result the opposite of that shown in the balance sheet of the bookkeeper and auditor. His analysis of "Assets" may disclose defunct notes and worthless accounts, etc. His examination of "Stock on Hand" may bring to light superannuated débris which time, invention, fashion and modern custom have robbed of value. This is a feature that has to be carefully considered in "Stock in Hand" in connection with street railway operation. His inspection of the facts behind the asset items "due from auxiliary companies" may show losses entailed by those companies, a vital drain instead of an asset "A." His scrutiny of the "Liabilities" items, such as "Accounts Accrued" and "Accounts and Notes Payable," may show that the concern is sadly in arrears and unable to meet current obligations and expenses. The liability items, "Accounts Payable" and "Bills Payable," may prove to be "quick liabilities" which imply a receivership;

while, on the other hand, the offsetting asset item, "Accounts Receivable," may stand for long-time or outlawed accounts and "dead horses." His examination of the surplus account may show a padding, or that items have been charged to this account directly that should have been charged against revenue in the monthly or yearly statements; that the so-called "Reserve Accounts" show items charged to this account that should have been charged directly to the cost of operation; that profits have been credited and dividends declared and the physical condition of the property allowed to deteriorate.

On the other hand, the accountant may find that the records accurately reflect the true condition or facts for which they stand, but, nevertheless, cannot be relied upon for investment and future successful management, because the facts themselves are exceptional, fluctuating, or of temporary duration. The large volume of profits may be due to a sudden boom in selling prices, or to an exceptional bargain in the purchase of raw material. The splendid showing of gross earnings may be due to abnormal conditions or to a temporary monopoly which competition or public policy may bring to an untimely end. The phenomenally low record of operating expenses may be due to the failure to provide for depreciation and maintenance, or because the expenditures for maintenance were charged to capital account instead of to operating expenses. The large income balance may have resulted from the revenue derived from other securities owned or the manipulation of the securities of subsidiary companies, instead of from operation of the business, and the surplus shown or dividends paid may not have been earned.

In short, the accountant must go behind the books and study the business which they record; and he must look yet again and study the men behind the business. In the world of accounts he is at once industrial expert and physiognomist, reporter and detective, historian and prophet. He deals with the book equation, the business equation, the personal equation. He must know records, things, men. He may ascertain that the only valuable asset of a corporation is future expectation or good will, or that the one productive factor in the business is the untiring genius of a manager who conquers all obstacles; that he is a "Napoleon" of the business under his control, yet his organization is such that should he sever his connection the business would be embarrassed.

The accountant must be a student of markets, of banking, of investment. He knows that capital competes with capital for safe investment, and that whatever strengthens the security lowers the rate upon the loan and thereby increases the margin of profit for dividends.

The movements of the market, the opinions of the investor, the requirements of the banker, the interests of the business managed, as well as the character of the latter, must receive the accountant's close study.

The accountant should know something of law—commercial law, corporation law, the law of ultra vires, the law of contracts, tax laws, franchise laws, constitutional law relating to legislative powers and the rights of property—and he must know something of the validity of legal instruments and the validity of titles. Take municipal investments. Municipal bonds are amply secured, as they ordinarily do not exceed from 1 per cent to 10 per cent of the assessed valuation of the taxable property of the city, county, village or school district which issue them. The danger is in the validity of the bond issues. The average State Legislature is called upon biennially to pass a score or more of local "curative acts" to validate and legalize the bond issues or other financial acts of certain cities, counties, townships, villages and school districts, whose officers acted in ignorance or careless non-compliance with the laws. As a student of tax laws, the accountant should know not only the laws which exist, but those which ought to exist for the best interests of business and property. He should know enough of constitutional and franchise law to know whether the charter of the company for whom he is acting has a copper-bottomed exclusive franchise or merely a license which hangs on the whims or caprices of the public and its chosen representatives. He should know enough of corporation law to know whether the company and its officials are acting within their legal and charter powers, and whether the meetings of stockholders and directors were regularly and properly convened and the minutes are in regular form. He should know enough of legal principles and of popular sentiment to judge whether the company may be swamped within the year by a vital decision of the courts or by an avalanche of hostile legislation.

The successful accountant must be a student, not only of business, but of public affairs and public opinion. Legislation, taxes, franchises, public contracts, public improvements, executive policy, political principles, party ascendancy, the press and public sentiment, are all business factors demanding his study. He must be a student of civilization and its forces. The value of the real estate mortgage relies upon the prosperity of the community, just as the value of the railroad mortgage depends upon the volume of transportation business, and both rest upon population and the progress of civilization. The earning power and spending power of the public is the most vital factor in determining the value of any business property, and is the most important measure of the security of its stocks and bonds for investment. The prosperity and progress of the community is the measure of the value of the business, good will or franchise.

In short, the up-to-date accountant is an economist. He is a practical working economist. He is to private and corporate finance what the political economist is to public affairs; and he is more. He deals with the things he studies. His work is on life's busy stage, and not on paper only. He deals with material things, instead of theories. He studies men in place of abstractions. He is an economist of the inductive school. He handles applied finance and comes against industry, trade and traffic in the concrete. He should know the personnel, the physical machinery, the working methods, the raw material and the finished products of the mills, mines, mercantile institutions, financial houses and transportation systems which carry on the world's work.

The accountant, like the political economist, should be a student of economic principles. Both are students of population trend, of inventions and processes, of soil and climate, of crops and bank deposits, of milling and mining, of trade and transportation. But the one is a student of the facts and principles of economics in order to produce literature, the other to produce interest payments and dividends. The study of the one results in intellectual inspiration and training, of the other in wages, products and bills receivable. The mission of the one is educational, of the other industrial and commercial. The goal of the political economist is culture, of the accountant work and wealth. The political economist is the accountant in the field of literature. The accountant is the economist in the world of finance.

The Old World has given us great economists and great accountants; but New World conditions cannot blindly accept either. European conditions are crystallized into hard and fast customs, fixed by class distinctions and hardened into ruts. American conditions are influx. Our civilization is fluid. The prairie dog village of yesterday is to-day's metropolis. The Indian trail has become a transcontinental traffic route. The Great American Desert has been converted into the bread basket of the universe. Consequently, American values rest on a different basis from European values. European values rest on the past; American values upon the future. The value of a real estate site depends upon what the population around it is going to be to-morrow. The value of a franchise or of a railroad bond depends upon to-morrow's human tide and traffic. The European accountant may find it sufficient to deal with the facts of to-day and the records of yesterday; but the American accountant must consider not only yesterday and to-day, but, most of all, the promises and expectations of to-morrow. He must study business expectancy, as the underwriter studies life expectancy. He must deal with prophecy as well as with history. He must not only dig in the mold of the past, but draw aside the veil of the future. The American accountant has greater

Form 119c. 50m-12-1901.

______ LINE.

No. ______ ______ Conductor

No. ______ ______ Motorman

Motor No.	Date ______ 190__
	Register at ending - - - ______
	Register at Commencing - ______
Trailer No.	Fares Registered - - - ______
	Ticket Fares - - - - ______
Relieved by Conductor No.	Cash Fares - - - - - ______
	Total Cash - - $ ______
	Cash Received - $ ______ Clerk.

TRIPS	TIME ...... M	North East Fares	North East Free	South West Fares	South West Free	TOTAL Fares Registered	TOTAL Tickets	TRIPS FROM	TRIPS TO
U									
D									
U									
D									
U									
D									
U									
TOTAL									

Notice: This report will not be accepted unless FULLY and CAREFULLY made out. NOTE CAREFULLY TRIPS MADE. WRITE REMARKS ON BACK.

FORM 1

problems to solve than the European accountant. He should become more expert, for the conditions are more diversified and the laws governing corporations are not as rigid in America as in European countries.

It is apparent from the foregoing that the accountant has a field and a mission worthy of his ambition in this day of trusts, mergers, great combinations and a tendency to overcapitalize and inflate values and promote schemes simply for the benefit of the promoters. Wherever in the world there is credit that requires security, wherever there is work that needs direction, wherever there is capital that needs investment, there the accountant has a field and a mission. What the architect is to the builder, what the lawyer is to the client, what the physician is to the patient, what the priest is to the parishioner, what the trainer is to the aspirant for honors—that may the up-to-date accountant be to the business with dividends to meet, to the capitalist who seeks investment, to the employer with wages to pay, to the business man in straits, to the ambitious moneymaker without expert training whatever in his financial field.

Show me the manager who is not in sympathy with an up-to-date system of accounting, and who does not make a careful comparison and analysis of the statistics that enter into the expense and revenue accounts, and I will show you a failure.

From the Conductor to the Bank; with the Passenger Earnings of the Twin City Rapid Transit Company

The Twin City Rapid Transit Company maintains, on its system, eight stations, and at each station there is a day and a night clerk. The conductors settle with the station clerks

TRANSFERS.

Conductor No. ______ ______ LINE,

Commencing No. D / U

Ending ______ ______ 189__

TRIP		MOTOR No. TIME	Min. Late	Fares Registered	TICKETS	TRAILER No. Fares Registered	TICKETS	TOTAL TICKETS MOTOR AND TRAILER
	D	M						
	U	M						
TOTAL,								

______ Conductor No. ______

FORM 2

for the amount of cash called for by their respective trip sheets at the end of each relief. (See form 1).

The transfers and tickets are turned in in special envelopes at the end of each trip. (See form 2.) These

Form 429 5m-7-98

Bloom Station, Jan 25 1892

J. F. CALDERWOOD, Esq., Auditor.

Dear Sir. The following is a summary list of moneys sent this date from ______ Station to the General Office, covering the passenger earnings for ______ 189__

CLERK.	RECEIVED.	Time Delivered.	AMOUNT.
E. Simock	A. Denny	9:00	528 87
E. Simock	A. Denny	1:35 am	212 39
E. Simock	Jan 26	7:05 am	67 34
			808 60

NOTE.—The Clerk, also the Receiver, will personally sign on the proper line, as above indicated, with each delivery of money, noting carefully in the proper columns the exact amount of money so delivered, inserting exact time of delivery to the Receiver. Send this report each morning before 9 a. m., in the envelope with trip sheets.

FORM 3

transfers and tickets are not handled by the station clerks, but go directly to the auditor of receipts. The station clerk receipts for the amount of cash called for on the conductor's trip sheet and does not attempt to verify, in any manner, this amount with the actual amount that he should turn in. The money is rolled in packages by the clerks, each denomination being separate and each package marked with the name of clerk who handles. A collector calls at each station several times a day, taking the cash from the clerk, giving a receipt for the money, which is taken directly to the office of the assistant treasurer. (Forms 3 and 4.) The clerk at the station lists the amount of cash called for by the trip sheet and for which he has receipted, distributing same by lines and by cars on sheets especially ruled (form 5). The total of these sheets should agree with the total cash delivered to the collectors. The listing sheets, together with the trip sheets, are sent directly to the office of the auditor of receipts. The registers used are stationary, affixed to the end of the car. The

Form 795. 50 bks 1-1900

TWIN CITY RAPID TRANSIT CO.

Counter's Cash Statement ______ Station.

______ 190__

	ITEMS					
Currency						
Gold						
Silver						
Nickels						
Pennies						
Loose						
Checks						
Total						

CHECK ITEMS.

______ Counter

Received ______ Receiver.

FORM 4

station master makes a report at the beginning and close of each day's business of the state of each register of each car in service, and these are sent directly to the office of the auditor of receipts. (See form 6.)

The assistant treasurer deposits the total passenger earnings of the preceding day in the bank on the following day before 12 o'clock. The auditor of receipts checks first the register reports, the beginning number of the current day with the ending number of the previous day. These reports are then extended into fares.

The contents of the envelopes (form 2) containing the tickets and transfers are checked against the record made by the conductor on the face of the envelope, and all differences are noted on the back of the envelope. This envelope is then checked against the amount which is entered on the trip sheet (form 1). The tickets and transfers in the envelopes are carefully examined to see whether the tickets are regular, and also that all transfers are correct as to date, line, etc.

The cash reduced to fares plus the tickets should equal the total of the register, as indicated by the register report (form 6). In the adjustment, all amounts in excess of the amount necessary to adjust the total amount required to balance the register, are returned in cash to the conductor and all amounts necessary to meet the amount called for by the register report are collected from the conductors. A

_______ DIVISION _______ LINE.

_______ 190__

FORM 5

Twin City Rapid Transit Co.

DAILY CAR REGISTER REPORT.

Date: _______

_______ Division.

_______ Line.

_______ Foreman.

No CAR	REGISTER		FARES	REMARKS
	COMMENCING	ENDING		

FORM 6

Form 76 25 bks. 12-01.

TWIN CITY RAPID TRANSIT COMPANY.

SHORTAGE SHEET.

_______ Station. _______ 190

CAR No.	NAME	No.	REGISTER OVER	REGISTER SHORT	TICKETS OVER	TICKETS SHORT	SIGNATURE
	TOTALS						

This statement must be returned with collection at the earliest opportunity, and not later than the Sunday Morning following its receipt.
Before returning this sheet fill in the following date and sign.

Total Received from Office _______ 190 $ _______

Total Returned to Office _______ 190 $ _______

_______ FOREMAN OR CLERK.

FORM 7

TWIN CITY
RAPID TRANSIT CO.

MINNEAPOLIS. ST. PAUL. STILLWATER.

Auditor of Receipts Daily Report _______ 190

MINNEAPOLIS DIVISION.	FARES REGISTERED	TRANSFER CHECKS	FREE TICKETS	FOREIGN TICKETS	CASH
4th Ave. S. and 6th Ave. North, 4th Ave. S. "Short Line," 8th and Central, 8th Ave. "Short Line," Plymouth and Bloomington, Bloomington "Short Line," Cedar and Emerson, Cedar Ave. "Short Line,"					
TOTALS.					
GRAND TOTALS.					

MEMORANDUM.

Correct _______ *Auditor of Receipts.*

FORM 8

TWIN CITY RAPID TRANSIT COMPANY.

MINNEAPOLIS DIVISION. *DAILY REPORT* *1901*

LINE	CARS RUN Time Table Mtrs	CARS RUN Time Table Trl's	CARS RUN Actual Run Mtrs	CARS RUN Actual Run Trl's	FREE TICKETS Employees	FREE TICKETS Compl'm'ry	FREE TICKETS Construct'n	FREE TICKETS Amusem'ts	FREE TICKETS Total	FARES Transfers	FARES Passenger Earnings	MILEAGE Motors	MILEAGE Trailers	MILEAGE Total	Motor Hours	EARNINGS Cts per Mile	EARNINGS Per Mt'r Hr
4th Ave. So. and 6th Ave. No. 4th Ave. So. "Short Line." 8th and Central Aves 8th Ave. "Short Line." Plymouth and Bloomington.																	
TOTALS,																	
GRAND TOTALS,																	

	COMPARATIVE STATEMENT RECEIPTS.					COMPARATIVE STATEMENT MOTOR HOURS.				
	MINNEAPOLIS DIV.	ST. PAUL DIV.	INTERURBAN DIV	STILLWATER DIV.	TOTAL	M'p'ls Div.	St. Paul Div.	Interurban Div	Stillwater Div.	Total
Day 1901										
" 1900										
Increase or Decrease. Per Cent										
Month to Date 1901										
" " 1900										
Increase or Decrease. Per Cent.										
Year to Date 1901										
" " 1900										
Increase or Decrease. Per Cent.										

COMPARATIVE STATEMENT MILEAGE.

Day 1901					
" 1900					
Increase or Decrease. Per Cent.					
Month to Date 1901					
" " 1900					
Increase or Decrease. Per Cent					
Year to Date 1901					
" " 1900					
Increase or Decrease. Per Cent.					

WEATHER REPORT.

	1901 Plus	1901 Minus	1900 Plus	1900 Minus	WEATHER 1901	WEATHER 1900
6 A. M.						
12 M.						
6 P. M.						
12 P. M.						

Approved:

Auditor.

FORM 10

transcript of these adjustments is sent to the assistant treasurer by the auditor of receipts, who makes the collection and refund (form 7). At the close of the month a statement is rendered by the auditor of receipts, and the assistant treasurer either deposits in the bank or has a voucher drawn in his favor which adjusts the balances of the overages and refunds with the conductors and leaves the

MINNEAPOLIS, ST. PAUL, STILLWATER — AUDITOR OF RECEIPTS DAILY REPORT TO TREASURER. T. C. R. T. Co.

_______________ 190

STATIONS	EARNINGS CAR REGISTER		ADJUSTMENT OF CONDUCTORS TICKET ACCOUNT	
	OVER	SHORT	OVER	SHORT
East Side,				
31st Street,				
Bloomington,				
Midway,				
East 7th Street,				
Selby,				
Smith Avenue,				
Interurban Balance,				
Register Adjustment				
Stillwater,				
Due . . Earnings,				
Coupon Tickets				
Mail Carriers				
TOTAL,				
Due . Adjustment,				
TOTAL				

RECAPITULATION.

NAME	DR	CR.	NET
Total Cash,			
Value Coupon Tickets,			
Register Dif			
TOTAL EARNINGS,			

Correct, *Approved,*

Auditor.

FORM 9

amount deposited in the bank to the account of earnings exactly the same as the total passenger earnings for the month.

After the auditor of receipts has completed his check and made his report (forms 8 and 9) of the earnings and adjustments to the assistant treasurer and comptroller, his tabulations of the earnings sheets (form 5), together with the conductor's trip sheets (form 1) are turned over to the mileage clerk, who, from the conductor's trip sheets, computes the mileage and completes the daily report (form 10).

Responsibilities of an Accountant

When you consider that 60 per cent of the property of this country is controlled by corporations, that the investor in the different classes of stock receives an income through the distribution of dividends on the various classes of stock, you can judge something of the duties and responsibilities of an accountant.

While the directors pass on the declaration of dividends, such a distribution is based upon true exhibits made to the directors by the accountant. In some cases, the task of the accountant is comparatively easy. In others, it is complex, especially where the assets are of an exhausting nature, such as mines, lumber lands, etc.

There has within the last decade been a marvelous evolution in the methods of accounting, the same as there has been in the methods of conducting business, and this has produced a new school of accountants. Out-of-date methods of accounting are as injurious to a property as out-of-date methods in the mechanical department.

Creation of Reserve Funds

BY H. C. MACKAY,

Comptroller, Milwaukee Railway & Light Company, and President, Street Railway Accountants' Association of America.

Through the persevering and painstaking efforts of the Street Railway Accountants' Association of America, and the valuable assistance given by the street railway papers in presenting the results of their labors, the operating and accounting departments of the various street railway systems have been brought into such intimate relations that the benefits of uniform methods of accounting are very generally understood and put to practical use. Statistical comparisons with other periods and other systems are being carefully worked out and analyzed, and to this can be attributed many suggestions which have led to improved methods whereby earnings have been increased or expenses reduced.

There is a factor, however, which, up to the present time, has received very little attention on the part of those entrusted with the direction and management of street railway properties, at least it is rarely shown on their balance sheets, viz., an adequate provision out of income for all depreciation of way, buildings, machinery, power plants, equipments, etc., and that before anything is set aside for dividends or passed to a surplus account. This is a matter that should appeal to and be demanded by the investing public, for, upon it, to a very great extent, does the safety of the companies' future depend. Depreciation can be likened to a mortgage, as it begins to take effect at once, and is always at work night and day, and no amount of repairs can ever eliminate it. To demonstrate this point, let us assume that no provision has been made for depreciation of way, but instead, all repairs have been made as soon as required, the expense having been charged to operating expenses. The road has been in operation for, say fifteen years, and during the past five years one-half of the track and overhead construction has been rebuilt. Now we need only assume that the road cease operations and it will be apparent that there is a very great depreciation, in spite of the fact that it was repaired as soon as necessary, as some of it would require rebuilding within the coming year, the life of the other portions being greater, but in every case there would be a lesser life than is shown by the ledger or new value. Of course the same rule is applicable, whether operations were suspended or not, but it serves to better illustrate the conditions of the property and its depreciation.

The ordinary operating or current repairs and expenses should not be passed to depreciation account, but should be charged directly to maintenance. Under the conditions usually existing in large cities, the life of the track will not exceed ten or twelve years, but for the sake of argument, we will assume it to be fifteen years, provided necessary repairs were promptly made, and as a further illustration we will assume that 10 miles of road were built and equipped, an equal amount being constructed every year for fifteen years, making a total mileage of 150 for the system. From this time on it becomes necessary (in addition to making the current repairs) to rebuild at least 10 miles of track every year in order to retain the original trackage, and not $1 of this heavy expense should be added to property account. Experience has shown that the cost of keeping up the current repairs to way and rolling stock is approximately the same as is the depreciation in these departments.

True costs and profits cannot be shown until provision has been made for this depreciation, and this should be done by charging, monthly, as a deduction from income, a sum sufficient to cover same; the credit passing to a reserve account, this in turn to be charged with the renewal or replacement. The effect of this method is to distribute over a longer period of time (the period during which the depreciation is going on) an amount sufficient to take care of the renewals, as it becomes necessary to make them. As to what constitutes a sufficient amount no set rule can be given, as it depends upon so many factors, such as the character of the construction, weight of rail and relative weight of rolling stock, volume of traffic, frequency and speed, climatic conditions, etc., but each company should determine from a careful and conservative investigation of all the factors the probable life of all its property. In general, I would say that the amount set aside for this purpose should be sufficient, together with the amount expended in ordinary or current repairs, to leave the property in as good or better condition at the end of each year during a long period of years, as at the beginning of any year, without increasing the capital account, except for actual additional equipment, track or property. The serious mistake made by most properties of this kind is owing to the fact that for several years after a property is newly constructed and put in operation, there is very little evidence of wear, and therefore an insufficient amount provided to make good the wear that commences in all departments from the time the first wheel is turned over.

Provision should likewise be made for the contingent liability of claims for injuries and damages, a liability which no road is free from, as the possibility of a serious and expensive accident is ever present, as is usually the unsettled claim.

A reserve should also be created to cover all uninsured fire losses. For the reason that the liability of a total loss on any risk is considered small, and there being fair chances of a considerable salvage in case of any loss, it is customary to cover an insurable property from 80 per cent to 90 per cent of its sound value. It will therefore be apparent that there is a contingent liability of no small amount which provision should be made for, as before mentioned. Not only should these reserves be created, but an amount equivalent should be invested in safe interest-bearing securities and placed in a trust fund in such a manner that they are not assignable to any other use. A further safeguard, particularly applicable to all systems operating under limited franchises is a provision for a sinking fund, to guarantee the return of the amount invested by all bond and stockholders.

Looking at the question of accounting from the standpoint of an investor (and by investor I refer to one who is looking for a safe and permanent investment upon which will be realized a fair return in interest, and 100 per cent of the principal, if required), the question of stability is of the first importance, and I have endeavored to show the absolute necessity of making provisions for such matters as are sure to present themselves sooner or later. As a general proposition it is sooner than desired.

There is no doubt but that the street railways of this country are paying now more than their proportionate taxes, and yet we see on every hand the evidences of attempts to compel them to shoulder many additional burdens, by either an increase in property valuation or rate, or by indirect taxation, such as additional charges for street paving, street lighting, street sprinkling, snow and ice removal, car licenses, gratuitous transportation of city employees, etc. This agitation is due, to a great extent, to the erroneous and misleading methods of accounting which have largely prevailed, and which still to a large extent exist. Methods which seem to have been devised for the promoters' interests, and from which statements have been presented of excessive and likewise incorrect net earnings, and, in the writer's opinion, the cry of municipal ownership is largely due to this same cause, and would not have been given the same support and serious consideration by the thinking public had it not been for this reason.

Meeting of the Street Railway Accountants Association

Notice has been issued by W. B. Brockway, secretary and treasurer of the Street Railway Accountants' Association, for the meeting of the sixth annual convention of the association at Detroit, beginning October 8. The headquarters of the association during the meeting will be at the Hotel Cadillac, and the convention will be held at the same time as the annual gathering of the American Street Railway Association. An interesting programme is being prepared, and several papers have already been promised by members of the organization, so that an instructive and interesting meeting is assured.

Mr. Brockway reports that the association has gained in membership during the last year and that it is more representative in its character and membership than ever before. In view of the interest that is being taken in the organization's work it is probable that the meeting will be very largely attended.

The compilation of statistics is expensive, but you will find that the keynote of success with our modern mercantile, manufacturing or transportation companies is an accurate knowledge of statistics; especially is this true with our up-to-date methods of street railway operation, where the items that enter into the cost of operation are so numerous and varied.

A successful manager, by an analysis of his accounts, establishes not only the data for his future advancement, but the basis of an increased revenue with a minimum of expense.

As a practical illustration of the necessity of careful scrutiny on the part of an accountant, I quote the following from the *Wall Street Journal* of March 26, 1902:

Among the assets was one entitled "Bonds and Stocks Owned," being a total of $2,347,364. The composition of this item was apparently as follows:

Evansville & Ind. stock (par value)	2,000,000
Miscellaneous stocks	133,500
West Jackson Hill stock	134,956

Evansville & Indianapolis stock, therefore, is taken at par and so carried as an asset. This company has not earned a surplus over its charges since 1893, and last year the deficit as stated in the income account was over $86,000. It is fair to say, therefore, that the stock is practically worthless, and it is very obvious that the assets of the Evansville & Terre Haute Company are overstated in the balance sheet to the extent that Evansville & Indianapolis stock is overvalued at par. If we assume that the stock is worth 10 cents on the dollar, Evansville & Terre Haute Company should write off at least $1,800,000 from the value of its assets in order to exhibit the true condition of the property.

The total profit and loss surplus on June 30 last, was $1,475,000, so that if the company were to write down its holdings of Evansville & Indianapolis stock, to represent its actual value, it would show a deficit to profit and loss of about $300,000. This in itself would be a very good reason for suspending dividends on the stock.

No doubt the carrying of the stock on the books at par is the matter to which reference has been made as constituting "irregularity." The stock has been so carried for many years, consequently there is nothing new in the situation from this point of view. It is, however, clear that before paying any more dividends the management ought to write down its assets something approaching their proper value.

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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, accounting, 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 news columns.

All matters intended for publication in the current issues must be received at our office not later than Wednesday of each week.

Address all communications to.

The Street Railway Publishing Co.,
Engineering Building, 114 Liberty Street, New York.

This number of the STREET RAILWAY JOURNAL is issued from our new offices, which are much more commodious and better adapted in every way to our requirements. Friends who have visited us in our former quarters need not be told that we had outgrown the space available at the old site. Fortunately the change of location is a very slight one in point of distance, as our new offices are in the building adjoining the one formerly occupied. We are now occupying much more extensive and luxurious rooms, comprising the tenth floor of the new Engineering Building, 114 Liberty Street. The editorial rooms overlook New York Harbor, and a cordial invitation is extended to our friends when in New York to come and enjoy this view with us. It is needless to say that with our more commodious offices we shall be enabled to continue satisfactorily the increasing work necessitated by the growth of the paper, and the inspiration of our surroundings, we hope, will be evidenced in these pages.

What will be the result of Mr. Yerkes' effort to introduce American ideas on the question of charging a uniform rate of fare into the management of London traction properties? The extensive network of lines which will come directly under his control will enable him to make a fair test of his plan, and with the superior service that his new equipment ought to insure he may induce enough patrons to select his lines to enable him gradually to overcome the deep-seated prejudice that now exists against this method.

Experienced managers not only in London, but throughout Great Britain, do not regard the innovation with favor. This feeling is not confined to any particular class, but is shared by those interested with the management of municipal systems, as well as those operated by private capital. John Young, of Glasgow, for instance, who will be accepted as a representative municipal manager, advised the corporation in his last official report against adopting a uniform rate, although in the same document he advocated graded fares and a very cheap rate during the hours most workingmen use the cars and also for short distances.

We present in the current issue an important paper on train resistances by W. J. Davis, Jr., together with comments upon it by Dr. John Lundie, S. T. Dodd, Dr. Louis Bell and H. V. Wille. The matter is of so great importance, in view of the present tendency toward high-speed electric railways, as to be well worth the fullest possible discussion.

The formulæ given by Mr. Davis are based on experimental runs made on the Buffalo & Lockport road, and are the first, so far as we are aware, made on a modern electric road at high speed and under approximately service conditions. The results derived are very striking and of so ominous a character as to invite the most searching examination. In brief, they indicate about double the total train resistance found by other recent experimenters and revert more nearly to the early values obtained at various times upon steam roads.

All the old formulæ for train resistance consisted substantially of a constant term mainly due to axle friction, a term in V, chargeable mainly to miscellaneous track resistances, and a term in V^2 intended to take account of the air resistance. These were based on experimental results at rather moderate speeds, and were current for many years. Somewhat less than twenty years ago runs at high speed had become common enough to afford some evidence that trains actually ran more easily at these higher speeds than the formulæ would indicate, and a dozen years since O. T. Crosby, in doing the preliminary work for the Weems high-speed project, made an elaborate series of experiments which resulted in the conclusion that the relation between tractive effort and speed was a linear one, and that the term in V^2 must be abandoned. More recently other workers, notably Sinclair, Barnes and Vauclain, working on steam railways, came to a similar conclusion. It is therefore somewhat surprising to find the first tests on a fast electric line showing not only a term in V^2, but one large enough to demand double the tractive effort previously assumed.

This situation requires explanation. Mr. Davis' formula, it should be understood, is not derived from direct measurement of the tractive effort, but was obtained from coasting tests and an independent determination of the head air pressure measured by the deflection of a hinged shield on the front of the locomotive. If it be correct, it shows very plainly that light single cars cannot be operated electrically at speeds approaching 100 miles per hour except by the application of an amount of power which is substantially out of the question, and that even trains at such speeds will require enormous energy; so much as to be of very dubious commercial practicability. If it be incorrect, the error should be investigated at the earliest possible moment; and while the expert opinions which we publish are decidedly against its validity, there is every reason to assume that Mr. Davis' work was carefully done. Moreover, the discrepancy is so great as to indicate either that some one is shockingly in the wrong or that there is a real and great difference between the power required by an electrically driven train and that taken by ordinary locomotives doing substantially the same work.

* * *

Certain it is that trains on ordinary railways have on divers occasions given in a calm and on level track tonnage coefficients at great speeds markedly less than would be given by Mr. Davis' formula. For example, a train weighing 347 tons was driven a few years since at the rate of 86 miles per hour on the North-Eastern Railway (England) with the expenditure of 1068 horse-power measured directly by indicator cards. This amounts to 13.4 lbs. per ton, while Mr. Davis' formula on its most favorable showing would give a little over 30 lbs. per ton under similar circumstances. In fact, Mr. Davis' assumed value of journal and track friction amounts to more than the total resistance found in these tests. Is this difference a real one, and, if so, to what conceivable cause can it be attributed? It is worth noting in this connection that Dr. Lundie's formula gives likewise values larger than those obtained from locomotives. If there is any constitutional disability in electric traction, which seems scarcely possible, it should certainly be investigated. We feel, with Dr. Lundie, that all possible light should be thrown on such experiments, and that it cannot be done too quickly. When the Zossen tests are made public we must expect a most valuable fund of information, but meanwhile we republish the preliminary tests with whirling bodies as throwing some light on the situation.

* * *

Truth to tell, there is wonderfully little known about the exact nature of the air resistance to a moving train—far less than is known about it in the case of projectiles—thanks to the masterly work of Bashforth and others. It is very clear that comparatively small changes of shape in the moving front change the resistance very greatly, but just how this is effected is at present unknown. Under certain circumstances, too, there are powerful inrushing currents at the sides of a train, but we are ignorant of their real source and significance.

In view of the great discrepancies which exist we are disposed to give considerable weight to the suggestions made by our contributors, that it would be well to obtain values of the train resistance anew, and by independent methods, not involving the same quantities experimentally as those used by Mr. Davis. The rate of speed decrement in a coasting train is a thing rather sensitive to disturbing causes, and it seems as though a more direct measurement of tractive effort would be desirable and preferable. It would not take a large braking effort in the motors, such as might be due even to residual magnetism, to introduce a spurious term in V^2 into results obtained by coasting, and, as Dr. Lundie points out, wind pressure obtained by deflecting shields seems to involve a good many unknown factors.

* * *

Not only are fuller experiments desirable for obtaining the net tractive resistance, but for learning the extent to which remedies for air resistance may be applied by shaping the front and smoothing the contour of the train. The Zossen experiments, as well as the earlier ones of Crosby, show a chance of great reduction in pressures by adroit shaping of the locomotive front. Another thing that needs investigation is the effect of length of train on resistance. Has a train, like a steamship, certain critical speeds at which driving becomes relatively easy and others at which a small increment of speed demands a large increment of power? The existence of such a condition would account for many discrepancies otherwise very difficult to explain.

The fact is, that the very disquieting results obtained by Mr. Davis have reopened the question of high-speed train resistance in its broadest aspects and indicate the immediate necessity for an investigation fuller and more searching than anything yet attempted. It would be of great value to the engineering world if the train resistances obtained in the Zossen experimental runs could be made public at an early date, for they would throw a deal of light upon the matter and would at least furnish data for directing further investigations. The demand for high-speed electric roads is steadily growing, and if no unforeseen obstacles are interposed we look for great developments along this line within the next decade. If the values of the train resistances are such as to set a close limitation on practicable speeds, it is of the utmost importance to know it at once. The subject is of so great moment that we hope for the fullest discussion of it on the part of those who have available data that can be of use.

It is seldom that a greater disregard is shown for facts than was found in daily press reports of the strike of the firemen on the Chicago City Railway last week. Evidently the reporters realized that, as a news feature, the event would become commonplace should it become known that only six men were on a strike, so they increased this number to suit themselves, each one being guided solely by his sense of what was necessary to make a good story. In like manner other facts regarding the settlement were polished up or deliberately misstated to make it appear that the company had been badly beaten, a version that was given doubtless because such a result would be acceptable to a certain proportion of their readers. The actual history of the affair is given in our news columns. Briefly, two firemen in one of the power houses became indifferent in their work and so unfriendly in their attitude toward their employers that they were discharged in the interests of good service and good discipline. As a result, six of their companions struck, and the coal teamsters' union refused to haul coal. This, under the circumstances, was the most serious aspect of the situation. After a conference the union representatives virtually admitted that the management was right in its position and agreed that the men who caused the trouble should not be reinstated, and as this was the only point at issue in the strike it is hard to see where the victory comes in. The advocates of management of street railways by labor unions and walking delegates made a serious mistake, and they now realize it.

The Management of Men

Street railway management consists primarily of two things, the management of employees and the management of machinery and equipment. Great as has been the change in motive power and equipment of American street railways the last fifteen years, the change in the method of dealing with employees and in the employees themselves have in most cases been equally as great. During the transition period from horse to mechanical traction the engineering problems overshadowed all else in the management of a road, and the handling of employees was often given a secondary place or left to continue under the same old methods in vogue in horse car days. The last five years, however, have seen considerable steady improvement all along the line in this respect, as noted from time to time in these columns, and the attention given to the improvements in the operating department is as earnest as that given to the engineering branches in the more progressive companies. It requires a higher order of intelligence to drive a high-speed electric car than it does to drive a mule team, and it takes a more active and able-bodied man on the rear platform to collect fares on a 40-ft. car running 10 miles an hour than on a 12-ft. horse car traveling at 6 miles an hour. To be sure, many horse car employees have held over to the present time, but they are better men than they were in horse car days, for they have grown to their new positions along with the advancement of the industry.

Looking over the whole field, it is a pleasure to note the general tendency to adopt plans intended to make employment in street railway service more desirable and to secure and hold a better class of men in the service. We doubt if any of our roads realize the extent or the variety of forms these efforts toward improvement of employees is taking the country over. A recapitulation of some of the more noteworthy points will be profitable at this time.

While the rate of wages paid to conductors and motormen is not by any means the only criterion of the desirability of a position, it is, nevertheless, one of the important factors, and a perusal of our news columns the last two years shows that with the prosperous times many companies which did not formerly pay high wages increased the rate per hour.

The rate of pay is, however, not so important as the actual wages a man can make with the assignment of runs the company offers him. The regular men who put in full time can always make good wages; the extras and trippers may not fare so well unless considerable skill and judgment is used in making assignments of runs. To give the extra men a chance to make good wages is one of the vexatious problems the progressive superintendent of to-day has to solve. A constantly shifting extra list has a most pernicious influence on the service, giving rise not only to accidents because of the employment of inexperienced men, but also to a general lowering of the standard of efficiency and discipline. Not only justice, but good service, demand that extra men should be able to make fair wages in order that the good men may be retained. A large extra list is often necessary to take care of traffic on special occasions, and the army of trippers required to take care of the crowds during the morning and evening rush hours must also be provided for. How to supply sufficient work all the time for this list of trippers and extras is the problem. It is manifest that in order to provide this work time must be taken from the regular runs in some way and distributed among the extras. This, of course, means, in the first place, that on ordinary days the length of the regular runs must be kept down considerably below the maximum number of hours a man could possibly work. When the regulars ask for days off, of course, the extras can be given that much more work. In some cities the regulars ask to get off frequently enough to provide for the extras fairly well. There is considerable difference in different cities in this respect. As a regular system is better than a hit-and-miss plan, some companies have made it a rule, with the acquiescence of the men, to give the regulars a day off every seventh or eighth day (days of special crowds always excepted). This provides a definite amount of work for the extras and often avoids dissatisfaction and disappointment arising from an indefinite understanding as to the days that regular men can get off. It has the further advantage that it compels some of the regulars that are not in the habit f taking days off out of the rut of every-day work. It is believed, with reason, by the companies adopting this practice, that better service and more alert attention to business can be secured by making it convenient or compulsory for the men to take regular days of rest rather than have them taking days off at irregular times. Another plan sometimes adopted to help even up wages and compensate for the undesirable features of some of the broken-up runs is to give a bonus to the men having runs which do not foot up many hours in a day and which are especially hard for the man assigned to them on account of the intermittent character of the work.

Assuming that matters are arranged so that all the men, extras included, can make good wages, the attractiveness of the service depends next on the justness of the promotions and discipline and the personality of the officers and foremen with whom the men come most closely in contact. In regard to the latter, a man occupying a high position in the management of one of our largest street railway systems, in looking over the history of the company for the last fifteen years, remarked, concerning a strike of a number of years ago: "That could have been avoided with a superintendent less harsh in the management of men." While firmness is absolutely essential, it is now generally admitted that some of the harsh treatment of former horse car days will never succeed with the intelligent conductors and motormen of to-day. Self-respecting men of the kind the company wants must also be respected by the management. The personal element enters largely into any business, and the successful manager realizes this is especially true in regard to the superintendents and foremen who come into direct contact with the employees.

It is a striking indication in the change of methods mentioned at the beginning of this article as having taken place during the last fifteen years that long suspensions for carelessness or for breaking the rules are now almost unknown. Indeed, suspensions of all kinds have been abolished as a means of discipline on many roads on the theory that if a man will not improve by being reprimanded by the superintendent he is not a desirable kind of a man, and that an enforced idleness of ten, twenty or thirty days will not do him any good, and may do him or his family considerable harm. This brings us to the consideration of the various plans of disciplining and promoting employees that have been adopted to take the place of fines and suspensions. One of the first steps away from the suspension policy was the Brown system, now well known and adopted by the majority of the steam railroads of the United States, as well as by a number of the street railways, and described, in its several modifications, in recent issues of this paper. The original Brown system has been so modified in most cases, however, that it now represents a more radical change from old ideas than was probably ever contemplated by the originator of the system. Another radical innovation is the change from the usual seniority plan of promotion to the percentage system of rating and promoting men, which is used on at least three electric roads in the United States to our knowledge, and possibly on others. In brief, under this scheme each man is given a certain percentage to his credit when he enters the service. For creditable acts a certain amount is added to this percentage, while for breaking of the rules a certain amount is deducted. Promotions to better runs are not made by seniority in service, but entirely according to a man's percentage as compared to other men on the list. Other things being equal, however, the older men in the service have the advantage, as a certain per cent is added to each man's record each month. Every month runs are reapportioned among the men. The men having the highest percentages are given their choice of runs according to their relative rank. The older men stand the best chance because of the amount added each month to their record if their behavior is good, but a good new man will soon outdistance a less efficient employee who has been in the service longer.

The merit system of promotion is doubtless the ideal one in theory, as it advances men entirely according to their merit, combined with their age and experience in the service. That more roads have not adopted it is due partly to the fact that it is not generally understood among managers the country over, partly to a fear that the employees will not take kindly to it (although they apparently do wherever it has been tried) and partly to a fear that the management cannot administer the system in perfect fairness to the men; or, in other words, that the management will fail to receive, in many instances, reports of what the men are doing and that a system of marking based on the reports received would not be just or would be so open to criticism by the men as to tend to a contempt of the system because of the incompleteness of the reports. As said before, these objections do not seem to hold on the roads using the system. Of course, much depends on the manager and the manner of marking, but the same can be said of the way any kind of a system is administered. All admit that the promotion by seniority of service pure and simple pays but little premium on good behavior, but since it is the plan that is commonly used, its defects are probably not considered as much as those of any new system.

Many roads which have not gone so far as to adopt the merit system of rating and promotion, as just outlined, have adopted a system of ranking, which is a step in the same direction, though not going so far. In some cases the assignment of poor runs lower down on the list follows breaking of rules or misconduct for which a man would be given demerit marks under the merit system or suspended under the old methods. As the effect of demerit marks with the merit system is to put a man lower on the list of runs next month if he has not credits to counteract them, the ultimate effect of the two plans is practically the same except that meritorious acts receive positive credit under the merit system which they do not in the latter system mentioned. Several roads keep a merit system of marking, but do not use the percentages standing opposite each man's name as a basis of promotion. In these cases the record is kept for its moral effect on the men, and promotions are made by seniority of service as usual. This is in fact the Brown system. The exact methods of keeping the records differ, some companies keeping simply a record of acts without figures, others keeping percentages opposite each man's name. It is argued by those who promote according to the percentage merit system that there is no use in keeping such a percentage record unless the man has the positive inducement of securing better runs to spur him on to keep his percentage high. While there is, of course, some truth in this, it is also undoubtedly true that when a percentage record is kept, even though it is not used in promoting, it stimulates competition among the men to make good records. Few men worth having like to know that poor records stand against their names. It has been found as a practical fact that the starting of such a percentage record has a very beneficial effect, even if promotions to better runs are not made according to it. Of course, there are no suspensions under any of these percentage merit systems.

As to the publicity of records and announcements of credits or demerits, the companies using the merit system differ. One method is to announce this to the men directly interested only by a private letter. Another is to announce credit or demerit marks awarded by a bulletin, in which case one plan is to publish the names in connection with such bulletins and another is to withhold the names, giving only circumstances and the amount of credit or demerit given. Sometimes the mere announcement is made without comment. There are, however, those that believe these bulletins afford an excellent means for calling attention of trainmen to special difficulties or infractions of rules that extra care is needed to avoid, and also to commend meritorious acts before a man's fellow workman and give the man pride in special achievement. Although it is a common saying that a laborer is paid to do his best and should not be paid extra for doing better than his fellow workman, the merit system of promotions and the offering of bonuses for especially good service and freedom from accidents is really in accordance with the principles everywhere prevailing in the world of trade where competition enters. The world will probably always be divided on the question of whether competition is right and whether one man should receive more than his fellow workman for doing more or better work; the fact remains that there is naturally a constant though sometimes artificially arrested tendency to pay a premium on good work, and this tendency is making itself felt in street railway management, not only as exhibited in the merit system and its modifications, but in the offering of additional pay or other inducements to those having records free from accidents. Most of these plans have yielded very gratifying results to those superintendents trying them, and are liked by the best class of men.

In reviewing the improvements in the management of employees, we should not omit to mention the clubs and club rooms which are being fitted up by street railway companies all over the country and which are coming to be so much of a matter of course in street railway men's lives as to cease to be matters of comment.

In the foregoing summary of the most notable points of change and progress of the management of street railway employees for the last few years it is evident that there is a great variety of opinion on many of these problems. On one point, however, all successful managers of men agree, and the manager is most successful who confines himself most closely to it; namely, that absolute justness and fairness must prevail in every act concerning an employee, and that the employee must be made to feel that this is the case. The moment a man considers that he is being treated unfairly, that his position and promotion depend on something besides his industry, care and ability, discipline goes to the winds. Combine with justness, kindness, and, as far as possible, a personal acquaintance with and interest in every employee, and experience has demonstrated that the foundations of successful management have been laid.

The General Electric Report.

The tenth annual report of the General Electric Company was published last week, covering the year ended Jan. 31, 1902. In spite of the fact that it was quite generally understood that a very favorable showing would be made, the document created a profound impression in financial and electrical circles. That the company has enjoyed a season of unprecedented prosperity is amply demonstrated by the fact that during the year about 160,000 separate orders were received in addition to contract work, an average of 528 per day, and that the total sales billed to customers during the same period amounted to $32,-338,036.64, upon which a profit of $7,083,914.64 is reported. This splendid record should be a source of gratification to everyone interested in electrical industries, as it affords convincing proof of the vitality, stability and remarkable development of the business.

As a financial statement the report is a masterpiece. The present document is the culmination of the policy that has been followed by the General Electric Company during the last five years, and to appreciate fully its significance and the phenomenal growth which it records it should be considered in conjunction with those that have immediately preceded it. Probably the most noteworthy feature of these reports is the insight they afford into the actual condition of the business, the methods employed and the policy adopted. The same frankness characterizes all statements pertaining to the financial affairs of the company as is displayed in the records of the manufacturing and selling branches of the business. For instance, in the list of assets the value of the patents, franchises and good will of the company is continued at $2,000,000, the same as last year, allowing the writing off of $452,072.14; and the account representing investment in factory plants is similarly treated, the value to-day being placed at $4,000,000, which is practically the same as was carried on the books in 1893, although many improvements and additions have been added. To offset depreciation in this property during the intervening nine years there has been written off $7,817,-881.11. Probably the best example of the conservatism that has marked the policy of the company is shown in the statement that as a result of a careful examination of securities held it was found advisable to make a net increase of $2,057,685.07 in their total book values. An idea of the manner in which the company has regulated the book values placed upon the securities which it holds is shown in the result of sales of some of these securities during the last year. Their total par value was $2,090,918, and they were carried on the books at a value of $1,244,102.43, but during the last year they were sold for $2,182,687.20, showing an actual profit of $938,584.77 based on the company's valuation. On the other hand, it is a matter of interest to note that the company has no outstanding notes and that there is no paper bearing the company's endorsement or guarantee under discount. It is mentioned incidentally, but is a matter of considerable importance as throwing some light on the financial condition of the company, that since January, 1895, it has not borrowed any money nor at any time since that date has its credit been used either by issuing notes, endorsing a customer's paper for discount or lending its name in any way. The company paid during the year in dividends on preferred and common stock and interest on debentures $1,997,966.40 and added to surplus account $8,657,960.01, which is equivalent to a dividend of more than 34 per cent on the present capital stock of $25,-242,200.

In the reports of the several departments there are many items of interest which show the phenomenal growth of the company's business. These are considered in detail elsewhere in this issue, but there are some features that are worthy of mention here. It is shown that the orders received during the year amounted to $34,350,840, as against $27,969,541 the previous twelve months, while the report for the year ended Jan. 31, 1895, showed only $12,160,-119, and that for 1897, $11,170,319. The returns from the railway department are gratifying. The orders received included railway motors exceeding 600,000-hp capacity. The company's foreign business has shown improvement in keeping with the advancement in this country. Among the most notable installations reported during the year was the entire equipment of the traction system of Tokyo, Japan, including 3600-kw generators, 250 car equipments and accessory apparatus. Another important order was for 3000 hp of generators, 4700 hp of rotary converters and 12,800 hp of railway motors for an electric railway connecting Milan, Gallarate and Varese, Italy. This road is now being operated by steam, and the decision to equip it electrically shows that the trend of opinion abroad, as in this country, is favorable for electric service in this class of undertakings. We are assured that the management is alive to the importance of the interest shown at this time among American steam railroad managers in electric traction. The company's engineers have for some time been studying problems presented by large terminals and heavy traffic conditions, and we are assured, as a result of these investigations, that they are convinced that the present development of the art is sufficiently advanced to warrant them in undertaking to handle heavy passenger traffic with success. The report calls attention to the perfection attained in the design and construction of apparatus for this class of work, particularly the transforming and controlling equipment, and the success that has been enjoyed in the operation of large systems in the more important cities of the country as evidence of the advancement already made in the practical solution of the problems involved.

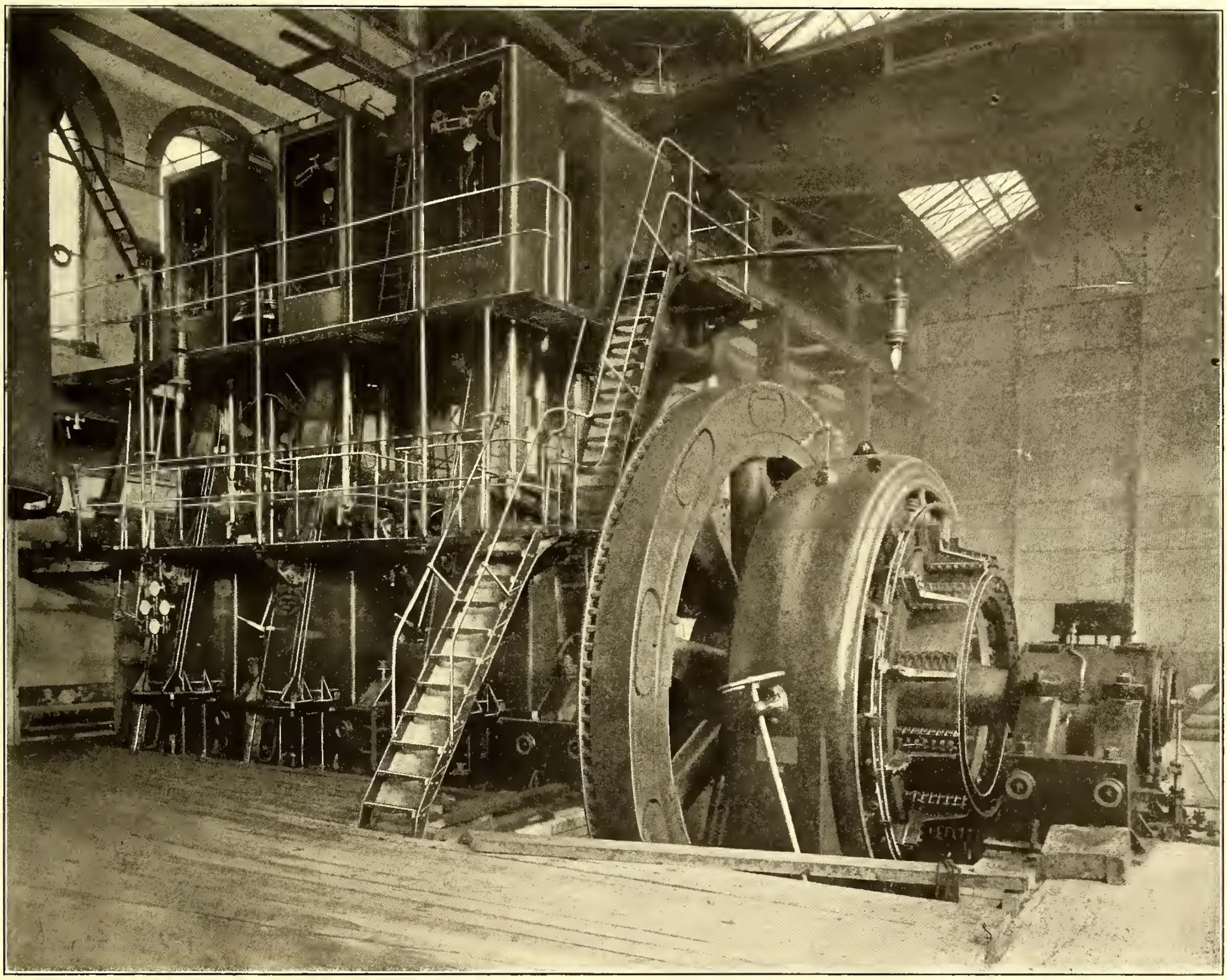
New Transportation System for Newcastle-on-Tyne

The city of Newcastle is now supplied with a complete system of transportation electrically operated. After long and bitter opposition the Newcastle Town Council succeeded in the municipalization of the system, but it failed utterly to come to any working agreement with the old Newcastle & Gosporth Tramways Company, and when the latter's lease expired last year the city was for months without tramway service. Now, however, the new system is in operation.

After investigating the claims of cable tramways the Council, acting on the advice of the late Dr. Hopkinson, finally decided on an overhead electric system. The plans for the system were carefully prepared and the work has been conducted under the supervision of B. Hopkinson, of Hopkinson & Talbot, who acted as consulting engineer, and A. E. Le Rossignol, who was appointed tramway engineer and manager early in the proceedings. The accompanying illustrations and description of the principal features of this system give a fair idea of the work that has been accomplished. The map shows the district served by the system and the extent of the undertaking.

POWER HOUSE EQUIPMENT

The power house is conveniently situated about half a mile from the heart of the city. It is a handsome red brick building and is arranged so as to permit a substantial increase. A plan of the power house and a cross section is given on the next page. The boiler house is in a separate building about 12 ft. from the main power house, and has in connection with it a large store, which is supplied by a railway track entering the top floor of the building over a trestle railway, a spur from the Manors station of the Great Eastern Railway. The boilers, of which there are eight, were supplied by Messrs. Thomas Beeley & Son, of Hyde, near Manchester. They are of the Lancashire type, 30 ft. x 8 ft. 6 ins., and are designed for a working pressure of 160 lbs. The boilers are all furnished with Vicar's mechanical stokers, supplied by the same firm, as well as the fuel economizers, engines for driving the ash chutes, the complete installation of steam, feed and blow-off piping, with valves, etc., steam superheaters, feed-pumps and injector, feed-water heater and other accessories. The short trestle railway is operated by an electric locomotive which pulls in the coal trucks. These are provided with specially constructed bottoms on hinges so that the coal is readily dropped into the bins. The ashes are conveyed out of the building by small trucks.

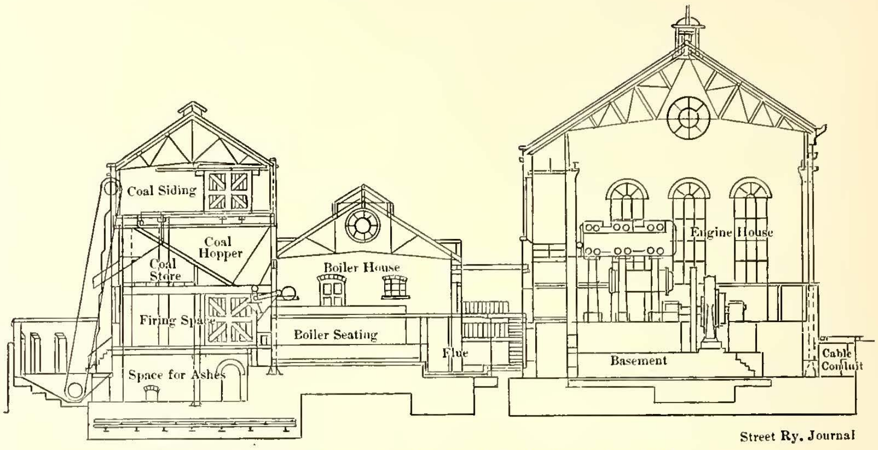


2000-HP GENERATING UNIT IN NEWCASTLE POWER HOUSE

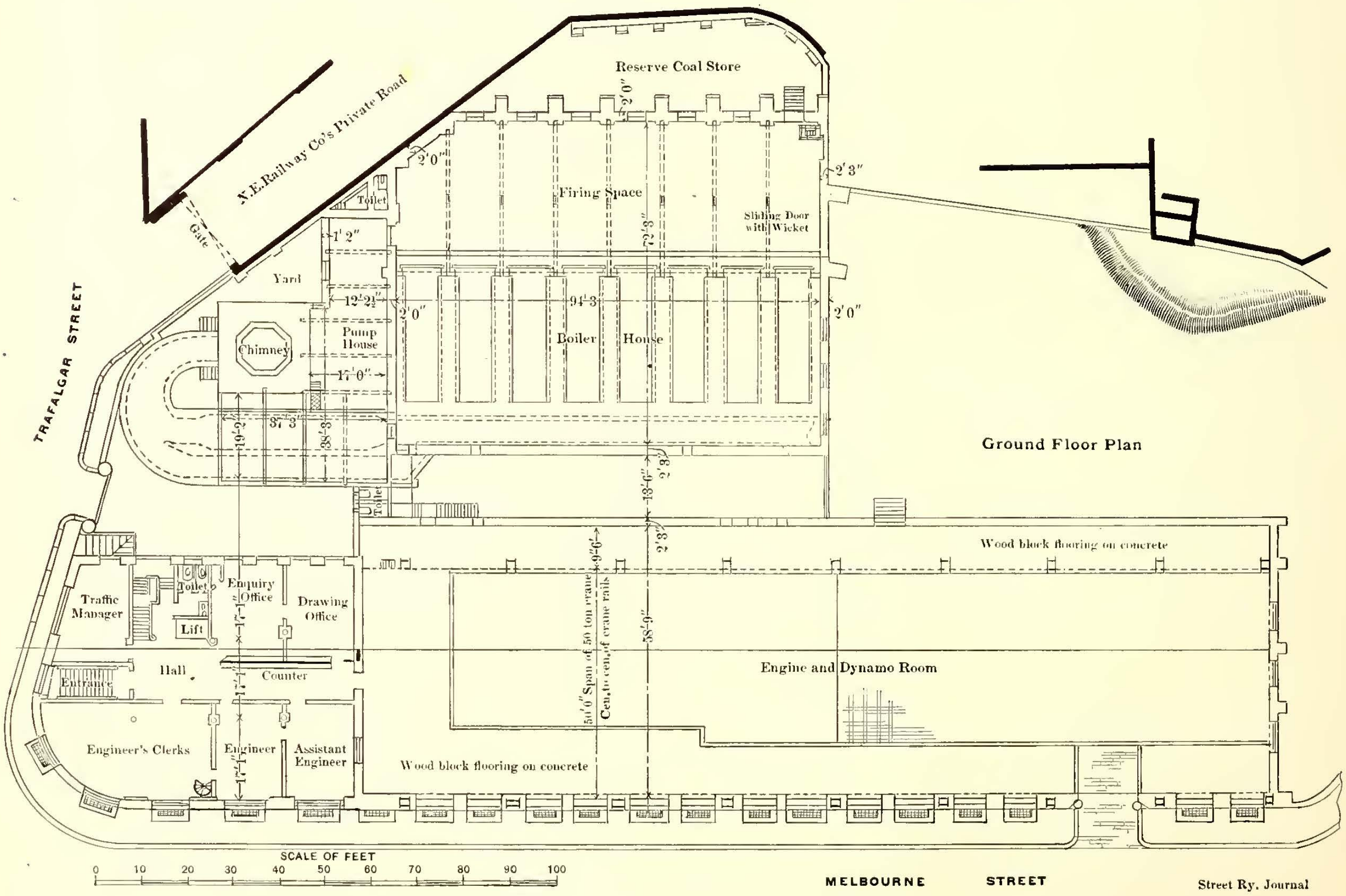
In the power house there are at present three main engines and generators. The largest engine is of 2000 hp, supplied by the Wallsend Slipway & Engineering Company, Ltd., of Newcastle. An excellent view of this engine is shown, the cut being a reproduction of a photograph made just after the engine was erected in the Newcastle station.

These engines are of the vertical inverted direct-acting three-cylinder triple-expansion type, with cylinders arranged in line and working on three cranks placed at angles of 120 degs. and arranged to work either condensing or non-condensing, the normal speed being 90 r. p. m. The cylinders, 25 ins., 39 ins. and 61 ins. diameter, respectively, by 42 ins. stroke, are steam-jacketed on the sides, top and bottom with pipe connections and reducing valves for admitting high-pressure steam to the high-pressure and reduced-pressure steam to the intermediate and low-pressure jackets. The jackets are drained by an efficient arrangement of steam traps, a separate trap being fitted for each jacket, and the whole connected to the hot well. To the steam inlet branch of the high-pressure cylinder is fitted a steam separator. The cylinders are covered with non-conducting composition protected by sheet iron. The pistons are of cast iron for the high and intermediate pressure and of cast steel for the low pressure, the high and intermediate pressure pistons being fitted with packing rings of the Ramsbottom type and the low pressure with a Buckley's patent packing ring. The piston rods are of steel, with solid cross-head fitted with cast-iron guide shoe. The guides are separate and bolted to the cylinder standards and are fitted with slippers. The connecting rods are of wrought iron with solid double eye at top, the crankpin bearings being of cast steel lined with white metal.

The bed-plate is of cast iron of the box girder type with recesses for the six crankshaft bearings. The bed-plate is made with closed bottom to retain the oil from the bearings and eccentrics, the troughs being all connected and drained to a reservoir. The standards are of cast iron, back and front, and of rectangular box section. The crankshaft is of ingot steel, 13½ ins. in diameter, and of the built type, the journals and pins being shrunk into the webs The valve gearing is of the Corliss type on all the cylinders. Recesses for the bottom valves are formed in the cylinder casting, while the top recesses are formed in the cylinder covers, the clearance space being thus reduced to a minimum. The valves themselves are of cast iron with steel spindles. For the high-pressure engine, separate eccentrics are fitted for the steam and exhaust valves; the steam admission valve has a trip gear and is closed by means of vacuum dash pots; the exhaust valve has a frontage motion. The intermediate and low pressure engines have one eccentric each for working both the steam admission and exhaust valves, which are all positively driven. The eccentric sheaves are of cast iron, the straps being of steel lined with white metal, while the rods are of forged iron. The governor for regulating the speed of the engines under ordinary working conditions is of the Whitehead type and works in conjunction with the Corliss valve gear on the



CROSS SECTION, NEWCASTLE POWER HOUSE

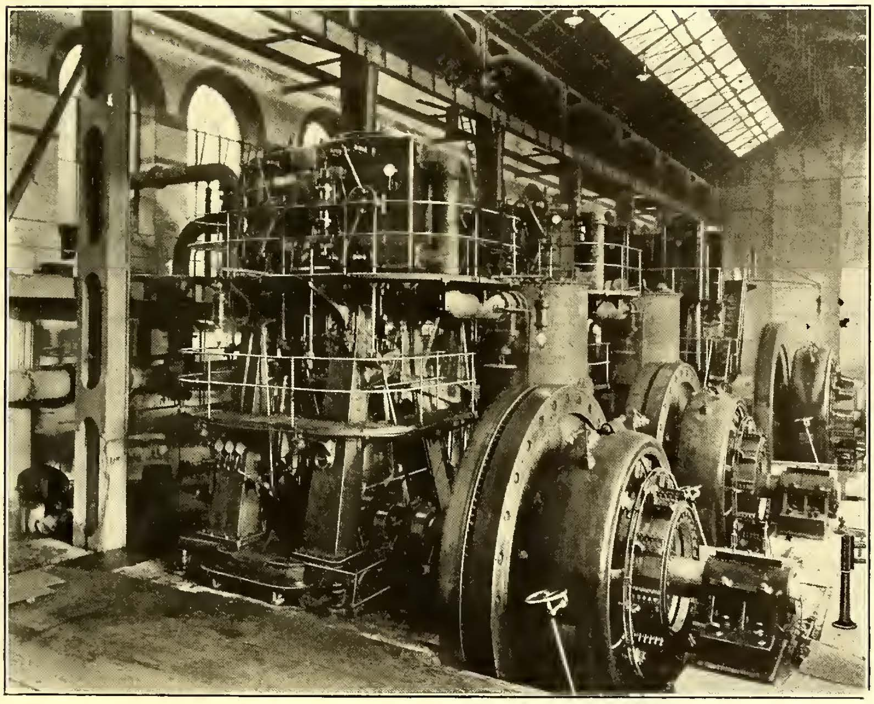


PLAN OF NEWCASTLE POWER HOUSE

high-pressure engine, and is driven by chain gearing from the crankshaft. In addition, an independent emergency governor is also furnished.

The fly-wheel, mounted on the generator shaft, is entirely of cast iron, the hub and arms being formed in two portions, while the rim is made in segments. The condenser is constructed of wrought-iron plates riveted together with angle-iron flanges, the waterways and ends being of cast iron and the tubes and tube plates of brass. The condenser is carried on suitable brackets on the back standards of the engine. The air pump is worked by means of levers from the high-pressure engine.

For working non-condensing, a shut-off valve is fitted in the low-pressure exhaust pipe, and in addition to this an atmospheric valve is fitted to this pipe, which opens automatically if a given pressure in the condenser is exceeded. The engine is fitted with a complete system of lubrication, the oil being pumped into the generator bearings. Pressure and vacuum gages, counter and tachometer are mounted in convenient positions. The generator shaft is of ingot steel, having a coupling formed at one end for attachment to the engine crankshaft. The generator shaft bearings are made extra large, and provision is made for oiling in case the oil pump is put out of action.



GENERATING PLANT, WITH 1000-HP UNIT IN FOREGROUND

The other two engines in the power house were built by Victor Coates & Company, Ltd., of Belfast, and are each of 1000 hp. An excellent view is given of this equipment in the power house. They are of the vertical compound surface condensing type, the cylinders being 22 ins. and 46 ins. diameter with a 42-in. stroke, and run at a normal speed of 90 r. p. m. The steam valves are actuated by Coates' special trip gear and the exhaust valve is operated by a wrist-plate, all the valves being placed in covers at right angles with the shaft. The steam valves are of the Corliss type and are controlled by a sensitive high-speed governor. The crankshaft is of the best steel and is 12 ins. in diameter, the two cranks being set at an angle of 90 degs. Four bearings are provided on the bed-plate for supporting the shaft, which has a coupling at one end to which is attached the generator shaft. The air pump is placed at the back of the bed-plate and below the floor line, and is worked from the engine by means of rocking levers. The surface condenser is also below the floor line and has a cooling surface of 2000 sq. ft. Special attention has been given to the methods of governing, and in addition to the governor which controls the Corliss valves, there is a reserve governor which will entirely shut off the steam from the engine should it ever exceed its proper speed by 20 per cent. The usual staging and ladders are attached to the massive cast-iron standards, and suitable oiling devices, automatic in action, can be easily reached from the staging. A notable feature about the design of the Corliss valves is that they can be withdrawn from the back of the engine for inspection at any time without disturbing the valve gear. The fly-wheel of each engine is 14 ft. in diameter and weighs 40 tons.

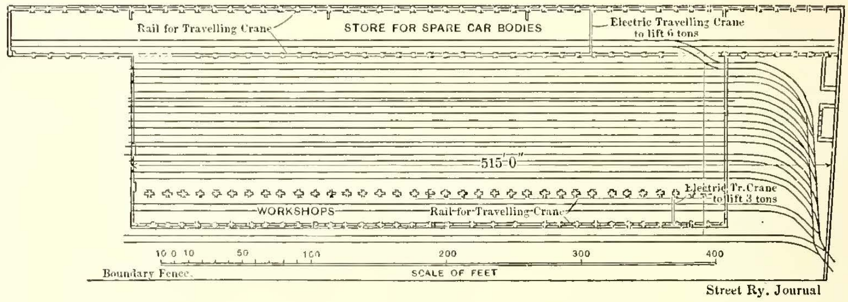
The three generators, one of 1300 kw and two of 630 kw each, were supplied by the British Westinghouse Electric Company, Ltd., and are mounted on the shafts of the driving engines. They develop from 500 volts to 550 volts when running at their normal speed of about 90 r. p. m. The fields consist of a cast-steel ring with pole pieces built up of soft-steel laminations cast on the inside. The ring is vertically divided, the halves being set on guide-plates and fitted with gear by which they can easily and quickly be drawn apart by hand, thus providing ready access to all parts of the machine. Each pole piece carries a shunt coil and a series coil. The coils are machine-wound on separate formers, which are held in position by lugs screwed to the ring casting. The field is overcompounded to give a rise of 10 per cent in pressure between no load and full load. The armature consists of a core of soft-steel laminations assembled on a cast-iron spider and clamped between cast-steel end-plates. The core is slotted, and the coils of the drum winding are of copper strap designed so that they can be forged to shape and insulated before being placed in the core slots, where they fall easily into position and are secured by hard insulating fiber wedges driven into notches in the upper walls of the core slots. The commutator is carried on an extension of the armature spider; it is built of the best materials and is of ample size for the capacity of the machine. An important feature in connection with the armature windings of Westinghouse railway type generators is the method adopted for securing the perfect magnetic balance of a multipolar field and thereby insuring sparkless and cool running. Additional cross connections are placed on the armature to connect certain points of the ordinary winding, which are normally at equal potentials. A want of balance in the magnetic field of the machine produces differences of potential between these points, and instead of the currents so induced passing by way of the armature windings and brushes, they pass by way of the additional balancing connections, which are so arranged that any current passing in them acts on the machine field so as to maintain its uniformity. Not only is sparkless running secured, but the heavy magnetic pull on an armature not exactly concentric with the field is entirely eliminated, and heated bearings and heavy wear and tear are thereby avoided.

An overhead electric traveling crane capable of lifting 50 tons, with a separate motor for each motion (three motors in all), has been installed in the power house by Higginbottom & Mannock, of Manchester. The centers of the side rails upon which the crane runs are 50 ft. apart. The hoisting crab has steel crab sides, steel wheels, steel wire lifting ropes, roller bearings in the snatch blocks, with a separate barrel in the crab for handling light loads, and is equipped with hand motion for hoisting, traveling and traversing, so that it can be used even though the electric current may be off.

The question of supplying circulating water to the surface condensers in the power house was a rather difficult one, as about 1250 gallons per minute are required. River water could be had in abundance; but the condensers are about 1150 ft. horizontally from the quays and about 80 ft. above high-water level. This led to the installation of a pumping plant at high-water level about 140 ft. from the quay side. The contract for this plant was given to Mather & Platt, Salford Iron Works, Manchester, and included two sets of pumps, together with electric motors for driving them and all pipe connections and valves between pumps and suction and discharge mains. Each pump is capable of delivering 1250 gallons per minute, or about 1,350,000 gallons per day of eighteen hours, against a total head, including suction and friction in piping, of 95 ft. These high-lift pumps are particularly worthy of notice, as their capacity and efficiency are quite exceptional. Each pump is coupled directly to a Mather & Platt 50-hp open type 4-pole motor arranged to run at 700 r. p. m. on a 500-volt circuit. Both pump and motor are bolted to a common bed-plate, the motor spindle being supported by two ring-lubricated bearings. A liquid type starting switch with automatic release is included with each motor. Besides the motor, however, the pumps are also to be connected to a water turbine actuated by the circulating water discharge, the motor being thereby relieved of a great part of its load after the plant is once properly started.

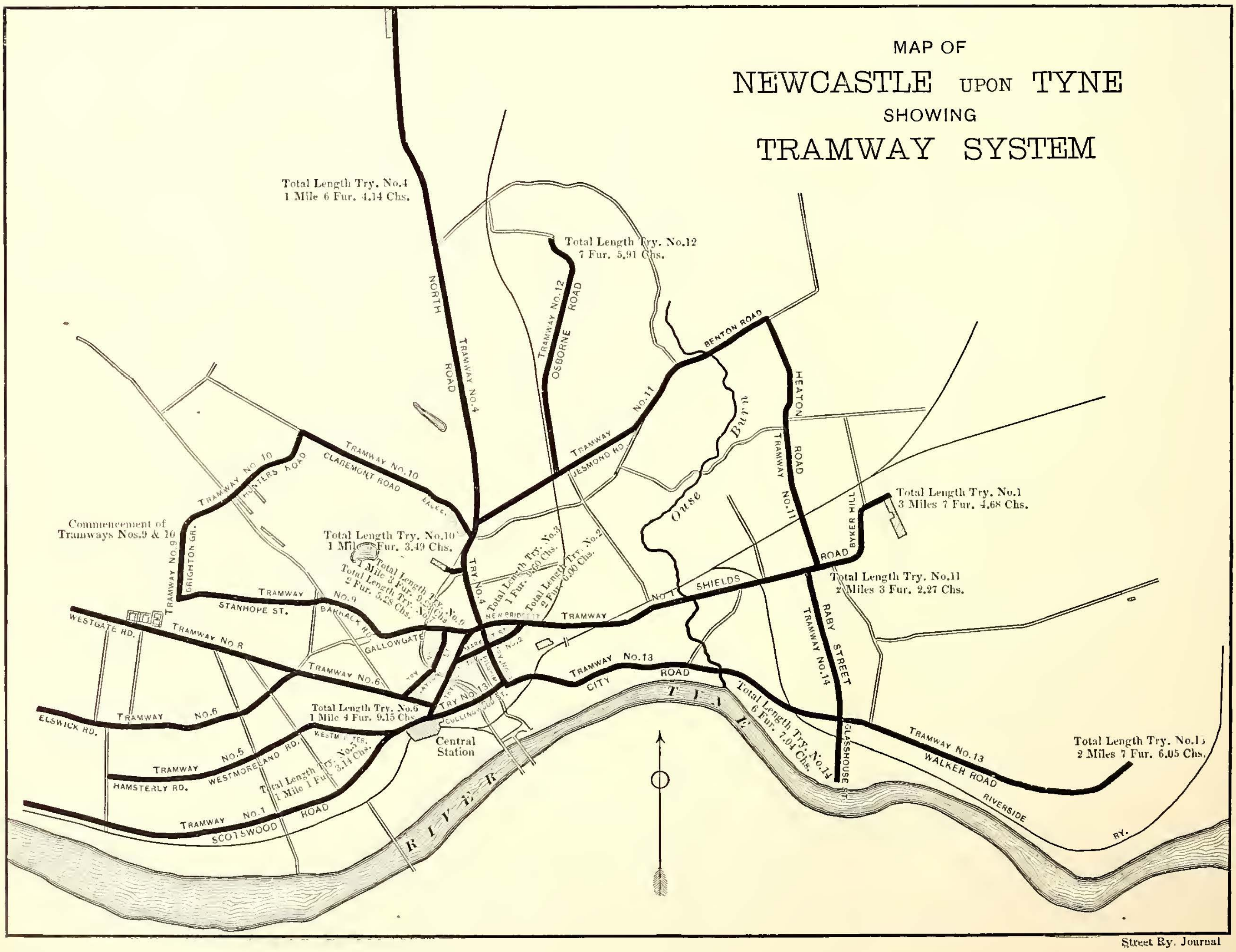
The switchboard was supplied by the British Thomson-Houston Company and consists of nineteen panels. It is 28 ft. x 7 ft. 6 ins. The panels consist of polished slate 2 ins. thick, black enameled, with the edges beveled $\frac{3}{8}$ in. The panels are divided as follows:

One generator panel, 2600 amps.
Two generator panels, 1300 amps. each.
One booster.
One power panel.
One arc-lighting panel.



PLAN OF CAR HOUSE AT BYKER, SHOWING ARRANGEMENT OF TRACKS

One Board of Trade panel.
Twelve feeder panels.
The equalizing switches are separate, being mounted on



black enameled slate slabs on cast-iron columns. All switches, circuit breakers, wattmeters, etc., are of British Thomson-Houston type, and many of the measuring instruments are of the Weston and Elliott Brothers illuminated dial type supplied by the British Thomson-Houston Company, while the Board of Trade panel is fitted with Elliott Brothers' special instruments for recording the fall of potential.

CAR EQUIPMENTS

There are 130 cars in the service, 100 of which are equipped with British Thomson-Houston motors and controllers, and thirty with Westinghouse motors and controllers. All of them are mounted on Brill trucks. Illustrations are given of a single-deck car and a double-decker, both of which types are in common use.

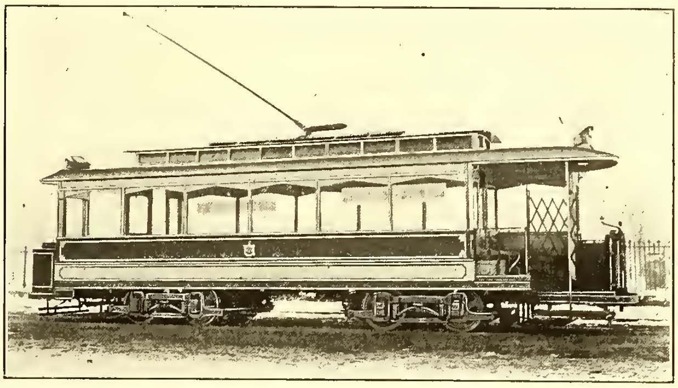
One hundred car bodies were built at the Motherwell works of Hurst, Nelson & Company, sixty being of the bogie single-deck vestibule type, having compartments at each end with an open side and with the front partly open, the latter being provided with collapsible gates to prevent the passengers interfering with the motorman. These cars are fitted with the Garden type of seats, having reversible

NEWCASTLE DOUBLE-DECKER

backs, seating accommodation being arranged for twenty-seven inside the saloon and five in each vestibule, making a total of thirty-seven. The inside roof is finished in alternate boards of light and dark wood, and the ends and sides are handsomely paneled in ash with oak frames. Twenty of the cars are of the single-deck type, mounted on four-wheeled trucks. The interior finish of these cars is the same as the double-truck cars, but longitudinal seats are provided, giving accommodation for thirty passengers. The remaining twenty cars are of the double-deck type, mounted on four-wheeled trucks, the seating capacity being for twenty-four inside and twenty-nine outside. The staircase is arranged to enable passengers both from the top and the inside to leave the car without any obstruction, the controller being placed between the stair and the dasher. All the cars have been fitted with the Hurst-Nelson sand valve.

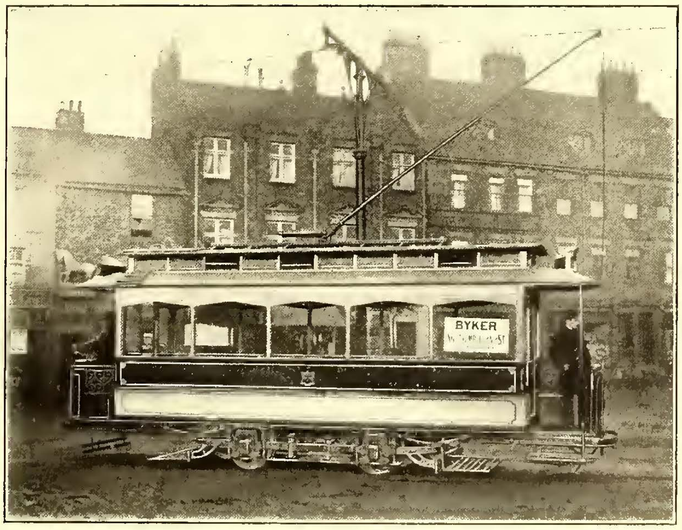
The cars just described were furnished with G. E.-58 four-turn motors, and B-3 magnetic blow-out controllers. The single-deck cars are fitted with the standard British Thomson-Houston trolley and the double-deck cars with the standard British Thomson-Houston top-deck trolley. The trolley heads are of the Towle type. All the cars have destination indicators on both ends, and are fitted throughout with electric bells. The electric bell push-buttons are distributed both over the inside and the outside of the cars.

The remaining thirty cars were manufactured by the Brush Electrical Engineering Company, Ltd., and are divided into three types. Some of them are of the single-deck bogie type, having a total seating capacity on cross seats of thirty-six. The length of this car is 37 ft. 4½ ins. over all. There are also some four-wheel single-deck cars with a total seating capacity of thirty-six on cross seats. The length of this car is 28 ft. 7½ ins. The remaining cars



LARGE CAR FOR HEAVY TRAFFIC

are of the four-wheel double-deck type, having longitudinal seats inside with a capacity of twenty-four and cross seats on the top with a capacity of thirty-five, making fifty-nine as the total seating capacity of the car. The length of this car was 28 ft. 2 ins. All of these cars are finished in the same general style as those already described and are equipped with Westinghouse 49-B motors and No. 90 controllers. The 49-B motor is specially designed for city tramway work and has four poles built up of annealed-steel stampings cast on the inside of the motor casing, which forms the yoke of the magnetic circuit and also completely encloses the motor. The yoke is horizontally divided and the two parts hinged so that the lower half can be dropped and the whole of the motor exposed for inspection and repairs. The field coils are machine-wound on formers. The armature is light and of small diameter. The armature is of the slotted-core, drum-wound type,



SINGLE-DECK CAR

with a two-circuit winding, which insures sparkless running. The motors are coupled to the car axles through single-reduction gearing enclosed in a cast-steel case. The car axles are 4 ins. in diameter and the wheels are 2 ft. 6 ins. in diameter, while the gage of the track is 4 ft. 8½ ins.

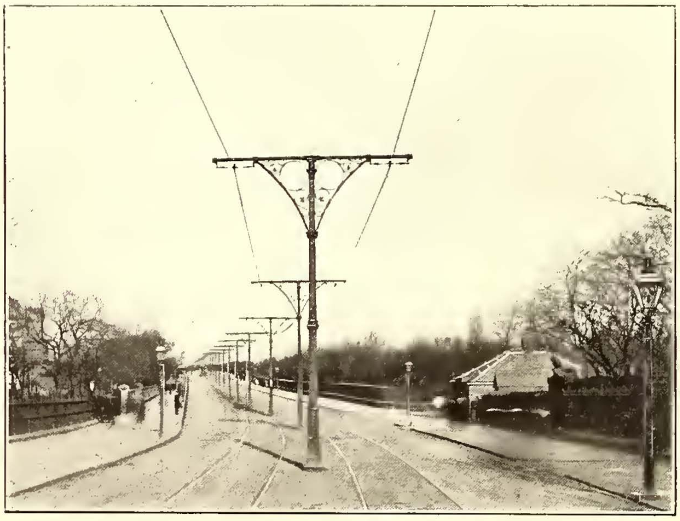
The Westinghouse No. 90 controller is of the series-parallel type and has an ingenious mechanical interconnection between the main lever and the reverse lever, whereby the number of electrical contacts is kept as low as possible. This feature reduces the "wear-and-tear" expenses. This controller is arranged on the Newcastle tramcars for "service" braking; contacts are arranged whereby a backward motion of the main lever beyond the "off" position places suitable resistances in circuit with the car motors, which thus run as generators on load driven by the momentum of the moving car. Used in this way it is practically an axle brake, but more recently adaptations for the same method have been made, and the Westinghouse magnetic brake combines the axle-braking effect with a track brake and a wheel brake. It is proposed to adopt this magnetic brake on the Newcastle tramways.

TRACK CONSTRUCTION

The whole of the track construction was undertaken by E. Nuttall, of Manchester, though various types of rail were used, some having been supplied by Messrs. Dick, Kerr & Company and some by the Leeds Steel Works. The drain rails were supplied by Messrs. Askham Brothers & Wilson, and the points and all of the special track work, including curved rails, were supplied by the Lorain Steel Company, Ltd. The tracks are of the usual standard gage, 4 ft. $8\frac{1}{2}$ ins., and the girder type of steel rails weighing 101 lbs. per yard has been used in lengths of from 45 ft. to 60 ft. The rails are 7 ins. high, 7 ins. wide in the base with a 2-in. tread, the groove being 1 in. wide and 1 in. deep. Steel fish-plates weighing 73 lbs. per pair were used for jointing the rails, and these were drilled with eight bolt holes $1\frac{1}{8}$ ins. in diameter. Steel tie-bars 2 ins. x $\frac{3}{8}$ in. were also used in the usual way. The rails were laid on a bed of concrete 7 ins. thick, which extended 18 ins. beyond the tracks, the conduits for the feeder cable being laid underneath. Double-crown flexible bonds 8 ins. long and having a capacity equal to 0000 B. & S. gage have been used, and cross bonds at from 90 ft. to 135 ft.

OVERHEAD WORK.

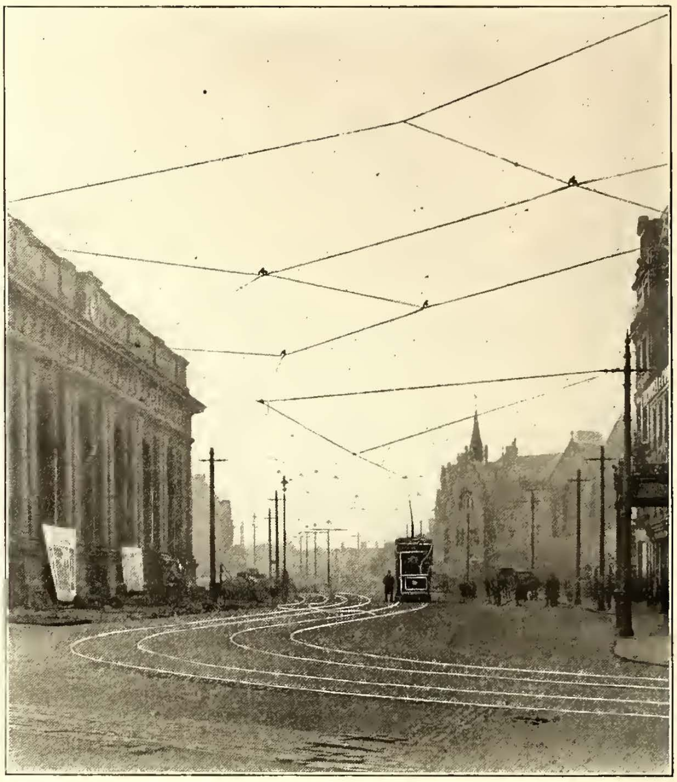
The overhead equipment, with the exception of some minor details, was installed by the British Insulated Wire Company, Ltd., of Prescot, Lancashire, including about 18 miles of double-track construction.



CENTER POLE CONSTRUCTION IN NORTH ROAD

The track is double throughout, the centers of the two lines being 5 ft. 10 ins. apart, and this permits center poles to be used over a considerable portion of the route. The chief roads where center poles are used are the North Road (illustrated), Jesmond Road, Northumberland Street, Granger Street, Pilgrim Street, Shields Road, Westmoreland Road, New Bridge Street and Stanhope Street. In other places span wires are employed, as on Westgate Road, Walker Road, City Road, Roby Street, as well as portions of Osborne Road (illustrated), Scotswood Road and Elswich Road.

The trolley wire is double throughout and consists of



CROSSOVER AT NEVILLE STREET JUNCTION

hard-drawn copper wire having a breaking strain of about 3 tons. It is hung as near the middle of each track as possible to insure easy running. The sag is about 7 ins. on a span of 40 yards at 60 degs. F.

On routes equipped with span wires the overhead work is of the usual type, double insulation throughout being obtained by the use of a Brooklyn strain insulator at each pole bracket and the insulated bolt in the hanger. On

SPAN WIRE CONSTRUCTION ON OSBORNE ROAD

straight portions, straight-line hangers are used and on slight curves double-curve hangers. Where necessary, pull-off poles are used with double and single curve hangers in the tails. The span wire is in general galvanized strand wire, calculated to stand a working stress of at least 1000 lbs., and in practice a stress of 1000 lbs. to 1200 lbs. was obtained in some places. On the City Road route considerable bridling was necessary owing to the number of curves. Under Pottery Railway bridge the trolley wire is carried on bridge hangers fixed to troughing, the latter being secured by bolts to cross beams of pitch pine placed between the iron girders. No anchoring is employed anywhere, the design of the work being such as not to require it. Guard wires are employed where telephone and telegraph wires cross the trolley wires. They consist of galvanized strand wire and are carried about 2 ft. 6 ins. above the trolley wire. On center bracket work, where not more than six wires cross at any one place, one guard wire is used, and is supported on a single-guard standard in the middle of the bracket and earthed to the rails about every six poles. Where more than six wires cross, two guard wires are used, placed about 8 ins. outside the trolley wire

MONUMENT JUNCTION

at each side and supported by side brackets as usual. On center-pole work the trolley wire is supported from the cross bracket by the fiddle bow suspension, consisting of a short span between two small brackets and insulated by two small Brooklyn strains with hanger, as on the span work. North Road, which is illustrated, is a fine example of this type of suspension, and being nearly straight for about a mile and a quarter a speed of 10 miles an hour is permitted. This is the only route where the speed is allowed to exceed 6 miles to 8 miles an hour.

The poles were supplied by the Corporation and are of several types. About 200 of them carry arc lamps for street lighting, the terminal switches being placed in enlarged bases. The center poles will deflect 6 ins. at the top with a horizontal load of 500 lbs. applied at that end. On curves, poles deflecting 6 ins. with a load of 1000 lbs. are used. These also act as span poles, but they are somewhat longer for this purpose. For pulling-off curves, a still stronger type of pole is used, requiring a load of 2000 lbs. to deflect its top 6 ins.

Frogs of the Redman type are used, those facing being automatically operated by the trolley boom in passing, while the trailing ones are simply spring frogs held open to the loop or crossover line. The crossings are of Wood's pattern, designed to work with Towle's swiveling trolley head.

The section boxes for spanwork have 400-amp. quick-break switches, fixed on a slate slab. Space is left for lightning arrester and telephone terminals if required. In the case of feeder boxes, two additional 800-amp. quick-break switches of special design are provided. By means of these switches breakdowns can quickly be isolated.

On center-pole work, a large base similar to those used to contain arc-light switches is used, and in this base is fixed a slate slab carrying a knife switch of about 600 amps. capacity. This switch cuts off the pair of trolley wires on one side of the pole from the pair on the other side. Where feeders are connected, two of these switches are used.

Neville Street Junction, at central station, and Monument Junction are perhaps the most novel portions of the work. At the former, two straight through lines are provided; also crossover and side lines for shunting and waiting.

CAR HOUSES.

The main car house of the Corporation is at Byker. The ground plan is given, showing the arrangement of the tracks. The structure is of steel framework and is over 400 ft. long by about 100 ft. wide. As will be seen, nine separate tracks enter the car house. Over one of them is erected a 3-ton electric traveling crane having a span of 19 ft. $4\frac{1}{2}$ ins., driven by one motor. Immediately adjoining the car house is a store for spare car bodies, and in this store is another electric traveling crane of 29 ft. 6 ins. span and capable of lifting 6 tons, all of the movements being driven, as in the case of the other crane, by one motor.

The battery installed at the Byker car house consists of 245 cells, manufactured by the Electrical Power Storage Company, and arranged in lead-lined wood boxes, each containing 17-P type-plates, and is capable of discharging at 150 amps. for five hours, or 300 amps. for half an hour. These are erected on single-tier stands, and the plates are separated by glass tubes, which are held in place at top and bottom, the approximate weight of cell, with acid, being 600 lbs.

More Railways for the Bronx, New York.

The Union Railway Company, of New York, has recently made public plans for the building of about 20 miles of line in the Bronx. The company has ordered 40 miles of track for this work, and the rails have already, to a large extent, been delivered. The company has also bought the necessary cars and other equipment. In addition to this, new equipment is being ordered for the present Union lines, a considerable mileage of which is to be changed from single to double track and entirely relaid with improved grooved girder rails. The Union system, with the construction of the new routes, will have three converging lines extending from the northerly line of the city through the park system, Van Cortlandt Park, with parade ground and lake; Bronx Park, with the botanical and zoological gardens, and the smaller parks, and joining at Central Bridge. These northerly parallel lines are intersected by various cross-town lines, which bring the entire borough of the Bronx to a focal point at Central Bridge and across the bridge to the connection with the Manhattan Elevated and the Metropolitan Street Railway system.

Train Resistance

BY W. J. DAVIS, JR.

The present tendency toward very high speeds on interurban electric railways has made the question of proper car or train resistance a very important one, especially as it is often necessary accurately to predetermine schedule speeds, heating of motors, and energy consumption for service conditions of a distinctly pioneer character. Maximum speeds of 50 to 60 miles per hour are frequently required and even 75 miles per hour have been occasionally demanded. The car ordinarily used in this class of service is of the vestibule type with rounded ends, and presents to the wind a surface radically different from that of the ordinary steam locomotive and passenger coach. Another condition peculiar to electric interurban problems consists in the practice of operating single cars on short headway instead of trains comprising four to eight cars at infrequent intervals, as is the usual steam railroad practice. All of these service requirements affect the train resistance, and the constructing or designing engineer has available almost no data or formulæ which may be used with any degree of accuracy.

In order that a formula should possess flexibility and be capable of application to all classes of service with proper changes in the constants, it must be theoretical rather than empirical in form, i. e., all of the various items going to make up the resistance of the car or train should be properly segregated. Expressed in torque or draw-bar pull, these items are:

(a) Journal friction of the car axles, which has been found to be practically independent of the speed for properly designed bearings.

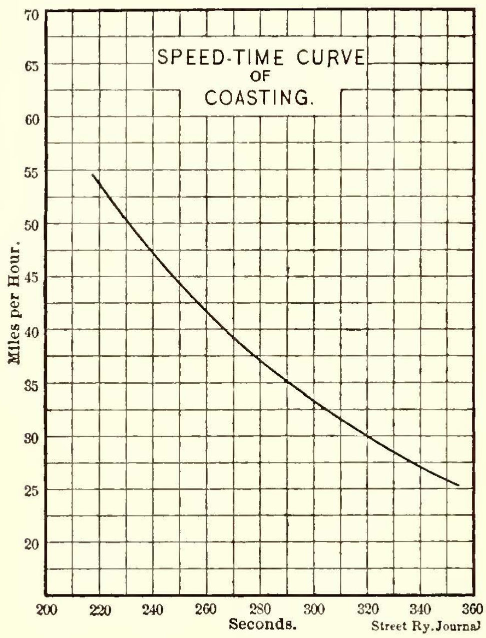


FIG. 1

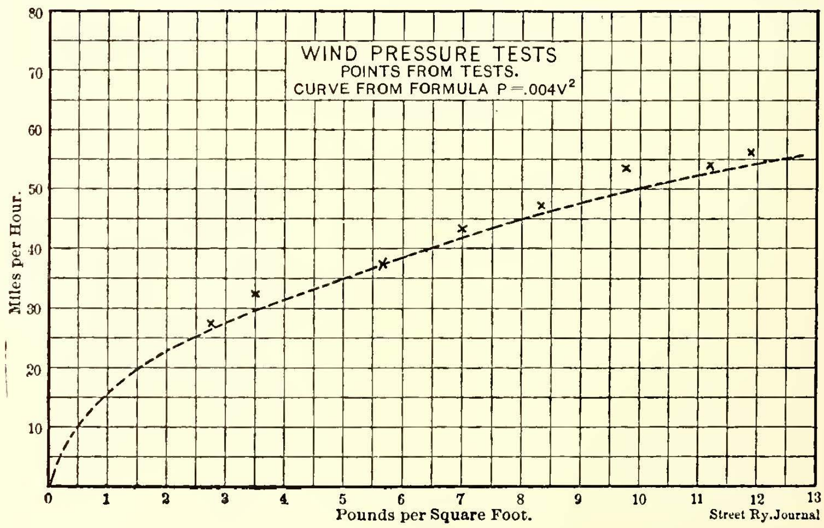


FIG. 2

(b) Rail friction, due to irregularities in the surface of the rails—assumed to be directly proportional to the speed.

(c) Wind resistance, varying as the square of the speed, the cross section and end shape of the car, and the number of cars forming a train.

When the cars are electrically operated, there is an additional item comprising gear and bearing friction of the motors. As this is largely a part of the motor design, it may best be, and ordinarily is, included in the efficiency or characteristic curves of the particular motor to be used. A formula containing the above elements will have the form

$$(1)\quad f = b + cV + \frac{dV^2}{T}\left[A_1 + m\,(A_2 + A_3 + A_4 + \text{etc.})\right]$$

Where f = friction in lbs. per ton.
V = velocity in miles per hour.
T = weight of train in tons.
A_1, A_2, etc., = cross section of car in sq. ft., including trucks, motors, etc.
b = journal friction.
c = coeffiecient of rail friction.
d = wind coefficient = equivalent effective pressure in lbs. per sq. ft.
m = coefficient showing proportional section of trailing car considered as affecting total windage.

If all cars are of equal cross section the formula becomes

$$(2)\quad f = b + cV + \frac{dAV^2}{T}\left[1 + m\,(n - 1)\right]$$

Where n = number of cars in a train including leading motor car.

In March, 1900, the writer conducted some tests for the General Electric Company on a section of the Buffalo & Lockport Railway, from which the various constants entering into the above equation were determined for the standard steam railroad local passenger coach of the non-vestibule type. A short description of these tests may prove of interest.

The section of track between Pendleton and Lockport, upon which the tests were made, is absolutely straight, with no grades exceeding one-quarter per cent; is laid with 90-lb. rails, has well-ballasted roadbed, and has ample facilities in the way of overhead copper and power station capacity to meet the demands of heavy high-speed service. One of the Buffalo & Lockport 37-ton electric freight locomotives was especially geared and connected to give a maximum speed of 55 miles to 60 miles per hour at average line voltage. The train was made up of a locomotive, baggage car and three standard passenger coaches furnished by the Erie Railroad, and weighing on an average 26 tons each, without load. The method of test consisted simply in quickly bringing the train up to maximum speed, then throwing off the power and coasting. Curves showing the variation of speed with time and with distance were taken by means of a Boyer speed recorder with chronograph attachment placed in the cab of the locomotive. Tests were made first with locomotive, baggage car and three coaches, and then the coaches were removed one at a time and the test repeated in each case until finally only the locomotive remained. The coasting curves obtained, of course, included the gear and bearing friction of the motors and were affected, to a slight degree, by the inertia of the revolving elements of the train, such as motor armatures, gears and wheels. The first of these items was eliminated by special tests taken at the factory showing the loss in the gears and bearings of the motors at various speeds. The second item was calculated and proper allowance made therefor. A sample curve is shown in Fig. 1.

During the test, observations were made to determine the prevailing direction and velocity of the wind. In this respect, the conditions were very fortunate, as the maximum velocity observed did not exceed 12 mile per hour and was

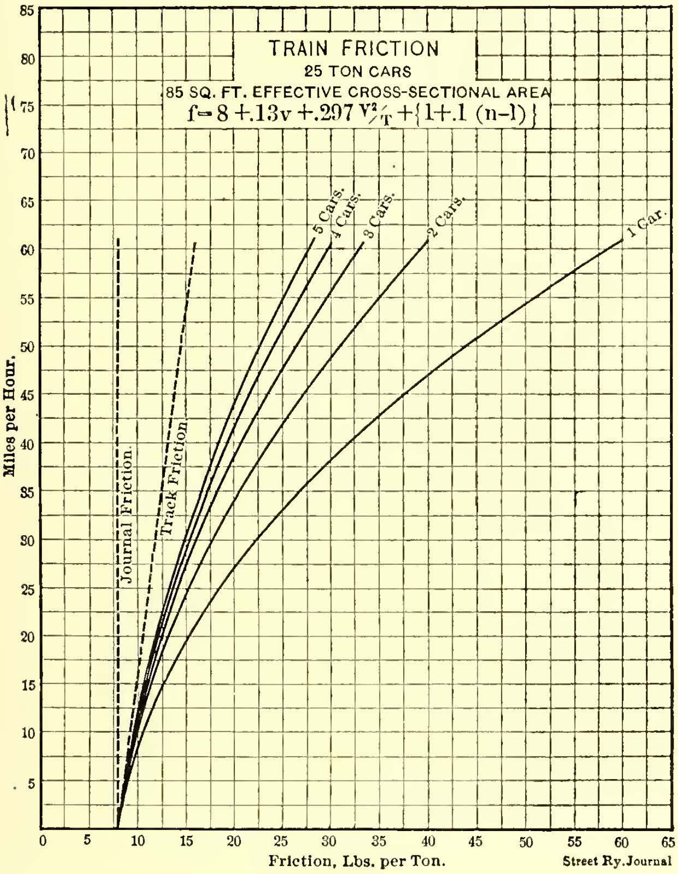


FIG. 3

approximately at right angles to the track. During the greater part of the test there was not enough wind to affect, to any appreciable extent, the running resistance of the train.

As a result of these tests each car added to the train was found to increase the effective cross section by approximately 10 per cent. The constant for wind pressure was determined by a series of tests made after the regular run, in which a wooden shield was mounted on the front end of the locomotive, hinged at the lower end, and fitted with a system of levers and an adjustable spring balance in the cab to register the pressure. Curves representing these tests are shown in Fig. 2.

The coefficients in formula (2) were found to have values

$b = 4$
$c = .13$
$d = .004$
$m = .10$ giving

$$(3)\quad f = 4 + .13V + \frac{.004AV^2}{T}\left[1 + .1\,(n - 1)\right]$$

A comparison of the above formula and constants with available data of a reliable nature shows very close agreement, and its application has also been found to closely approximate the standard practice of the prominent steam railroads. The cross section, *r*, given in the formula comprises the section of the car body proper plus the section bounded by the car wheels, the under side of the car body,

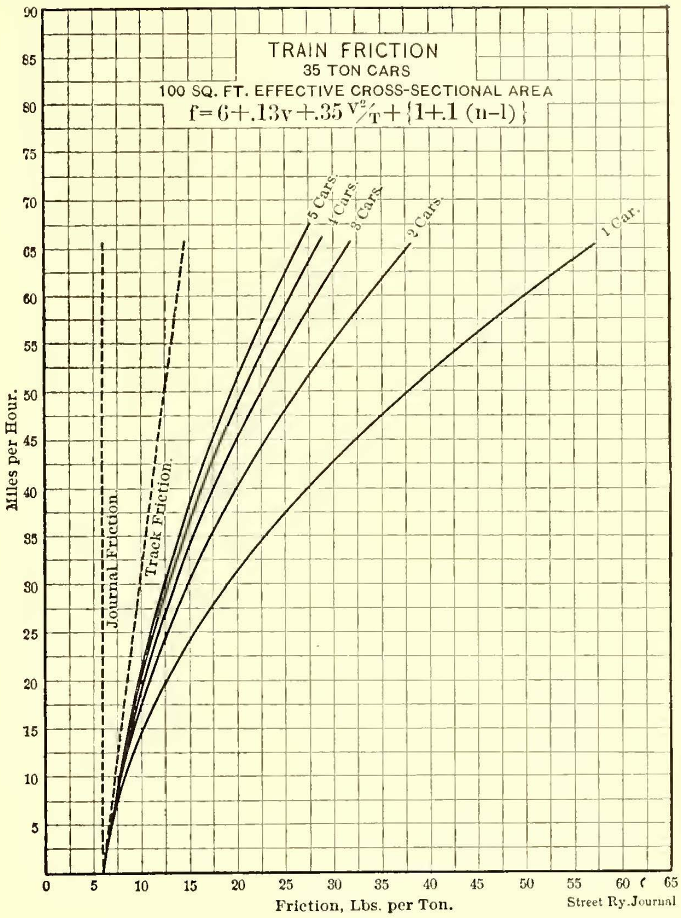


FIG. 4

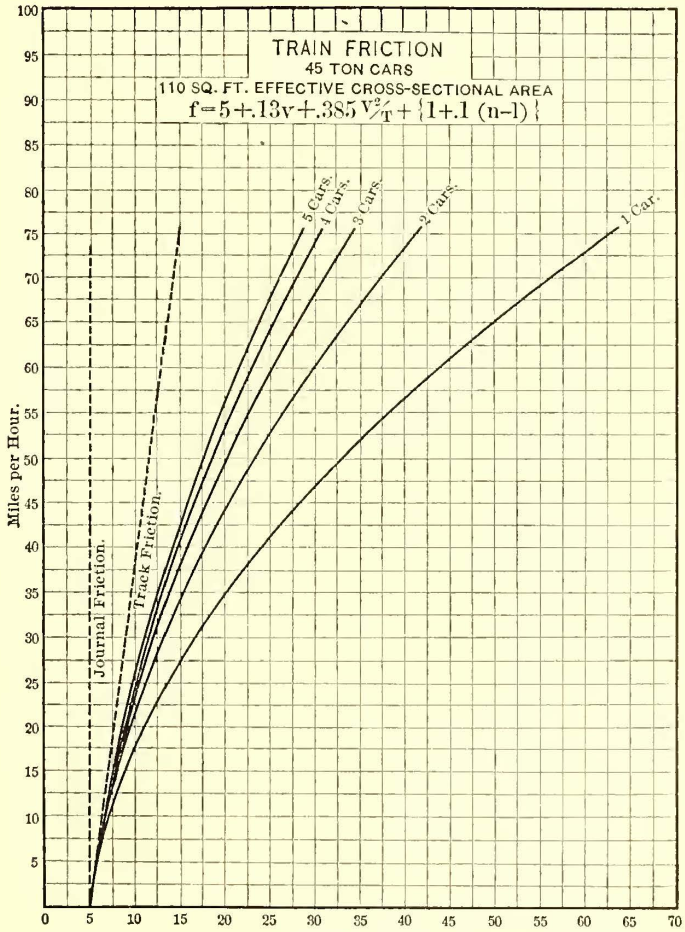


FIG. 5

and a horizontal line tangent to the head of the rails and normal thereto.

Unfortunately no reliable tests at high speed have as yet been made to determine the effect of wind pressure on the modern vestibuled type of interurban car. There are several interurban electric railways now under construction where long stretches of level tangent track and adequate facilities in the way of power and equipment will permit exhaustive and valuable resistance tests to be made, and it is to be hoped that our data on this subject may be considerably augmented within the next year or so.

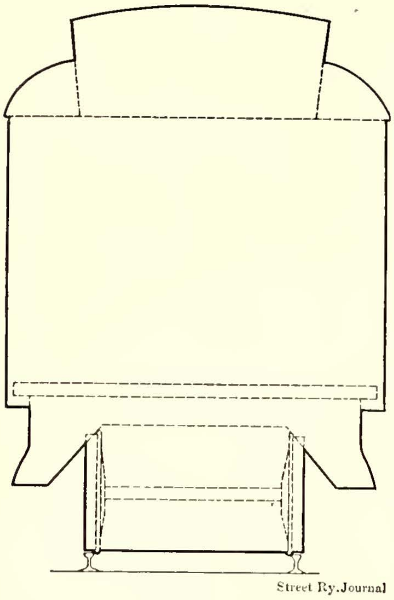


FIG. 6

Pending this information, it has been thought advisable to modify the formula obtained from the Buffalo & Lockport tests for temporary use in high-speed interurban problems, changing the various constants to conform with such isolated tests and data on cars of the interurban type as are available. On account of the rounded ends of the usual high-speed interurban car, the wind coefficient *d* has been taken as .0035. The constant *b* has also been increased to conform with the weight of body and trucks favored for electric interurban work. Three curves have been laid out, based on formulæ as follows:

(a) Twenty-five ton car, 85 sq. ft. cross-sectional area.

$$f = 8 + .13V + \frac{.0035\,A\,V^2}{T}\left[1 + .1\,(n - 1)\right]$$

(b) Thirty-five ton car, 100 sq. ft. cross-sectional area.

$$f = 6 + .13V + \frac{.0035\,A\,V^2}{T}\left[1 + .1\,(n - 1)\right]$$

(c) Forty-five-ton car, 110 sq. ft. cross sectional area.

$$f = 5 + .13V + \frac{.0035\,A\,V^2}{T}\left[1 + .1\,(n - 1)\right]$$

For convenience in practical application these formulæ have been plotted in the form of curves and are shown in Figs. 3, 4 and 5. It should be specially noted that the cross section of the car expressed by the quantity *A* is taken as shown in Fig. 6.

An inspection of the curves will show that as the number of cars forming a train is reduced, the relative value of the wind resistance is considerably increased, so that when a single car is operated at high speed the effective wind pressure is so large compared to the weight of the car as to demand an exceedingly large proportion of the power required for propulsion.

This brings out forcibly the importance of reducing the effective resistance of the wind as far as possible by careful attention to the design of the ends of the car, where high-speed running is required, especially with single cars.

The curves and constants given herewith are not offered as representing complete and final information on the subject. They are rather to be considered as conclusions deduced from a single set of tests, checked, however, at several points by records from actual operation. It is only hoped that the information may be found of some value to the electrical engineer until completion of a more thorough investigation of this subject in further tests now being made by the General Electric Company.

Mr. Davis' Formula on Train Resistance

[With the consent of Mr. Davis, advance proofs of the preceding article were submitted to several engineers who have given especial attention to the subject of train resistance. Their comments are published herewith.—EDS.]

REVIEW BY JOHN LUNDIE, D. Sc.

It might be well in discussing train resistance to give this much-abused term a definition, so that in a discussion of the same all may be working on a common basis. What by common use is termed train resistance may be defined as the resultant of the forces opposing the motion of a train when running on a straight, level track, properly gaged and of standard railway construction, on clean rails, in still air.

Mr. Davis very properly suggests that a formula for train resistance ought to be rational, rather than empirical in form. He divides the elements constituting resistance into (a) journal friction, (b) rail friction, and (c) wind resistance. These are not, by any means, the whole of the elements constituting this complicated resultant force. Not the least of those omitted is that of lack of perfect resilience in the parts under strain. This applies not only to the rolling stock, but also, in no small measure, to the track.

It is natural to attempt to build up a formula of the general form $F = B + C\,V + D\,V^2$, etc., but extremely difficult to apply the coefficients of V. Taking up Mr. Davis' formula in detail, the constant B in the general formula, he states, was found to have the value of 4. Strangely enough, and for no given reason, he changes this so-called constant into a variable in the cases of the 25-ton car, the 35-ton car and the 45-ton car. The coefficient C of the first power of V remains constant in each of the cases given. Why, however, this term in his equation should be applied to so-called rail friction he does not mention, simply making the statement that "rail friction, due to irregularities in the surface of the rails, is assumed to be directly proportional to the speed." The coefficient of V^2 in the general formula is made up of a number of factors in the formula proposed by Mr. Davis. The first factor in this coefficient is the air pressure in pounds per square foot. This he obtained empirically by mounting a wooden shield on the front end of a locomotive and noting the pressure per square inch on this shield when the locomotive traveled at varying speeds. He makes the statement that the second factor, viz., the effective cross section of the train, should be obtained by adding together the area of the cross section of the first car and 10 per cent of the area of each succeeding car, stating that this was found as a result of his tests. The remaining factor making up the coefficient of V^2 is that of the weight of the train, which he uses arbitrarily so far as any explanation of the same is concerned, as if following the lead of some prior formula. The weights of similar passenger trains might be considered as approximately proportioned to their volumes, so that this element of weight might be considered as taking into account not only the cross section of the train, but also its length; and the length of a train, with its many irregularities of surface, has an important bearing upon the resistance presented to it by the air. The two factors, weight and area, entering into this coefficient would therefore seem to require some mutual adjustment, if the formula proposed by Mr. Davis is to be considered as a thoroughly rational one.

The first factor in the coefficient of V^2, as obtained from his experiments on the wooden shield, is faulty. Smeaton, a century and a half ago, obtained a similar formula for air pressure by a similar process applied to windmills, giving results 25 per cent in excess of the results obtained by Mr. Davis. Others have obtained coefficients of the square of the velocity of the wind differing from one another 100 per cent or more, depending on the area of the surface presented for test, the shape of the surface and what was behind the surface. An extensive series of experiments was carried out some twenty years ago, after the fatal accident to the Tay bridge in Scotland. The results of these experiments were not entirely satisfactory, but they indicated clearly that on a small surface a very much higher pressure would be registered than on a similar large surface. The well-known fact, moreover, was emphasized that with a moving train a large volume of air travels all around the train, and that in front of the train a high barometer volume of air exists, while in the rear of the train a low barometer of air exists. Some experiments have indicated that immediately in front of a train moving at high speed a volume of compressed air is carried forward, somewhat of the general form of a modern projectile.

In view of the high speeds which are talked of in connection with certain rapid transit propositions, the question of determining train resistance is a very important one, and it is far from the intention of the writer to carp at any general formula which will even approximately give this information at extremely high speeds. The formula of Mr. Davis, however, is simply presented as a formula, without stating the rationale of the same. On this score alone it is certainly open to friendly criticism. If Mr. Davis would present the simple time-speed records which he obtained, stating in detail the conditions under which they were obtained, he would not detract from the credit due him for his attempt to build up a rational formula, but such information would add materially to the comparatively accurate data which is in existence on train resistance at lower speeds.

In February, 1899, the writer gave to the Street Railway Journal the results of a large number of tests on the resistance presented to elevated trains as determined by him on the South Side Elevated Railroad in Chicago. A formula was then suggested by him, one of the factors of which was wholly of an empirical form. The results of these tests, together with the results of many others, have since justified a modification in this formula on a more rational basis. The formula, as modified, is as follows:

R, resistance in pounds per ton.
S, speed in miles per hour.
T, weight of train in tons.

$$R = 4 + S\left[0.24 + \frac{4.8}{T}\right]$$

It will be noted that this formula differs from that of Mr. Davis, principally in the third term, where, instead of the square of the speed being used, the first power is used. This formula the writer knows from his own experience to give correct results as applied to trains weighing from 20 tons to 100 tons up to speeds of about 30 miles per hour. The formula further conforms to results obtained on heavy trains at speeds as high as 60 miles per hour. Judging from Mr. Davis' formula (for lack of his data, which would have been preferable), the formula of the writer would not apply to light cars at very high speed. There is nothing to be gained by holding back such data on the part of anyone; but, on the other hand, there is much to be gained by the co-operation of engineers who have made tests on train resistance in seeking a reliable formula applicable to high-speed, light railway work. It is altogether probable that such a formula would contain a term involving V^2; but let us have the facts in the first place, when we shall all be in a position to better discuss and determine a formula on a thoroughly rational basis.

S. T. DODD ASKS FOR MORE DATA

It is rather remarkable that on a subject of as much practical importance to electric railway engineers as that of Mr. Davis' paper there should be available so little published data. A number of formulas for train resistance have been published by steam railroad engineers, but are striking only for their lack of unanimity of form or results when applied to single cars of the type and weight used in electric interurban service. It is peculiar that the ease of making such determinations on electric railways should not have given us by this time quite a mass of experimental data bearing on the subject as related particularly to electric railway proctice.

Some years ago, in a discussion of this subject (Street Railway Journal for September, 1898), I called attention to the lack of reliable information on this head, and noted that the best formulas of steam railroad engineers gave, at high speeds, values of the train resistance higher than the energy consumption of our electric railways seemed to warrant. I also pointed out that the resistance to motion developed by a single-motor car appeared to be, roughly speaking, about twice as great per ton of moving weight as that developed by trailer cars hauled by this motor car. I did not at that time have at hand data of sufficient extent or accuracy on which to base any very accurate formula, although I suggested a linear function of the velocity as expressing very fairly such data as I had at speeds between 25 m. p. h. and 50 m. p. h.

As far as I know, such curves as Mr. Davis has published in his Figs. 3, 4 and 5 are the first attempts to give, for modern interurban cars, in a form convenient for practical application, the variation of train resistance with speed and with different numbers of cars in a train, and based on experiments sufficient in number and accuracy to be considered as approximately correct. Of course, we must bear in mind the approximate character of this formula to which the author calls attention. But, even if these curves could only be considered accurate to within 10 per cent or 15 per cent, they would be of great use to engineers engaged in calculations on electric railway problems and would give far more accuracy than the coefficients often assumed as constant irrespective of speed or character of make-up of train.

The method used by Mr. Davis is practically the same as that used by A. M. Wellington in his experiments on train resistance of steam railroad trains (see "Economic Theory of Railway Location"). It would seem that a more convenient method of making such tests on electric trains would be to calculate the train resistance, by means of the characteristic curves of the motors, from the current taken by the motors when the train is running at a constant speed on a level or on known grades. There might be some errors introduced by such a method, but they would be eliminated in the practical application of the results. In view of the fact that the practical use of a train resistance formula is to calculate the speed and power consumption of different trains it would seem that a formula derived from readings of the power consumption would be apt to give the most reliable results.

The author says his formula shows a very close agreement with data of a reliable nature and with the standard practice of steam railroads. It would have added to the interest of the article if he had illustrated this point further with a tabulated statement of comparative results from experiment and calculation. I would be inclined to think that the formula would not be correct at high speeds on account of the high value that has been assigned to the coefficient of V^2. While differing in form and coefficients from Wellington's formula, it agrees with it in the use of a quadratic function of the velocity. As a matter of fact, I have always found Wellington's formula gave results too high to correspond to the results derived from readings of the power consumption of single, comparatively light electric cars running at high speeds, and the few data I have at hand would seem to indicate that Mr. Davis' formula is open to the same criticism. I have no data sufficiently recent or extensive to warrant me in publishing them in comparison with Mr. Davis' curves; but such readings as I have on interurban cars of 20 tons to 25 tons in weight, running at speeds of 45 miles to 50 miles per hour on a level track, point to a power consumption of from 3.2 kw to 3.6 kw per ton of car weight, i. e., to a train resistance of 28 lbs. to 32 lbs. per ton. On the other hand, the curves of Mr. Davis' paper would indicate that such cars may be expected to develop a train resistance varying from 37.5 lbs. per ton at 45 m. p. h. to 44 lbs. per ton at 50 m. p. h., i. e., with motors of 80 per cent efficiency the power consumption will vary from 4.2 kw to 5.5 kw per ton of car weight.

It should be a very simple matter to obtain a pretty accurate determination of the average power consumption per ton of electric cars running on level tracks at high speeds. High-speed interurban roads have been in operation for several years, and the requisite data must be easily accessible. Such data should be collected under sufficiently different circumstances to give not only an average value for the energy consumption, but also means for estimating the variations from this average which may be expected in different cases.

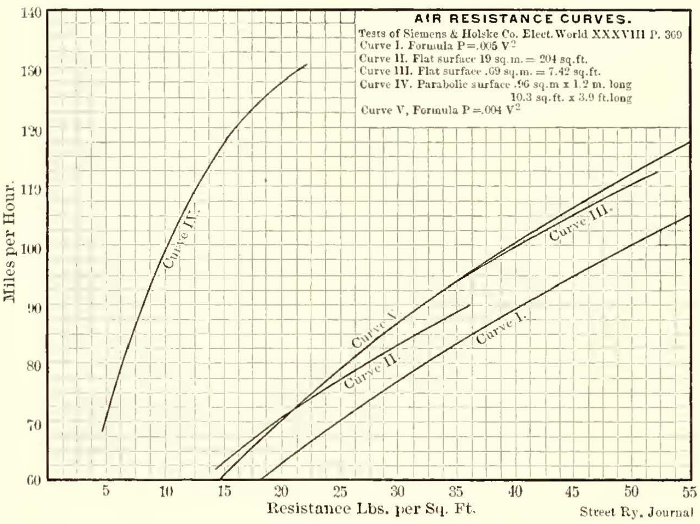


FIG. 7

Take as a simple illustration the Albany & Hudson road. This road is operating 34-ton cars at a maximum speed of 60 m. p. h. (Potter, STREET RAILWAY JOURNAL, December, 1901). According to Mr. Davis' curves, the train resistance at this speed is 50 lbs. per ton, so that the horse-power developed by the motors at full speed on the level is given by the equation:

$$\text{Horse-power} = \frac{50 \times 34 \times 50}{375} = 272 \text{ hp, or } 68 \text{ hp per motor.}$$

Assuming 85 per cent efficiency for the motors at this load, and a line pressure of 600 volts, this gives an input of 60 kw, or 100 amps. per motor. Consideration of such a problem as this gives rise to the very pertinent inquiry: Is it a fact that the minimum current used by the Albany & Hudson cars at full speed on a level track is 400 amps. per car? And, if so, what is the starting current? And what current does it take to carry the cars up the grades they have to encounter?

I have seen no tests on the above road, but my impression is that the actual current consumption is considerably less than that calculated from Mr. Davis' formula.

Both engineers and manufacturers are naturally sensitive about publishing data of tests such as above indicated; but, on account of the widespread interest there exists to-day among engineers in the construction of high-speed interurban roads at maximum speeds of over 50 m. p. h., and particularly in view of the ample facilities we have in the high-speed roads already constructed, it would seem that we have a right to expect some one with the proper facilities at his command to make and publish a series of reliable tests on the power consumption of electric roads under varying conditions, and especially at the highest practicable speeds.

It is of interest to compare Mr. Davis' results with those obtained by the Siemens & Halske engineers in their preliminary experiments upon the equipment of the Berlin-Zossen road (see Reichel, *Elect. World and Eng.* XXXVIII., p. 367). The method used by them to determine the wind pressure was to measure the power consumed by whirling a flat board or fan at the end of 10-ft. arm at various speeds. Complete data may be obtained from the article quoted, but some of the curves of that article are here reproduced (Fig. 7), having the ordinates expressed in "pounds per square foot" and "miles per hour" for sake of comparison.

Curve I. on this sheet gives the wind pressure on a flat surface calculated from the well-known formula $P = .005 V^2$ (Kent, p. 492) or (Hutte, part I., sec. F).

Curves II. and III. give the wind pressure on flat surfaces as determined from the tests described by Mr. Reichel. It is worthy of note that with surfaces of 204 sq. ft. (Curve II.) and 7.4 sq. ft. (Curve III.), at various speeds from an equivalent of 60 m. p. h. to 110 m. p. h., and by a method entirely different from that used by Mr. Davis, these curves show a very close approximation to the formula $P = .004 V^2$ (Curve V.), which Mr. Davis has adopted as expressing the result of his tests, between 25 m. p. h. and 50 m. p. h.

Curve IV. gives the result obtained by substituting for the flat surfaces an oblong body with ends roughly parabolic in shape. It will be noted that the equation of this curve is approximately $P = .001 V^2$. It is remarkable that the change from a flat surface to a solid body, as roughly parabolic as was the one used in the Reichel experiments, should give as decided an alteration in the wind pressure as is shown in these curves. The explanation is possibly to be found in the fact that a good part of the resistance of the flat surface, or vane, is due to the vortices, or eddies, produced around its edges and to the vacuum produced behind it. If so, the decreased pressure on the solid body is due as much to the parabolic shape of its rear end as to that of its front end. One would hardly expect that the air resistance experienced by an oblong body 4 ft. in length, with parabolic ends, whirling on the circumference of a 20-ft. circle, would be a very close approximation to that experienced by an electric car 50 ft. long, with vestibuled ends, running on a straight track. Mr. Reichel himself admits it is only a rough method, and engineers have been waiting with a good deal of interest to see how nearly the results of the tests on the energy consumption on the Berlin-Zossen line will coincide with the values calculated from these preliminary experiments.

The consequences, however, are so important that we cannot help asking if a parabolic body, as used in the Reichel experiments, shows a wind coefficient of about one-fourth that of a flat surface, what would have been the result in the Davis experiments if a shield had been used of approximately the shape of the rounded front vestibule of an interurban car? If the result of this had been to reduce the wind coefficient, as in the Reichel experiments, from .004 to .001, it would have affected the whole character of the Davis curves, giving a somewhat higher value to the coefficients *a* and *c* and making a very serious alteration in the values of train resistance at speeds of 75 miles to 100 miles per hour.

Of course, all this is pure speculation and can only await the result of tests. In the meantime we have as the result of recent work on this line two very different formulas for train resistance awaiting experimental verification.

The Siemens & Halske engineers have designed the motors for their Berlin-Zossen line on the basis of their experiments, which indicate a train resistance of 2980 lbs. at 125 m. p. h. for a 96-ton car of 108 sq. ft. front area, on which basis they anticipate their motors will have to develop about 950 hp at 125 m. p. h. On the other hand, the formula of Mr. Davis would indicate that the train resistance of the car under the above conditions will be 7845 lbs. and the power demanded of the motors will be 2620 hp.

While we have the utmost faith in the work of American railroad engineers, we are inclined to hope, for the sake of the future development of electric traction, that in this case the continental engineers may be a little nearer correct.

COMMENTS BY LOUIS BELL, PH. D.

The experiments at Lockport which Mr. Davis describes are a useful addition to the data of engineering and are well worth critical examination. They are especially interesting from their very wide divergence from the general maps of recent results, and whatever one may conclude as to their accuracy, they show the need of renewed efforts in experimentation along this particular line. On their face they are so ominous as to threaten failure in some of the high-speed enterprises now under way, and hence they ought to be given more than usually careful scrutiny. Approximately, the equations derived by Mr. Davis call for about double the power found to be necessary in most recent investigations. Taken at their face value they show at once the utter futility of trying to run light single cars at high speed, and render it plainly evident that if high speeds are to be attempted commercially, they must be attained with trains, not with single-motor cars. I have long been inclined to the opinion that trains of moderate length were to be preferred for such service, but have hardly been prepared to back my opinions with such a formidable mass of data as are here presented. On Mr. Davis' formula the amount of power required to drive a 45-ton car 100 miles per hour on a perfectly level track in the absence of head wind or enough cross wind to affect the track resistance by flange friction comes out as 1244 net hp actually used in overcoming train resistance. The formula calls for 103.5 lbs. per ton of pure tractive effort. This result needs little comment as to the general impracticability of doing the thing commercially. The results in the preliminary experiments on the Zossen high-speed work indicated less power than this for a 90-ton car at 125 miles per hour; and the Zossen figures were considerably larger than would have been determined from the results obtained by various experimenters in this country. This is a discrepancy so grave as to call for immediate investigation, particularly as the speeds from which Mr. Davis derived his results are well within the range of practice in the near future. They are fortunately also within the range which has been thoroughly covered by experiments upon steam railways, so that data for checking them are immediately available.

In the first place, examine the factors which go to make up Mr. Davis' train resistance. They are three in number —journal friction assumed constant per ton; rail friction assumed to be a linear function of V, and air resistance assumed to be a function in V^2. Now let us first take up the first two factors and examine their competence apart from the third. These elements are taken as independent of the length of train, but their sum varies slightly with the weight of the separate cars, i. e., with the weight per wheel. The net result of these factors is to give at say 60 miles per hour tractive forces varying from 12.8 lbs. to 15.8 lbs. per ton apart from all air resistance. Now, it is not too much to say that this result is directly contradicted by all recent data obtained at such speeds on ordinary railways. It calls for journal and rail friction as great or greater than the total train resistances found experimentally at these speeds by Sinclair, Barnes and Vauclain. All the work done by these authorities showed beyond any chance of dispute that the track and axle resistances are not in excess of 10 lbs. per ton or so at any and all speed yet reached by locomotives. Actual tests by Barnes and Vauclain show that up to about 75 miles per hour, in operating with trains of moderate length, the total train resistances do not exceed those charged by Davis to journal and track resistances alone. Sinclair sets a slightly higher value on air resistance, but even his values show less tractive effort per ton at 100 miles per hour than the present equation for a five-car train of 45-ton cars demands for 75 miles per hour.

One can hardly escape the conclusion that the sum of the two factors in question is very wide of the truth, owing to error in the hypothesis. Steam railroad experience, which is now somewhat extensive, does not support any such values. It rather indicates that the assumptions here made are at fault, for the weight of evidence goes to show that the sum of journal and track resistance is nearly independent of the speed, and is certainly quite as great at low speeds as at those of a mile a minute or so. The alternative is to assume a value of the air resistance far smaller than anything yet proposed.

Now, coming to the question of the air resistance, one again finds values assigned which are considerably at variance with previous figures. The Zossen tests with whirling bodies gave a term in V^2 having a coefficient about one-third of that assumed by Davis from his experiments. The Zossen test body was not, to be sure, a normal plane, but it was not sufficiently modified to account for this difference. The earlier results of Crosby, also with whirling bodies, gave even lower results, 6.5 lbs. per square foot for a normal plane surface at 50 miles per hour, where Davis finds 10 lbs. Again, Sinclair, Barnes and Vauclain, each founding his empirical formula on actual tests at the speeds here involved, reached a linear equation between total resistance and speed. There is certainly no room in their results for a term in V^2, unless with a coefficient so small as to disappear in the necessary errors of experiment. Barnes and Vauclain unite upon a total resistance of almost exactly 20 lbs. per ton at 100 miles per hour, and Sinclair demands 26 lbs., where Mr. Davis wants 42 lbs. per ton for a five-car train and 103.5 lbs. per ton for a single car.

Now, this is a serious matter from every point of view. The discrepancies involved are so large that it is of the utmost importance to investigate the causes that have led to them. One cannot charge them up to experimental errors of one party or the other without further examination. Davis' results are the first which have been published from fast-runing electric trains on a first-class modern track, and thus they are particularly disquieting. A difference of 100 per cent in the tonnage coefficient of such a train and one drawn by steam locomotives in the ordinary manner, if a fact, would be most unpleasant to face. The first point to which investigation should be directed is the abnormal value of track and journal friction obtained in these experiments. It was apparently derived by difference from the coasting experiments and from those to determine the air pressure directly. To tell the truth, I have always looked with great distrust on the coasting method, owing to the involved way in which the losses in the motors and gears enter the results. Even granting that these losses can be determined in the factory for service conditions—which I doubt—the method is still open to the grave objection of involving conditions which are not duplicated when the train is running under full headway. If the motor and gear losses are known with any approach to precision, running tests with a dynamometer between the locomotive and train will come far nearer to giving the practical situation with respect to power required than any calculations made on the assumption that the constants are the same for coasting as for normal running. And, in any event, the nature and amount of the motor losses ought to be most carefully looked into. It has uniformly appeared in tests with electric motor cars that the tonnage coefficient at moderate speeds is very different in the motor cars and the trail cars, even after making the allowance supposedly due to gear friction and the like. Is this difference the same in coasting as in ordinary running, and, in either event, to what is it due? In practice the existence of this difference would be an argument for trains as against single cars, unless investigation shows that the facts can be otherwise explained.

It seems to me that some of the current questions could be best answered by towing trains of various lengths and weights by means of a long wire cable containing a dynamometer. It might be necessary to support the cable by light trucks at one or more intermediate points, but this is not a difficult task, and the result would be free from the errors introduced by motors and gearing. The same device would enable the head air pressure to be determined directly, which it is difficult to do satisfactorily, either by whirling bodies or by the deflecting front shield used by Mr. Davis. The former method is not easy to free from the effects of air currents and eddies, and the latter is open to the serious objection that the center of pressure is not easy to locate on account of the unknown nature of the air streams. It would assuredly have been better to pivot the shield along one vertical edge, instead of along the lower edge, and, better yet, if the shield had been arranged to slip bodily backward on anti-friction rollers. Of course, all this would have increased the difficulty of the experiments somewhat, but their purpose was to secure commercial data, and it certainly is of very great importance to know definitely whether the average train resistance at 100 miles per hour should be taken as 20 lbs. or 40 lbs. per ton. The former figure would indicate certain success in commercial railroading at these very high speeds; the latter verges upon impracticability.

When the preliminary results from the recent tests on the Zossen line are made public some very important light will be thrown on the power required for high-speed electric traction, but in view of Davis' results further experiments are certainly in order. In designing a high-speed system a considerable factor of safety is necessary to provide for slight grades, head winds, or strong side winds that may introduce flange friction. With these elements taken into account the amount of driving power required, on any theory of train resistance, is considerably enhanced. The ordinary data which I have cited on train resistances allow of a reasonable factor of safety without getting dangerously near the impossible at any speeds yet contemplated. With Mr. Davis' values accepted, one gets pretty near the brink at quite moderate speeds, and the outlook is very bad. His results should, therefore, be confirmed or disproved with all possible celerity. It would be bad indeed to order a 1000-hp locomotive for a task where 2000 hp is absolutely necessary, but it would be almost equally exasperating to build a 2000-hp locomotive at great cost of money and trouble in bringing down the weights and keeping up the efficiency when half the power would prove ample for the work. In view of the facts which I have adduced I am rather inclined to hold to the earlier and smaller values of train resistance, but Mr. Davis' results certainly cannot be turned down offhand however widely they may seem to vary from those heretofore accepted. If they prove to be correct, then high-speed electric traction "is an iridescent dream."

H. V. WILLE COMPARES DAVIS AND BALDWIN FORMULÆ

Determining train resistance by calculating the retardation of a train drifting has frequently been used and adversely criticised when the train is hauled by a steam locomotive. Many of these objections, however, are not applicable to such experiments when conducted on electrically driven motors. Aside from this, it is hardly fair to compare the results obtained by Mr. Davis with those obtained on steam roads, for, as he points out, the conditions, such as grade, roadbed and rail, are totally different

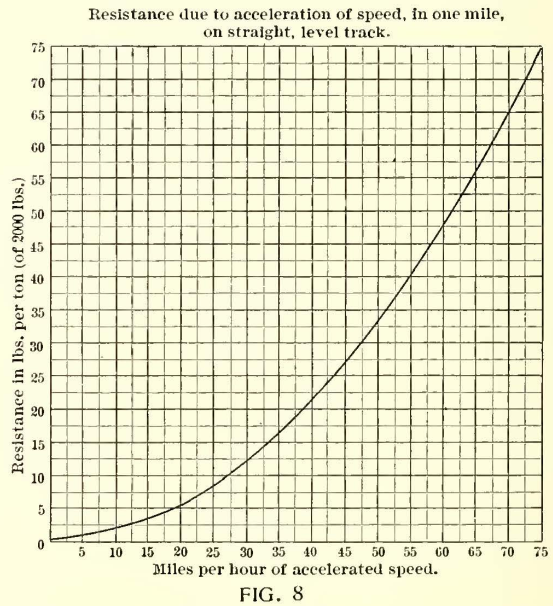


FIG. 8

in the two kinds of service. The chief difference, however, is that the electrically driven trains are of lighter units and is that the electrically driven trains are of lighter units propelled by steam. Mr. Davis points out that the train resistance per ton increases as the weight of the unit and size of the train decreases. It is therefore reasonable to expect that he should obtain a higher value than that usually accepted as standard by steam railroad engineers.

When trains are operated on short headway, and it is necessary to accelerate them to high rates of speed in short distance, the resistance due to acceleration is so large as to mask completely the frictional train resistance. This is clearly shown in Fig. 8. When these facts are considered the formulas check that derived by the Baldwin Locomotive Works very closely. This will be best shown by an illustration, taking the train of five cars of 45 tons each as most closely approximating passenger service on steam railroads:

	Resistance per Ton Davis	Resistance per Ton Baldwin
10 miles	6.	4.5
30 miles	11.	8.
60 miles	23.21	13.
75 miles	24.	15.5

The Baldwin formula, as compared with others suggested, is shown in Fig. 9. The curve actually obtained from the Baldwin experiments was not a straight line, but it so closely approximated one that for convenience of calculation the curve was flattened so as to make a straight line. It will be noticed that Mr. Davis' experiments also

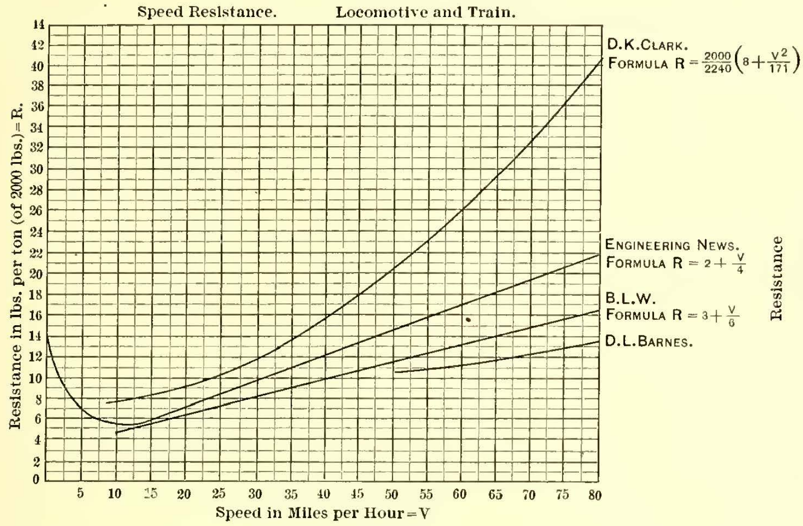


FIG. 9

show that as the number of cars and weight of the unit increase the curve more nearly approaches a straight line.

A Departure in Car Wiring

The Fair Haven & Westville Railroad Company, of New Haven, Conn., has made a departure in car wiring, which is illustrated in the accompanying diagram. As will be seen, the lamps are arranged in groups of four in multiple, instead of having five lamps in series, there being twenty lights in the car.

The arrangement has the advantage that in case a lamp burns out only one light goes out instead of five. The burned-out lamp is, of course, replaced as soon as convenient, but no great harm is done if the lamp is not immediately changed. The arrangement is particularly advantageous when the headlight is on the circuit, as it is not put out by the extinguishment of one of the lamps within the car.

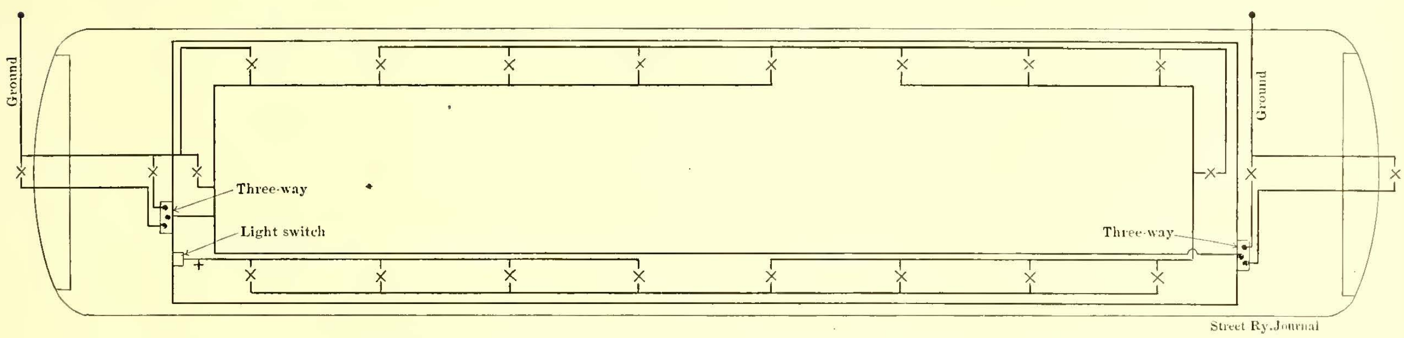


DIAGRAM FOR WIRING CARS WITH LAMPS IN MULTIPLES OF FOUR

Lord Kelvin, the distinguished scientist, who is now in this country, accompanied by Lady Kelvin, visited Buffalo and Niagara Falls on April 26. He made a thorough inspection of the power house of the Niagara Falls Electric Company and expressed himself as being greatly pleased with the improvements that have been made in the plant since his visit in 1897. It was the intention of Lord Kelvin and his party to make a trip over the beautiful Gorge Route while at Niagara.

Motor Troubles and Trolleys

At first thought the connection between motor repairs and the kind of a trolley system used, whether double or single trolley or underground conduit, would seem about as remote as some of the relationships proposed in conundrums. A very practical proposition, however, is suggested by the experiences of the present management of the Cincinnati Traction Company, and it might be presented in the following form:

"Why are motor repairs so low with the double-trolley system?"

W. Kesley Schoepf, president of the Cincinnati Traction Company, and his assistants, Messrs. Todd and Dunning, have had within the last few years extensive experience in operating three distinct kinds of roads in three different cities, namely, an underground conduit road in Washington, a single overhead trolley road at Pittsburgh and a double overhead trolley road at Cincinnati. It has been found that the cost of motor repairs is noticeably less with the overhead double trolley than with either the overhead trolley with ground return or the underground trolley with complete non-grounded circuit. If Mr. Schoepf and his staff were men of less experience in the street railway business, and were not likely to take into account all of the factors, the most plausible explanation of the matter would be that something else than the method of current supply was responsible for the lower motor repairs with the double trolley. However, all possible factors which influence motor repairs are taken into account by the management referred to, and, if anything, conditions are more severe in Cincinnati than in the two other cities as regards the amount of work motors are called upon to do in proportion to their capacity.

Assuming that the method of current supply to the motors by double or single trolley or underground conductor rails is responsible for part of the motor repairs necessary, there are a number of suggested explanations, but the first and most natural that occurs to one is that since the single trolley has a grounded circuit there is a greater strain on the insulation between the windings and motor frames, and that, consequently, more breakdowns of insulation will occur.

This explanation is favored so far as it applies to any differences between a single-trolley system with grounded return circuit and a double-trolley system with neither side grounded. It does not, however, explain why considerable more motor trouble was experienced with the underground double trolley than with the overhead double trolley and even more than with the single trolley. A satisfactory explanation of the unusual amount of trouble on the underground conduit road motors has long been sought. It has been suggested that this trouble was due to the strain on the insulation when the car passes an underground section insulator with the controller turned full on. In such a case the sudden breaking of the circuit causes an inductive "kick" in the field coils at the instant of breaking the circuit. Such a kick, of course, takes place also when the current is shut off at the controller, but it is not so pronounced because there is some reduction of the motive power current by the cutting in of resistance before the final opening of the circuit. It seems most remarkable if the few underground section insulators that may be passed in the course of a trip without shutting off the controller would cause sufficient strain on the insulation perceptibly to influence the cost of motor repairs.

Interurban Railway Development in Western Pennsylvania

BY WILLIAM GILBERT IRWIN

As in ancient days all roads led to Rome, so to-day all interurban roads in Western Pennsylvania lead to Pittsburgh. While the development of electric railway lines in the country districts of Western Pennsylvania may yet be considered in the first stages, enough actual progress has already been made to indicate what the future has in store for this great industrial center in the way of interurban rapid transit. The city of Pittsburgh and its twin sister across the river, Allegheny, to-day possess a population of more than 600,000 souls. Something like 800,000 population is included in the area of the proposed greater Pittsburgh, while within a radius of 10 miles from the court-house in Pittsburgh there dwell over a million people; increase the radius to 25 miles and we have a million and a half people. If we regard the country within a radius of 50 miles of Pittsburgh as the scene of the interurban rapid transit developments in Western Pennsylvania, we will have a population of upward of two and one-half million to be benefited from these transportation facilities; and from this vast population some idea of the prosperity of these lines now in operation can be gleaned. In view of the exceptional opportunities offered for this line of progress here in Western Pennsylvania it is but natural that those interested in electric railway development would center their efforts here; and this is what is now being done, millions of capital being now expended in this important work.

Within easy reach of Pittsburgh, and located in the rich valley of the Ohio, Monongahela, Allegheny, Youghiogheny, Kiskiminetas, Conemaugh, Beaver and Shenango Rivers, are scores of populous industrial communities, these valleys to-day presenting an almost continuous cosmopolitan appearance. While the some 5000 busy mills and factories of Pittsburgh give employment for an army of more than 200,000 workmen, this does not nearly tell the story of the industrial greatness of this district. The unprecedented industrial prosperity of the past three or four years has caused a new order of things in the varied manufacturing lines of the Pittsburgh district, the efforts of the great manufacturing concerns being directed to seeking new manufacturing locations outside of the city, and as a result hundreds of great iron and steel, electrical and various manufacturing concerns are to-day operating in these rich river valleys; hence the necessity of interurban rapid transit lines in Western Pennsylvania, for which no richer field is presented anywhere in this country.

According to the census of 1900, the thirty-three counties of Pennsylvania lying west of the Alleghenies had an aggregate population of 2,600,000, but this is by no means the population reached by the interurban roads of Western Pennsylvania in operation to-day, for these lines now extend well into Eastern Ohio and are reaching out toward West Virginia and Maryland, and eventually such cities as Cleveland, Erie, Wheeling, Columbus, Altoona, Johnstown, Steubenville and Youngstown will be connected in the grand link which is now being woven by the interurban railways of Western Pennsylvania and Eastern Ohio. It is a dream of a not far distant day when a population of five or six million people will be connected in this great electric railway network.

In view of what is to be in the near future in the way of electric railway development in Western Pennsylvania it may be interesting to know the status of this development at the present day and the progress made in recent years.

The report of the Bureau of Railways of Pennsylvania for the year 1887 showed a capital stock outstanding, invested in electric railways in the State, of $17,911,680, while the funded and unfunded indebtedness of such roads was but $7,677,131; the cost of road and equipment, $12,326,068; length of lines, 519.85 miles. This also included the tramways, horse car and cable car lines. In that year these roads carried 184,835,994 passengers; the total expense of maintenance of all the lines in the State was $5,646,606 and the total receipts from all sources were $10,025,905.65. In 1900, thirteen years later, the outstanding capital stock of the electric lines of Pennsylvania was $108,676,774, the outstanding funded debt $44,998,055, current liabilities $14,028,799 and total capitalization $167,703,628. In the latter year the cost of road and equipment was $94,616,247, and in addition to this the electric lines of the State now own bonds and stock to the amount of $54,734,372, and their current liabilities and other assets exceed $20,000,000, making the total of their assets over $170,000,000. The earnings of these lines in 1900 amounted to $27,398,143 and their disbursements $26,042,617. The total length of trackage in 1900 was 2167.91 miles, and in that year these electric lines carried 580,654,629 passengers. The total number of electric cars owned in the State in 1900 was 6,688, and in that year the 15,828 employees were paid in wages $8,745,024.

Between the years 1887 and 1900 there was an increase in trackage of more than 1600 miles, and the increase during the past few years has been nearly 200 miles annually. While these figures are for the entire State of Pennsylvania, they give some idea of electric railway conditions in Western Pennsylvania, where the greater part of these lines are located. To-day the rapid transit lines of Pittsburgh exceed in value those of Philadelphia, and while there has been a considerable interurban development in the vicinity of Philadelphia, this feature of electric railway matters is receiving its greatest development in the western part of the State.

Properly to realize the recent growth of Pittsburgh one must have a good idea of the development of street railway facilities in this city in recent years. In Wilkinsburg, Brushton, Homewood, Rankin and other boroughs which are continuations of the corporate limits of the city a great building boom has followed the extension of the street railways, and no longer we hear the complaint that these suburbs are too far from the business section of the city for business people. What the extension of the street railways has already done for these suburbs this development is now doing for other outlying towns, and in the near future the section for a radius of 50 miles around Pittsburgh will be enjoying the benefit of a cheap and efficient method of travel.

The recent street railway developments in Pittsburgh, whereby the Consolidated Traction Company, the United Traction Company and the Monongahela Street Railway Company, which, together with their accessory properties, included all the street railway lines in Pittsburgh and a number of important interurban lines, has somewhat simplified the matter of interurban railway work in Western Pennsylvania, and an impetus to this development has also been given by this gigantic deal which united these great systems under one head; this new system will henceforth be known as the Pittsburgh Railways Company. This company now controls the entrance to Pittsburgh of the interurban lines, and to-day there are extensive interurban lines operatingout of Pittsburgh in all directions, many of which, although operated under various names, are controlled by the Pittsburgh Railways Company. Especially is this the case with those numerous lines which connect Pittsburgh with the many industrial towns of the Monongahela, Ohio and Allegheny Valleys.

When the Pittsburgh Railways Company was formed by the consolidation of the Monongahela Traction Company, the United Traction Company and the Mellon street railway interests, the numerous interurban lines either operated or under construction by these interests came into possession of the new company. With the Consolidated Traction Company it obtained control of the Citizens' Traction Company, with its connections in Allegheny; the Duquesne Traction Railway Company, which gives an outlet to the Monongahela Valley; the Pittsburgh & Charleroi, another Monongahela Valley line, and the Suburban Rapid Transit Street Railway Company, which has lines extending from Pittsburgh down the Ohio River. Of the subsidiary lines acquired along with the United Traction Company, and which afford important interurban connections, are the East McKeesport Street Railway Company, which extends between McKeesport and Wilmerding; the McKeesport, Wilmerding & Duquesne Street Railway Company, which operated lines in the same locality as the aforementioned road; the Federal Street & Pleasant Valley Passenger Railway Company, an important Allegheny line; the Mt. Troy & Reserve Township Street Railway Company, another Allegheny line; the Southern Traction Company and the West End Traction Company, both of which have lines extending down the Ohio. The Mellon interests acquired lie principally in Pittsburgh, and extend east along the Pennsylvania Railroad and into the Monongahela Valley. The important lines, all feeders to the Monongahela Street Railway Company, are the Wilkinsburg & East Pittsburgh Street Railway Company, the Charleroi & West Side Street Railway Company, the Monongahela City Street Railway Company, the Tarentum Traction Company, the Wilkinsburg & Oakmont Street Railway Company and the Pittsburgh & Birmingham Traction Company. These important lines form the connecting link between the various interurban lines of Western Pennsylvania and the great rapid transit lines of Pittsburgh, and it is only through a working arrangement with the Pittsburgh Railways Company, which now controls these lines, that the interurban lines are able to gain entrance to this great industrial center.

Of the interurban lines of Western Pennsylvania, the most important are grouped in that great system, which is now reaching out to connect Pittsburgh and Cleveland by way of the Ohio, Beaver and Shenango Valleys, and at the same time this system is weaving a network of electric lines over Northwestern Pennsylvania and Eastern Ohio, and Pittsburgh is also to have electric rapid transit communications with Columbus, Steubenville and Wheeling. In this direction there is no great rivalry between the different street railway promoters, which seems to be the case nearly everywhere in Western Pennsylvania, the various interests confining their operations in a particular direction, leaving other fields for their rivals. Thus we see the Mellon interests dominant in the Monongahela Valley, the Consolidated Traction Company formally operating in Pittsburgh and Allegheny and the United Traction Company having a field of its own in Pittsburgh. In this development in the Ohio, Beaver and Shenango Valleys the Beaver Traction Company, in which the Quay interests predominate, has had a pretty clear field. The Pittsburgh Railways Company, through the West End Company (1) lines, operates on the south side of the Ohio as far west as McKees Rocks, with an extension under way to Coraopolis, and which is already in operation to Neville Island (2), some 15 miles down the Ohio from Pittsburgh; and at the same time this company operates branch lines to Sheridan and Crafton and has extended lines to Carnegie. About a year ago the Monaca, Allequippa & Coraopolis Street Railway Company(22)was chartered, and the work of constructing a line between these two points, which will give entrance to Pittsburgh, is now well under way, with a line chartered from Monaca to Hookstown(23). The incorporators of this new line are C. I. McDonald, of Pittsburgh; Herman W. Klein, of Allegheny; Henry Cooper, of Bellevue, and J. C. Whitla and H. T. Dempsey, of Beaver Falls. The line will connect with the Beaver Valley Traction Company's(5)line at Beaver Falls, and by way of New Castle, Lowellsville and Youngstown will reach Cleveland. There is another route by way of Salem, Sebring, Alliance, Ravenna and Kent by which direct connections between Pittsburgh can be secured, the latter being owned by the Everett-Moore interests and the former by the Mahoning Valley Traction Company and allied interests.

On the north side of the Ohio the Pittsburgh Railways Company is operating to Bellevue(3), and lines are proposed(4)to connect with the Beaver Valley Traction Company at Rochester, Pa., which will give another entrance to Pittsburgh for the different Ohio lines which are being extended in this direction. The Beaver Valley Traction Company operates between Rochester, Beaver Falls, Beaver, Mahoningtown and New Castle under various names, and a link known as the Sharon & New Castle Railway Company is about completed between New Castle and Sharon. The property of the Beaver Valley Traction Company consists of Beaver Valley Traction Company(5), the New Castle Traction Company(6)and the Sharon & New Castle Traction Company(7), which lines are now operating, and the following lines under construction: The Wampum & Hoytdale Street Railway Company(8), which is building a line 2½ miles long between Wampum and Hoytdale by way of the Beaver Turnpike; the Hoytdale & Beaver Falls Street Railway Company(9), which is constructing a line five miles long from Hoytdale to Beaver Falls; the Moravia & Wampum Street Railway Company(10), which will build a line from Moravia to Wampum; the Wampum Street Railway Company(11), which will build a short line in the borough of Wampum; the New Castle & Moravia Street Railway Company(12), which will build a line southward from New Castle; the Patterson Heights Street Railway Company and the Riverview Electric Street Railway Company, the latter two companies to build short lines in Beaver Falls.

A Philadelphia syndicate, headed by W. W. Wright, has chartered the following roads in the Beaver Valley: The Beaver & New Brighton Street Railway Company (13), the Beaver Falls & New Brighton Electric Street Railway Company(14), the Freedom & North Rochester Electric Street Railway Company(15), and the Union Electric Street Railway Company(16), which will construct a line from New Brighton to Rochester. The Ellwood City Street Railway Company(17)has been chartered to construct a line in that town in the Beaver Valley, the incorporators being A. W. M. Billings, George Hamilton, A. S. Hunt, W S. Huntley and S. H. Glass, of Pittsburgh. This is known as the Evergreen Street Railway Company, which is to reach many towns in Allegheny, Beaver, Lawrence and Butler Counties.

The Mahoning Valley Railway Company owns the Valley Street Railway Company(18), and the road has been completed between New Castle and Lowellville, which gives this company service between Youngstown and New Castle. The Beaver Valley Traction Company and other interests are making rapid progress south of the Ohio in the connecting link between Pittsburgh, Steubenville and Wheeling. The rapid construction of the Monaca, Allequippa & Coraopolis Street Railway Company's line and the work being done on the lines between Wheeling and Steubenville and between Steubenville and the Pennsylvania-Ohio State line leaves but a small gap in this great system, and this is being rapidly filled. When this scheme was evolved, more than a year ago, 55 miles of the 90 miles of line required to connect Pittsburgh and Wheeling were completed. The Steubenville lines are now pushing east to join the extension of the Beaver Valley Traction Company (21), which will extend to Hookstown, and this will complete the line so far as Western Pennsylvania is concerned.

Last summer improvements made by the Southern Traction Company(1)joined the towns of Sheridan, Crafton, Ingram and Carnegie, and the Pittsburgh Railways Company is extending these improvements. The Carnegie, McDonald & Canonsburg Electric Street Railway Company (24)is now well under construction. This line will connect with the Pittsburgh Railways Company at Carnegie, being an allied concern of which Edward McDonald is president; J. W. Nesbitt, vice-president; R. J. Stoney, Jr., secretary and treasurer, and R. J. Murray, W. J. Cassidy and E. W. Davis the other members of the company. Last July the Canonsburg & Washington Street Railway Company(25)was chartered by L. H. Matthews, G. H. Davis, W.L.Merwin,Charles E.Martin,of Pittsburgh,and Joseph Stewart, of Allegheny, and work is now progressing on this line, which, with the Carnegie, McDonald & Canonsburg line and the Pittsburgh Railways Company, will connect Washington, Pa., with Pittsburgh. This line will connect with the Washington Electric Street Railway Company (26)at Washington and with the West Washington Street Railway Company(27), the North Washington Street Railway Company(28), the East Washington Street Railway Company(29)and the Washington & Oak Grove Street Railway Company(30), which have been chartered by the promoters of the Canonsburg & Washington Street Railway Company. A line has been chartered, the Washington & Brownsville Electric Street Railway Company(31), to connect Washington with Brownsville by way of the old National road.

The first objective points of the lines which now traverse the Monongahela Valley were Homestead and Braddock, the great iron and steel manufacturing towns near Pittsburgh, and the United Traction Company was the first of the Pittsburgh companies to extend their service to these towns. From these towns lines were extended to McKeesport and to East Pittsburgh and Wilmerding, where the Westinghouse interests are located, and from these points the gradual extension of the interurban lines to the Monongahela Valley was made, the Monongahela Traction Company, the principal of the Mellon interests, being a factor in this field. The Monongahela Street Railway Company (32)extends to Braddock and McKeesport by way of Homestead, and a branch, the Monongahela City Street Railway Company(33), extends up to Monongahela as far as Riverview, with a line in operation further up the river. The Pittsburgh & Charleroi Street Railway Company(34) was chartered before the formation of the Pittsburgh Railways Company by the Mellons to build a line to connect Charleroi, on the Monongahela, with Pittsburgh. This line was to enter Pittsburgh by way of Finleyville, Mount Lebanon and thence by the Suburban tracks on South Side, Pittsburgh. In the meanwhile independent interests in which Dr. A. M. Pierce, of Elizabeth, and W. T. Pierce, of McKeesport, were the prime movers had chartered the Elizabeth & Dravosburg Traction Company (35), which will run up the east side of the Monongahela from McKeesport to Elizabeth. Other Monongahela Valley roads under construction, and which were organized by the Mellons before the sale of their street railway interests, are the Rostraver & Monessen Street Railway Company(36), which extends southward from Monessen across the Monongahela to Donora, and the Donora Street Railway Company(37), which latter line will connect Charleroi, Bellevernon, Webster and Donora. Colonel J. M. Schoonmaker and others connected with the Pittsburgh & Lake Erie road of the Vanderbilt system have chartered the Monongahela,Webster,Bellevernon & Fayette City Street Railway Company(38), and the Charleroi & West Side Street Railway Company(39)has chartered a line to connect the towns of Stockdale, Roscoe and Coal Center, while the Brownsville, Bridgeport & West Side Street Railway Company(40)will connect Brownsville with West Brownsville and California. Recently the plan to build a great electric line along the old National Road, which traverses this section, from Columbus, Ohio, to Cumberland and Washington, has received much attention, and numerous charters for this project are now being secured.

The United Traction Company, which now belongs to the Pittsburgh Railways Company, has lines in operation to Homestead, Braddock, McKeesport and Wilmerding, and two lines between McKeesport and Wilmerding(41, 42). The other interurban lines of this system are indicated by(43),(44),(45)and(46)on the accompanying map. The East McKeesport Street Railway Company(34) of this system has the costliest road in the country, being but little over three miles long and costing, exclusive of equipment, more than $300,000. The most difficult engineering features were encountered in building this line, a cut of 60 feet through solid rock being made at one place. The Mellon lines of the Pittsburgh Railways Company operate the Wilkinsburg & East Pittsburgh Street Railway(47) and have several other charters in this direction, namely, the Port Venue & Vankirk Street Railway Company(48), the Wilkinsburg & Turtle Creek Street Railway Company (49)and the Shady Avenue & Homestead Street Railway Company(50).

The Pittsburgh, McKeesport & Connellsville Street Railway Company now forms one of the great interurban systems of Western Pennsylvania, having already absorbed numerous independent street railway interests, and is now taking over other valuable properties. This system was formed in the spring of 1901 by the consolidation of the McKeesport, Wilmerding & Duquesne Railway Company (51), the McKeesport & Youghiogheny Street Railway Company(52), the Versailles Traction Company(53)and the Connellsville & Uniontown Railway Company(54). Since that time the company has purchased the Connellsville Suburban Street Railway Company(55), the Uniontown & Monongahela Valley Electric Railway Company (56), and negotiations have just been closed whereby this system obtains control of the Westmoreland Railway Company, which operates the Greensburg & Westmoreland Street Railway Company line(62)between Greensburg and Irwin, with extensions under way to connect with the Pittsburgh Railways Company lines at Wilmerding. The promoters of the Pittsburgh, McKeesport & Connellsville

Street Railway Company, the great "Coke Belt" line(58), (59),(60)and(61), are Congressman W. H. Graham and George I. Whitney, of Pittsburgh, and a number of New York capitalists. Work is being pushed to close up the gaps between the various parts of the system now in operation, and the entire line will be in operation within six months. The line extends into the Connellsville coke region by the "Yough" Valley, West Newton, Scottdale, Connellsville and Uniontown, and the recent purchases of properties in Westmoreland County will complete the loop for a return system by Greensburg, Irwin and Wilmerding. An independent company of Greensburg and McKeesport capitalists have chartered the McKeesport & Greensburg Street Railway Company(63), which will connect the towns of McKeesport and Greensburg, paralleling the Greensburg & Westmoreland Street Railway Company line from Greensburg to Irwin, and from that point continuing along the south side of the Pennsylvania road, while the present line follows the north side. The Pittsburgh, McKeesport & Connellsville road will run a line(64)from the Greensburg & Westmoreland Street Railway Company line at Irwin southward to Edna, Herminie and other mining towns.

The Greensburg & Southern Trolley Company(65), which has just been acquired by the Pittsburgh, McKeesport & Connellsville Street Railway Company, has chartered four lines in addition to the main one from Greensburg to Youngwood and Mt. Pleasant—one from Greensburg to Latrobe(66)along the old turnpike, one from Greensburg to New Alexander(67), one from Greensburg into the coke regions to Mammoth and Hecla(68) and one to run westward from Greensburg through Ludwick. The Latrobe Street Railway Company(69)has a line nearly completed between Latrobe and Youngstown, and this line will be extended into the southern Latrobe coal and coking fields. The Mellon interests have chartered the Ligonier & Chestnut Ridge Street Railway Company(70) to build a line 10 miles long between Latrobe and Ligonier.

Another system of interurban lines out of Pittsburgh traverses the Allegheny and Kiskiminetas Valleys, a number of interests being at work in the field. Through the Allegheny Traction Company's Millvale, Etna & Sharpsburg Street Railway Company line(71)the Pittsburgh Railways Company now operates on the north side of the Allegheny through Millvale to Sharpsburg, and is extending its line up the Allegheny. Through the Butler Street line(72)of the United Traction Company the Pittsburgh Railways Company also operates to Sharpsburg and Aspinwall. The Mellon interests began the erection of the Wilkinsburg & Oakmont Street Railway Company line(73)last summer, and this line is now ready for traffic between Oakmont and Wilkinsburg, thus forming a new line connecting the Allegheny Valley with Pittsburgh. This line connects the towns of Hulton, Verona, Sandy Creek and Wildwood. For some time a line has been in operation between Natrona and Hite(74), a distance of five miles, being owned by B. Rafferty, Horace Dravo, Julian Kennedy and other of the Mellon interests, and as this property is now in possession of the Pittsburgh Railways Company the nucleus for the further extension of electric lines in the Allegheny Valley is had.

The Leechburg, Freeport & Tarentum Street Railway Company(75)has been under construction for some time. The Kittanning & Ford City Street Railway Company(76) is building a line between Kittanning and Ford City, the Kittanning & Leechburg Street Railway Company(77) has been chartered to build a line to connect Kittanning with Leechburg, and the Kittanning & Cowanshonock Street Railway Company(78)has been chartered to build a line northward along the Allegheny River from Kittanning. The Bradys Bend & Pittsburgh Street Railway Company (79)is building a line southward from Bradys Bend, and this will eventually connect with the line building northward from Kittanning. The Apollo, Vandergrift & Leechburg(80)Street Railway Company is building a line between Apollo and Leechburg along the Kiskiminetas which will connect with the Leechburg, Freeport & Tarentum and thus give that section rapid transit connections with Pittsburgh.

The Butler Passenger Railway Company(81)will be connected with the Allegheny by a proposed line to Butler Junction(82), and a line has been proposed to connect with the Pittsburgh Railways Company in Lower Allegheny(82). The work of connecting the Franklin Electric Street Railway Company(83)and the Citizens' Traction Company(84), of Oil City, has been completed, and cars are now running over this connection line(85)between these two towns. The French Creek Street Railway Company(86)will build a line toward Meadville. The Oil City Station Railway Company(87)and the Oil City Street Railway Company (88)are two other lines in operation in that town with interurban lines under consideration. The Petroleum Street Railway Company is building a line 8½ miles long northward along the Allegheny River. The Titusville Electric Traction Company(89)will probably be connected with Oil City by a proposed line(90). The Warren Street Railway Company(91)now connects with several nearby towns, and the Bradford Street Railway Company (92) has similar connections.

A line is building, the Sharon Street Railway Company (93), to connect Sharon with Meadville by way of Greenville and Conneaut Lake with a line from Meadville to Andover, Ohio(94). Local capitalists have chartered a line from Mercer to Sharon(95), and connections with this line from Franklin to Mercer(96)will bring Oil City and Mercer into connection with Pittsburgh through the Beaver Valley lines. The Meadville Traction Company(97)operates to a number of nearby towns, and the Meadville & Interurban Street Railway Company(98)will connect Meadville with Conneaut Lake, while another branch of this company will run up Oil Creek to Saegertown(99)and eventually to Erie(100). The Erie Electric Traction Company (103)at present connects with nearby towns, as does the Erie Motor Company(101), and recently a line has been chartered from Erie to the Ohio State line, the Conneaut & Erie Traction Company(102). This line will run through Mill Creek, Fairview and Girard, and at Conneaut will connect with the Pennsylvania & Ohio Company, which is building a line along the lake shore to Cleveland. In the Upper Allegheny Valley, the Olean, Rock City & Bradford Passenger Railway Company(150)connects a number of Northern Pennsylvania towns and extends into New York.

The DuBois Traction Company(104)is operating a line at DuBois, in Clearfield County, which connects with a number of mining towns, and the Punxsatawney Passenger Railway Company(105)also operates to adjoining mining towns. The Citizens' Clearfield & Cambria Traction Company (106), owned by the Union Traction Company, of Philadelphia, has a line in operation at Clearfield, with proposed lines to connect with Ebensburg(107)and Johnstown(108). The Johnstown Passenger Railway Company (109) operates in Johnstown and to Conemaugh and other points up the Conemaugh Valley, and the Conemaugh Valley Street Railway Company(110)will build a line from Ebensburg to Johnstown by way of Summer Hill, Wilmore and South Fork. The Johnstown Passenger Railway Company has also opened a line(111)between Johnstown and Windber, the great coal mining town of the Berwind

White Coal Mining Company, and it has a proposed line (112) along the Somerset and Cambria branch of the Baltimore & Ohio road toward Somerset. The Somerset County Street Railway Company (113) has been chartered by George R. Scull and other Somerset capitalists to build a line to connect Somerset with nearby towns, and the Myersdale & Salsbury Railway Company (114) is building a line between Myersdale and Salsbury, in Somerset County, in which T. H. Nelson, of Chambersburg; George E. Parker and J. S. McFerren, of Pittsburgh, are interested.

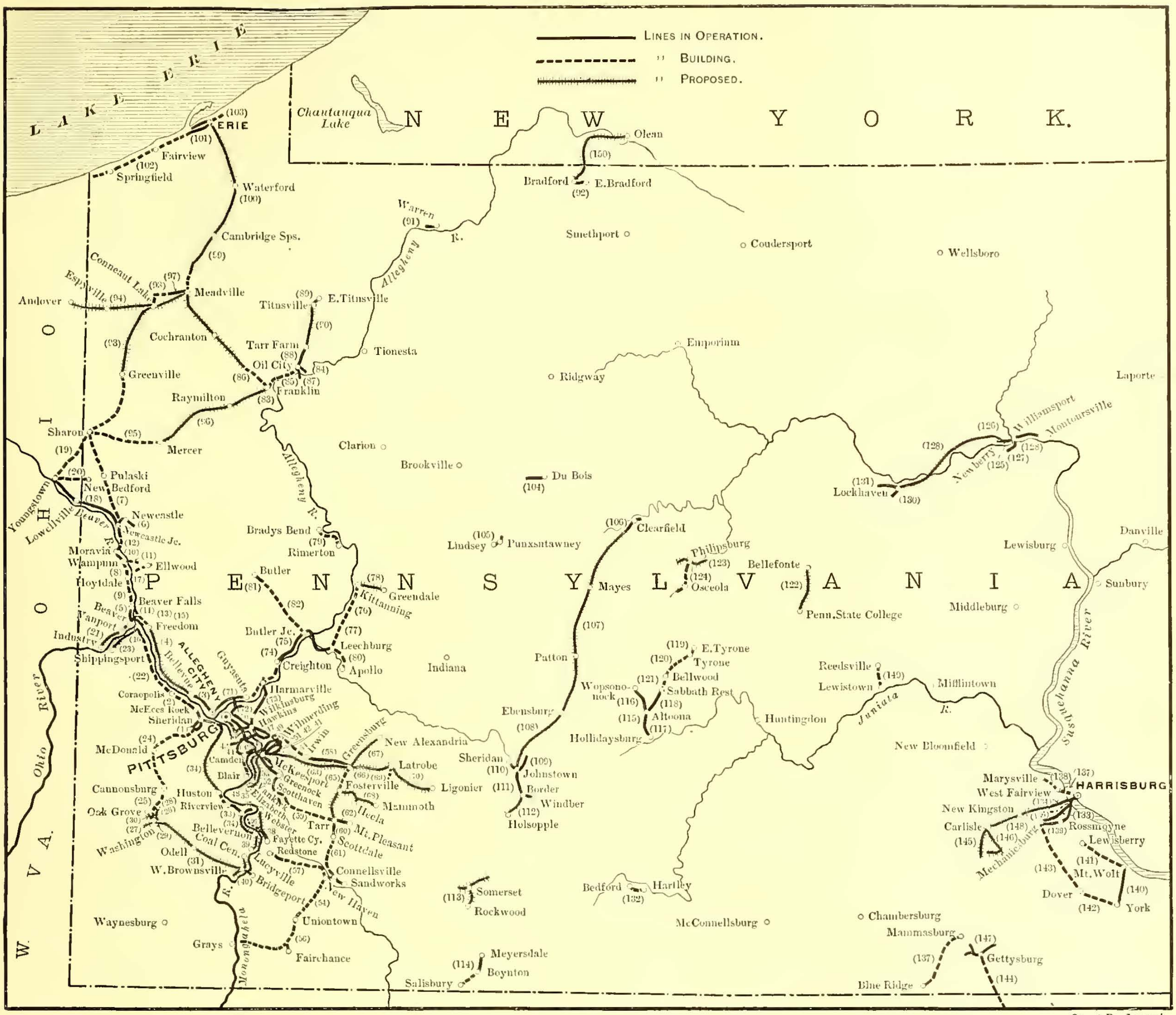
The Citizens' Passenger Railway Company (115) has been operating in Altoona for some years, and now has a line to Woopsononock (116), and is interested in the Altoona & Logans Valley Electric Railway Company (117). The Belt Line Extension Railway Company (118) was chartered about a year ago and will operate out of Altoona. The Tyrone Street Railway Company (119) is building a line 10 miles long toward Altoona, and the Tyrone & Bellwood Electric Railway Company (120) will connect Tyrone and Bellwood, while proposed lines from Altoona (121) will connect Altoona and Tyrone by way of Bellwood. The Bellefonte Electric Railway Company (122), in which E. A. Tennis and S. L. Hibbard, the well-known New York street railway magnates, are interested, will connect Bellefonte and State College. The Phillipsburg Electric Railway Company (123) and the Center & Clearfield Street Railway Company (124) are being constructed in Center and Clearfield Counties.

The Williamsport Passenger Railway Company (125), the East End Passenger Railway Company (126), the South Side Passenger Railway Company (127), the Vallemont Traction Company (128) and the Williamsport & Lock Haven Street Railway Company (129) are largely owned by Senator J. H. Cochran and his associates of Williamsport, who are interested in numerous steam and electric railway enterprises. The Lock Haven Traction Company (130) has interurban connections (131), and there is a proposed line (132) to connect Bedford with Bedford Springs, the well-known summer resort, in Bedford County. Most of the other electric railway lines west of the Susquehanna are those connected with the system which traverses Dauphin, York, Adams, Cumberland, Mifflin, Franklin, Perry and Juniata Counties, which system largely emanates from Harrisburg.

The nucleus of these lines is the Harrisburg Traction Company, which operates in Harrisburg. The lines of this system which have interurban connections are the following: The Harrisburg & Mechanicsburg Electric Railway Company (133), the Lancaster & Mechanicsburg Street Railway Company (134), the Dauphin Street Railway Company (135), the Hummelstown Street Railway Company (not shown because east of Harrisburg), the Camp Hill & Harrisburg Passenger Railway Company (136) and the Blue Ridge & Linglestown Electric Railway Company (137). The Star Street Railway, of Mechanicsburg, is the nucleus of another system which has interurban connections with the West Fairview & Marysville Street Railway Company (138) and the Eastern Traction Company (139). The York Street Railway Company controls the York County Traction Company (140), a line to Lewisbury (141), and the York & Dover Trolley Company (142). The Mechanicsburg & Dover Electric Railway (143) is under construction, and the Baltimore, Westminster & Gettysburg Electric Railway Company (144) will eventually reach as far north as Harrisburg. The Carlisle & Mt. Holly Electric Railway Company (145) is building a line to Mt. Holly, and the Mt. Holly & Boiling Springs Street Railway Company (146) has been chartered. The Gettysburg Transit Company (147) has been chartered, and the Cumberland Valley Street Railway Company (148) extends east of the Susquehanna. The Lewistown & Reedsville Electric Railway Company (149) will connect Lewistown with Reedsville when completed. In the northern part of the State the Olean, Rock City & Bradford Street Railway Company (150) is now at work on a line which is destined to become the nucleus of an extensive interurban system, and which will eventually connect a number of Northern Pennsylvania and Western New York towns.

Following is a list of the companies, systems and branches included in this scheme of development, numbering 150 in all, and indicated by numbers, which afford a key to locate them in the map on the opposite page:

No. 1. West End Traction Co. line of Pittsburgh Railways Co.
No. 2. Extension of Pittsburgh Railways Co. lines to Coraopolis from McKees Rocks.
No. 3. Pittsburgh Railways Co. line through Allegheny to Bellevue.
No. 4. Proposed Pittsburgh Railways Co. line from Bellevue to Freedom.
No. 5. Beaver Valley Traction Co.
No. 6. New Castle Traction Co., owned by the Beaver Valley Traction Co.
No. 7. Sharon & Newcastle Traction Co., owned by the Beaver Valley Traction Co.
No. 8. Wampum & Hoytdale Street Railway Co., owned by the Beaver Valley Traction Co.
No. 9. Hoytdale & Beaver Falls Street Railway Co., owned by the Beaver Valley Traction Co
No. 10. Moravia & Wampum Street Railway Co., owned by the Beaver Valley Traction Co
No. 11. Wampum Street Railway Co., owned by the Beaver Valley Traction Co.
No. 12. New Castle & Moravia Street Railway Co., owned by the Beaver Valley Traction Co.
No. 13. Beaver & New Brighton Street Railway Co., Wright Syndicate.
No. 14. Beaver Falls & New Brighton Electric Street Railway Co., Wright Syndicate.
No. 15. Freedom & North Rochester Electric Street Railway Co., Wright Syndicate.
No. 16. Union Electric Street Railway Co., New Brighton to Rochester, Wright Syndicate.
No. 17. Ellwood City Street Railway Co., a local company.
No. 18. Valley Street Railway Co., owned by Mahoning Valley Railway Co.
No. 19. Mahoning Valley Railway Co., Youngstown & Sharon Street Railway Co.
No. 20. Mahoning Valley Railway Co., New Bedford & State Line Street Railway Co.
No. 21. Western Extension of the Beaver Valley Traction Co. lines.
No. 22. Allequippa & Coraopolis Street Railway Co.
No. 23. Allequippa & Coraopolis Street Railway Co., extension west from Monaca.
No. 24. Carnegie, McDonald & Canonsburg Street Railway Co.
No. 25. Canonsburg & Washington Street Railway Co.
No. 26. Washington Electric Street Railway Co.
No. 27. West Washington Street Railway Co.
No. 28. North Washington Street Railway Co.
No. 29. East Washington Street Railway Co.
No. 30. Washington & Oak Grove Street Railway Co.
No. 31. Washington & Brownsville Electric Street Railway Co., over the old National road.
No. 32. Monongahela Street Railway Co., Mellons, now owned by Pittsburgh Railways Co.
No. 33. Monongahela City Street Railway Co., Mellons, now owned by Pittsburgh Railways Co.
No. 34. Pittsburgh & Charleroi Street Railway Co., Mellons, now owned by Pittsburgh Railways Co.
No. 35. Elizabeth & Dravosburg Traction Co., Dr. Pierce and other.
No. 36. Rostraver & Monessen Street Railway Co., Mellons.
No. 37. Donora Street Railway Co., Mellons.
No. 38. Monongahela, Webster, Bellevernon & Fayette City Street Railway Co., Col. Schoonmaker.
No. 39. Charleroi & West Side Street Railway Co., Col. Schoonmaker.
No. 40. Brownsville, Bridgeport & West Side Street Railway Co., local interests.



MAP SHOWING DEVELOPMENT OF INTERURBAN RAILWAYS IN WESTERN PENNSYLVANIA

No. 41. East McKeesport line of United Traction Co., Pittsburgh Railways Co.
No. 42. McKeesport & Wilmerding line of United Traction Co., Pittsburgh Railways Co.
No. 43. Interurban lines of United Traction Co., Pittsburgh Railways Co.
No. 44. Interurban lines of United Traction Co., Pittsburgh Railways Co.
No. 45. Interurban lines of United Traction Co., Pittsburgh Railways Co.
No. 46. Interurban lines of United Traction Co., Pittsburgh Railways Co.
No. 47. Wilkinsburg & East Pittsburg Street Railway Co., Mellons, Pittsburgh Railways Co.
No. 48. Port Venue & Van Kirk Street Railway Co., Mellons, Pittsburgh Railways Co.
No. 49. Wilkinsburg & Turtle Creek Street Railway Co., Mellons, Pittsburgh Railways Co.
No. 50. Shady Avenue & Homestead Street Railway Co., Mellons, Pittsburgh Railways Co.
No. 51. McKeesport, Wilmerding & Duquesne Railway Co., Pittsburgh, McKeesport & Connellsville.
No. 52. McKeesport & Youghiogheny Street Railway Co., Pittsburgh, McKeesport & Connellsville.
No. 53. Versailles Traction Co., Pittsburgh, McKeesport & Connellsville.
No. 54. Connellsville & Uniontown Railway Co.. Pittsburgh, McKeesport & Connellsville.
No. 55. Connellsville Suburban Street Railway Co., Pittsburgh, McKeesport & Connellsville.
No. 56. Uniontown & Monongahela Valley Electric Railway Co., Pittsburgh, McKeesport & Connellsville.
No. 57. Line from Connellsville, via Broadford, Vanderbilt, etc., to Fayette City, Pittsburgh, McKeesport & Connellsville.
No. 58. Pittsburgh, McKeesport & Connellsville Street Railway.
No. 59. Pittsburgh, McKeesport & Connellsville Street Railway, Mount Pleasant Division.
No. 60. Pittsburgh, McKeesport & Connellsville Street Railway, Scottdale Division.
No. 61. Pittsburgh, McKeesport & Connellsville Street Railway, Connellsville Division.
No. 62. Greensburg & Westmoreland Street Railway Co., of Westmoreland Traction Co., Pittsburgh, McKeesport & Connellsville.
No. 63. Greensburg & McKeesport Street Railway Co., independent line.
No. 64. Extension of Greensburg & Westmoreland Traction Co. line by Pittsburgh, McKeesport & Connellsville.
No. 65. Greensburg Southern Trolley Co.
No. 66. Extension of Greensburg Southern lines from Greensburg to Latrobe, Pittsburgh, McKeesport & Connellsville.
No. 67. Extension of Greensburg Southern lines from Greensburg to New Alexander, Pittsburgh, McKeesport & Connellsville.
No. 68. Extension of Greensburg Southern lines from Greensburg to Mammoth and Hecla, Pittsburgh, McKeesport & Connellsville.
No. 69. Latrobe Street Railway Co., owned by local people.
No. 70. Ligonier & Chestnut Ridge Street Railway Co., chartered by the Mellons, of Pittsburgh.
No. 71. Consolidated Traction Co. from Allegheny up Allegheny River, Pittsburgh Railways Co.
No. 72. Butler Street line of United Traction Co., Pittsburgh Railways Co.

No. 73. Wilkinsburg & Oakmont, to run to New Kensington, Pittsburgh Railways Co., formerly a Mellon line.
No. 74. Line from Katrona to Hite in operation, Mellon, now Pittsburgh Railways Co.
No. 75. Leechburg, Freeport & Tarentum Street Railway Co., Mellon, now Pittsburgh Railways Co.
No. 76. Kittanning & Ford City Street Railway Co., local capitalists interested.
No. 77. Kittanning & Leechburg Street Railway Co., local capitalists interested.
No. 78. Kittanning & Cowanshonock Street Railway Co., local capitalists interested.
No. 79. Brady's Bend & Pittsburgh Street Railway Co., New York capitalists.
No. 80. Apollo, Vandergrift & Leechburg Street Railway Co., local capitalists.
No. 81. Butler Passenger Railway Co.
No. 82. Butler Passenger Railway Co., extension.
No. 83. Franklin Electric Street Railway Co.
No. 84. Oil Traction, of Oil City.
No. 85. Oil Traction, of Oil City, connecting line with Franklin Electric Street Railway line.
No. 86. French Creek Street Railway Co., chartered and line building.
No. 87. Station Railway Co., of Oil City.
No. 88. Oil City Street Railway Co.
No. 89. Titusville Electric Traction Co.
No. 90. Titusville Electric Traction Co. proposed line to Oil City.
No. 91. Warren Street Railway Co.
No. 92. Bradford Street Railway Co.
No. 93. Sharon Street Railway Co., to run to Meadville by Greenville.
No. 94. Line from Andover, Ohio, to Meadville, Pa.
No. 95. Line from Mercer to Sharon, chartered by local capitalist.
No. 96. Line from Franklin to Mercer, chartered by local capitalist.
No. 97. Meadville Traction Co.
No. 98. Interurban Street Railway Co., of Meadville, to connect Meadville and Lake Conneaut.
No. 99. Interurban Street Railway Co., branch to run up French Creek to Saegertown.
No. 100. Interurban Street Railway Co., branch to Erie.
No. 101. Erie Motor Co.
No. 102. Conneaut & Erie Traction Co., Erie to Pennsylvania-Ohio State line.
No. 103. Erie Electric Traction Co.
No. 104. Dubois Traction Co.
No. 105. Punxatawney Passenger Railway Co.
No. 106. Citizens' Clearfield & Cambria Traction Co., owned by Union Traction Co., of Philadelphia.
No. 107. Citizens' Clearfield & Cambria Traction Co, proposed line.
No. 108. Citizens' Clearfield & Cambria Traction Co., proposed line.
No. 109. Johnstown Passenger Railway Co.
No. 110. Conemaugh Valley Street Railway Co.
No. 111. Johnstown & Windber line of Johnstown Passenger Railway Co.
No. 112. Proposed line of Johnstown Passenger Railway Co.
No. 113. Somerset County Street Railway Co.
No. 114. Myersdale & Salsbury Railway Co.
No. 115. Citizens' Passenger Railway Co., of Altoona.
No. 116. Citizens' Passenger Railway Co., of Altoona, branch line.
No. 117. Altoona & Logans Valley Electric Railway Co.
No. 118. Belt Line Extension Railway Co., of Altoona.
No. 119. Tyrone Street Railway Co.
No. 120. Tyrone & Bellwood Electric Railway Co.
No. 121. Proposed line of the Altoona Belt Line Extension Railway Co.
No. 122. Bellefonte Electric Railway Co., E. A. Tennis and others, of New York.
No. 123. Phillipsburg Electric Railway Co.
No. 124. Center & Clearfield Street Railway Co.
No. 125. Williamsport Passenger Railway Co., Senator J. H. Cochran and others, of Williamsport.
No. 126. East End Passenger Railway Co., of Williamsport, Senator J. H. Cochran and others, of Williamsport.
No. 127. South Side Passenger Railway Co., of Williamsport, Senator J. H. Cochran and others, of Williamsport.
No. 128. Vallemont Traction Co., of Williamsport, Senator J. H. Cochran and others, of Williamsport.
No. 129. Williamsport & Lock Haven Traction Co., Senator J. H. Cochran and others, of Williamsport.
No. 130. Lock Haven Traction Co.
No. 131. Lock Haven Traction Co., interurban line.
No. 132. Bedford to Bedford Springs.
No. 133. Harrisburg & Mechanicsburg Electric Railway Co., controlled by Harrisburg Traction Co.
No. 134. Lancaster & Mechanicsburg Street Railway Co., controlled by Harrisburg Traction Co.
No. 135. Dauphin Street Railway Co., controlled by Harrisburg Traction Co.
No. 136. Camp Hill & Harrisburg Passenger Railway Co., controlled by Harrisburg Traction Co.
No. 137. Blue Ridge & Linglestown Electric Railway Co., controlled by Harrisburg Traction Co.
No. 138. West Fairview & Marysville, controlled by Star Street Railway Co., of Mechanicsburg.
No. 139. Eastern Traction Co., controlled by Star Street Railway Co., of Mechanicsburg.
No. 140. York County Traction Co., controlled by York Street Railway Co.
No. 141. A line to Lewisbury, controlled by York Street Railway Co.
No. 142. York & Dover Trolley Co.
No. 143. Mechanicsburg & Dover line under construction.
No. 144. Baltimore, Westminster & Gettysburg Electric Railway Co.
No. 145. Carlisle & Mount Holly Electric Railway Co.
No. 146. Mount Holly & Boiling Springs Street Railway Co.
No. 147. Gettysburg Transit Co.
No. 148. Cumberland Valley Street Railway Co.
No. 149. Lewistown & Reedsville Electric Railway Co., connects Lewistown and Reedsville.
No. 150. Olean, Rock City & Bradford Street Railway Co.

General Electric Report

The General Electric Company's tenth annual report for the year ended Jan. 31 shows profits, including $938,585 from the sale of securities, after deducting all general, patent and miscellaneous expenses, expenditures of $1,131,584 on factory plants and machinery and allowances for depreciation and losses, to have been $8,598,241. Deducting $1,997,966 for dividends on the preferred and common stock and interest on debentures, and adding $2,057,685 for increase in the value of stocks and bonds owned by the company, the sum added to surplus account is found to be $8,657,960. The balance sheet of Jan. 31, 1902, follows:

ASSETS

Cash			$4,058,448.00
Stocks and bonds		$9,825,120.93	
Real estate (other than factory plants)		464,195.68	
Notes and accounts receivable		11,364,345.05	
Work in progress		1,338,258.93	
Total		$22,991,920.59	
Merchandise inventories:			
At factories	$7,742,605.55		
At general and local offices	1,037,968.16		
Consignments	96,309.47		
Total		$8,876,883.18	
			31,868,803.77
Factory plants		$4,000,000.00	
Patents, franchises and good will		2,000,000.00	
			6,000,000.00
Total			$41,927,251.77

LIABILITIES

Five per cent gold coupon debentures	$372,000.00	
Accrued interest on debentures	3,100.00	
Accounts payable	1,349,335.33	
Unclaimed dividends	4,775.79	
		$1,729,211.12
Capital stock		24,910,900.00
Surplus		15,287,140.65
Total		$41,927,251.77

Some idea of the magnitude of the business transacted may be gained from the statement that about 160,000 separate orders were received during the year, not including contracts, an average of 528 per day. An interesting statement is herewith reproduced, showing the orders for the last eight years and the amounts billed to customers as follows:

Year Ended Jan. 31	Amounts Billed	Orders Received
1895	$12,540,395	$12,160,119
1896	12,730,058	13,235,016
1897	12,540,994	11,170,319
1898	12,396,093	14,382,342
1899	15,679,430	17,431,327
1900	22,379,463	26,323,626
1901	28,783,275	27,969,541
1902	32,338,036	34,350,840

The orders received during the year under consideration call for generators and converters aggregating 350,000-kw capacity, transformers 200,000-kw, and railway motors 450,000-kw. The last-mentioned item includes 1800 motors of 125 hp each for the Manhattan Elevated system, with controllers. In the foreign department, the sale is reported of the entire equipment for the Tokyo (Japan) system, including 3600 kw in generators, 250 car equipments and all accessory apparatus, making the largest electric plant in Asia. Another notable installation is the transformation of a steam road into an electric system, requiring 3000 hp of generators, 4700 hp of rotary converters and 12,800 hp of railway motors. This road, now being operated by steam, will connect Milan, Gallarate and Varese, Italy.

The phenomenal growth in the company's business has made necessary many additions and extensions to the old plants. To increase the manufacturing capacity, 186 acres of land have been purchased during the year, and the extensions now under way will add nearly half a million square feet to the available floor space. An expenditure of $1,500,000 for buildings and machinery has been entailed by these improvements. At the Schenectady works, the pattern shop of 52,000 sq. ft. and the additions of 70,000 sq. ft. to the machine shops have been completed. Buildings for the manufacture of wire and cable and insulating materials, of 180,000 sq. ft.; a machine shop for large work, of 117,000 sq. ft.; a building of 60,000 sq. ft. for manufacturing switches, controllers and other small articles and an addition of 13,000 sq. ft. to the testing shop are now under way.

The building now used for general offices at Schenectady was originally designed for manufacturing purposes, and when the new office building, which has been under construction for the last year, is completed the present building will be utilized for manufacturing, adding about 40,000 sq. ft. An extension is being made to the shipping department of 30,000 sq. ft., and a new power house will add 6000 hp to the present equipment. At the Lynn works, the machine shop and testing facilities were increased by the addition of a building having 25,000 sq. ft. of floor space; substantial additions were made to the power plant, and plans are now being prepared for a building of 55,000 sq. ft. floor area for the manufacture of meters and instruments. At the Harrison works, the fireproof storage building of 68,000 sq. ft. area was completed last summer, and plans are being prepared for further substantial additions to take care of the increased sales of incandescent lamps.

The floor area of all factory buildings is approximately 2,500,000 sq. ft., which will be increased this year about 400,000 sq. ft. by the buildings now under construction. The erection by the British Thomson-Houston Company of large works at Rugby, England, will relieve the pressure on the American manufacturing facilities, as the British company has hitherto been principally supplied by the works in this country.

The advancement in the street railway field is particularly noticeable, and is the subject of extended comments in the report.

"There has been a notable increase in the mileage and importance of electric railways, due to the consolidation of adjoining systems and the development of high-speed interurban lines. Steam railroad managers are showing more interest in electric traction, and our engineers have carefully studied the problems presented by large terminals and heavy traffic conditions.

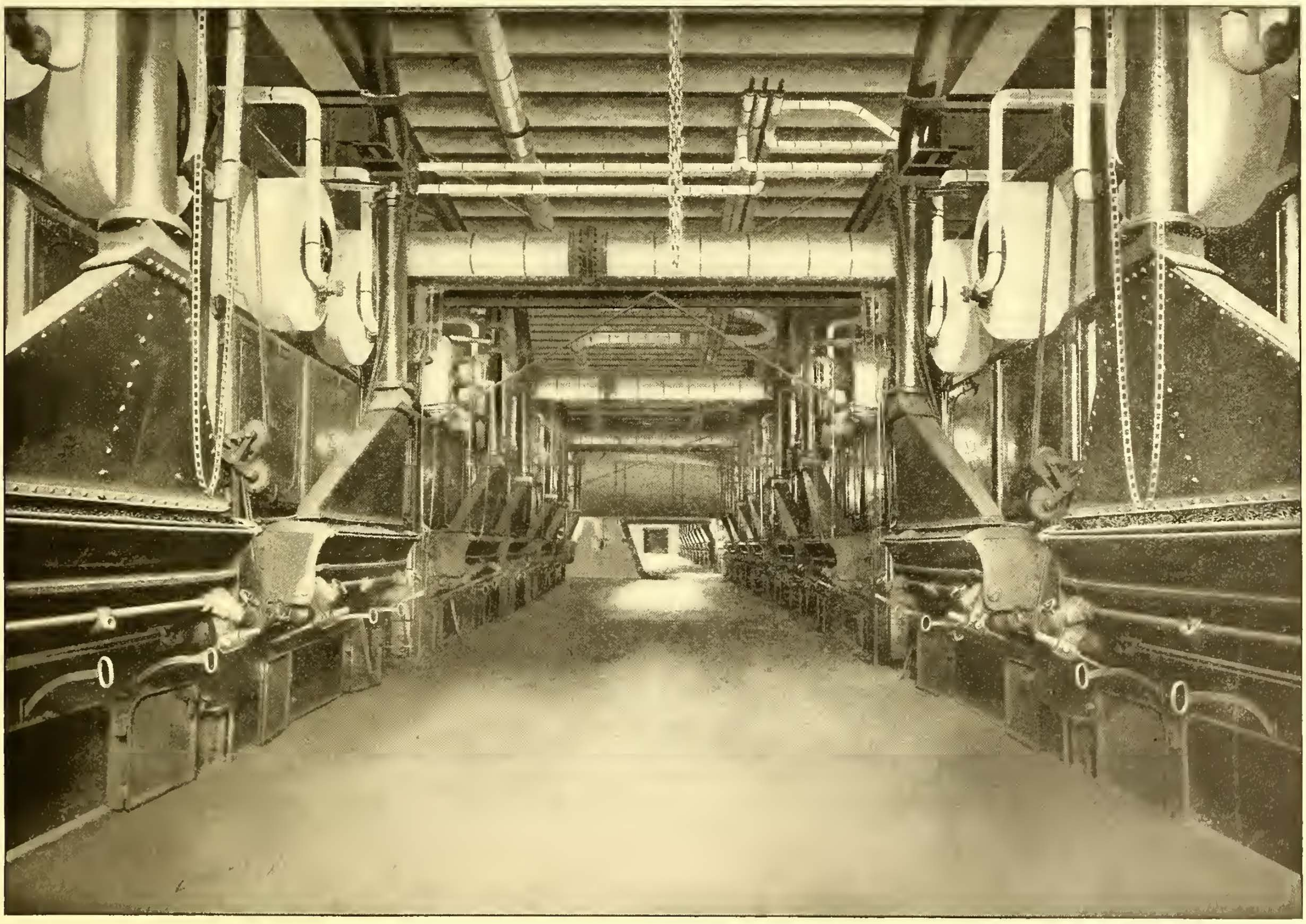
"We have so perfected the methods of collecting current, controlling motors and transmitting the electric current that we see no serious engineering obstacle to the displacement of steam locomotives on many existing steam railroads where the conditions of traffic show the electric system to be economical.

"That electricity is thoroughly reliable and entirely able to handle heavy passenger traffic with success has been amply demonstrated by many installations in regular operation for several years."

The report also calls attention to the increasing demand for electric locomotives.

Firing the Metropolitan Company's Power Plant

The Metropolitan Street Railway Company, of New York, has established a small laboratory in connection with its operating department, and one of the purposes of this branch is the collection of data relating to the steam plant, to determine the efficiency of the stoker department and the relative values of several grades of coal. These investigations have been particularly directed toward the work of the Ninety-Sixth Street station, which enjoys the distinction of being the largest electrical street railway power plant in the world in actual operation at the present time. The magnitude of the enterprise, however, is not its most interesting nor its most important feature. The entire system of the Metropolitan Company presents an interesting study for engineers and managers of large power plants and street railway properties, but in no department

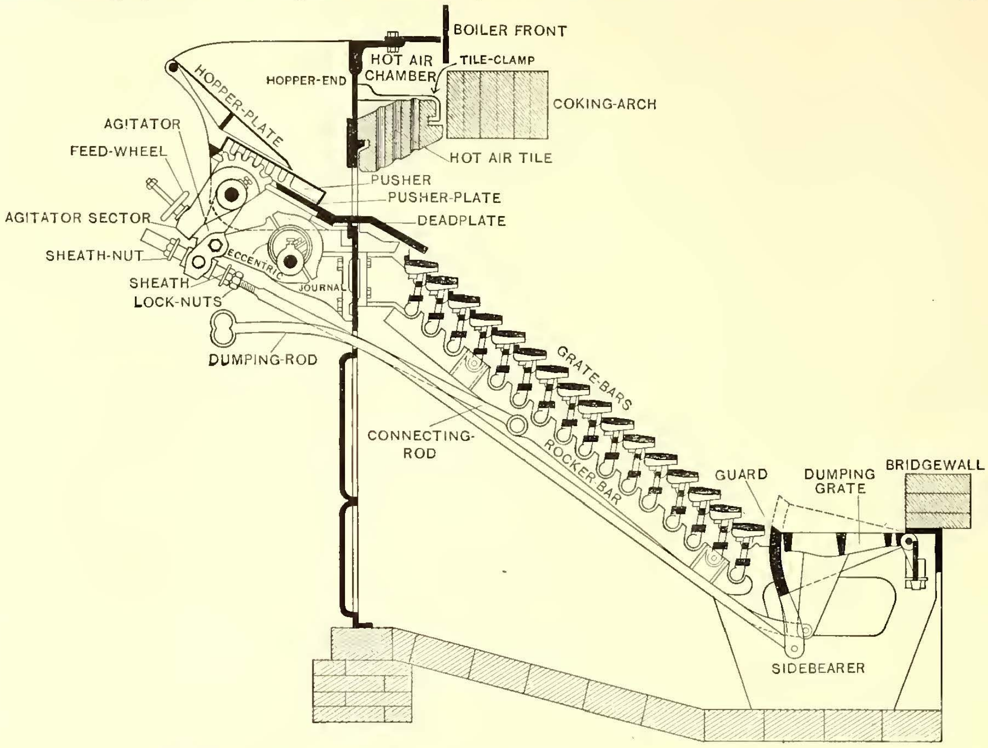


BOILER ROOM OF METROPOLITAN STREET RAILWAY COMPANY, NINETY-SIXTH STREET POWER HOUSE is there greater opportunity for experimental investigation than in the steam plant, where the highest type of mechanical equipment is employed throughout.

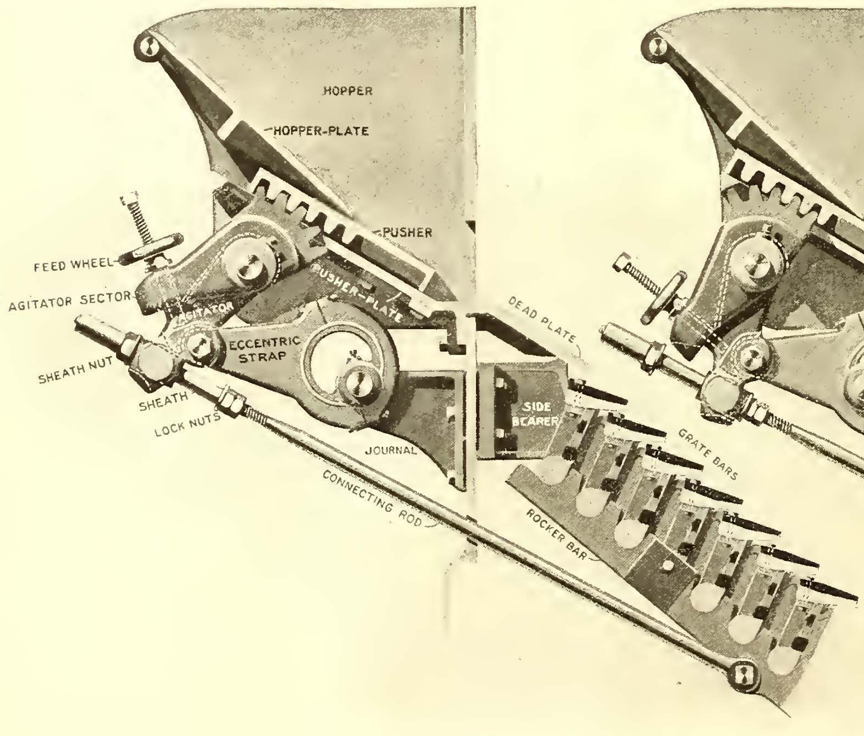
The steam plant contains eighty boilers arranged in three tiers, 200 ft. x 166 ft. each. They are Babcock & Wilcox water-tube boilers, with 126 4-in. tubes 18 ft. long and two 42-in. drums 9-16 of an inch thick and 23 ft. 3⅝ ins. long. The boilers are built to carry 200 lbs., but at the pressure adopted for the station, 160 lbs., they have a rated capacity of 250 hp, although they can develop 400 hp. These boilers are supported by steel beams connected with the steel structure of the building, and they are thus entirely independent of the brickwork and of the floor itself, this part of the equipment having been installed before the brickwork was put in place.

The boilers were equipped with Roney mechanical stokers by Westinghouse, Church, Kerr & Company, and this plant has the distinction of being the largest installation of mechanical stokers in the world in actual operation to-day. There are other plants now in course of construction in New York which, when completed, will have larger capacity, and these, too, are being equipped with Roney mechanical stokers—the Manhattan Railway, for instance, with its ultimate equipment of 384 stokers attached to ninety-six boilers of 50,400 hp; the New York Edison Waterside station, which will have 224 stokers under boilers developing 35,000 hp, and the Third Avenue Street Railway plant of the Metropolitan Company with 240 stokers under 31,500 hp of boilers. But for some time the Ninety-Sixth Street station of the Metropolitan Company can rightly claim the distinction of leader in number and capacity of stokers as well as in character of equipment.

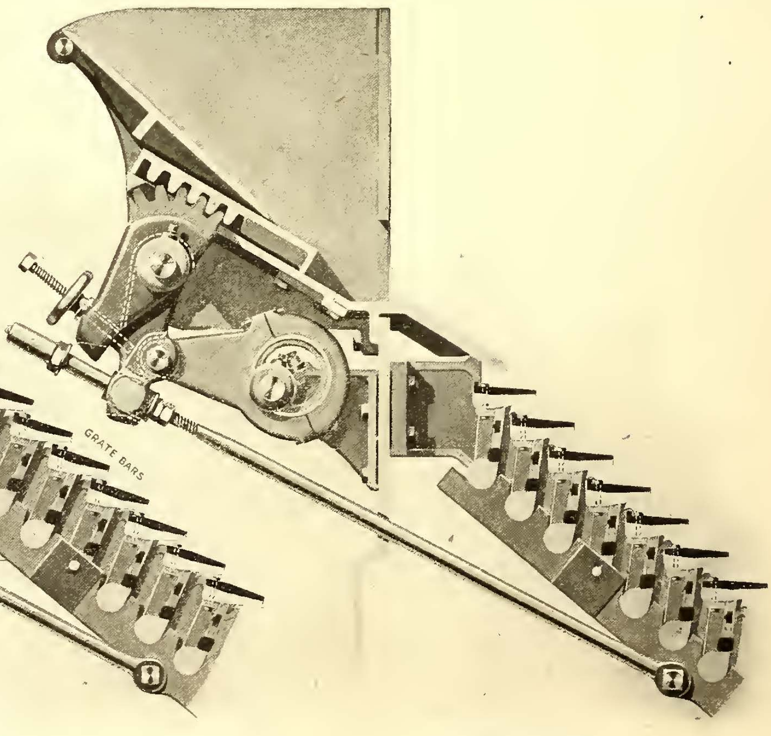
A brief description of the present form of the Roney mechanical stoker, which is playing such an important part in these large power equipments, will be interesting at this time, when so many large plants are being installed. The details of construction are shown



DETAILS OF CONSTRUCTION OF THE RONEY MECHANICAL STOKER



Inclined Position



Stepped Position

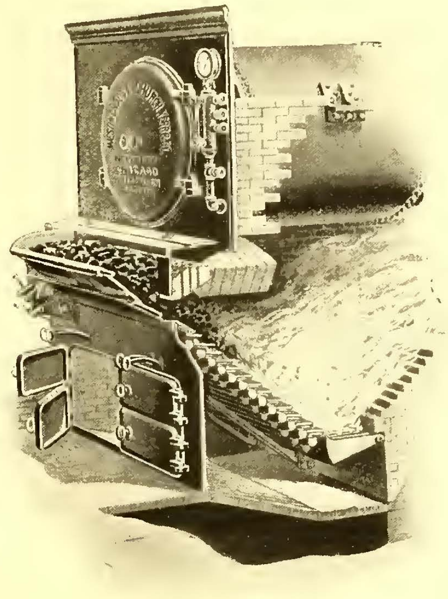
DETAILS OF FEED AND GRATE MEASUREMENT

in the accompanying diagrammatic illustration. The equipment consists of a hopper for receiving the coal, a set of rocking stepped grate-bars, inclined at an angle of 37 degs. from the horizontal, and a dumping grate at the bottom of the incline for receiving and discharging the ash and clinker. The dumping grate is divided into several parts for convenience in handling.

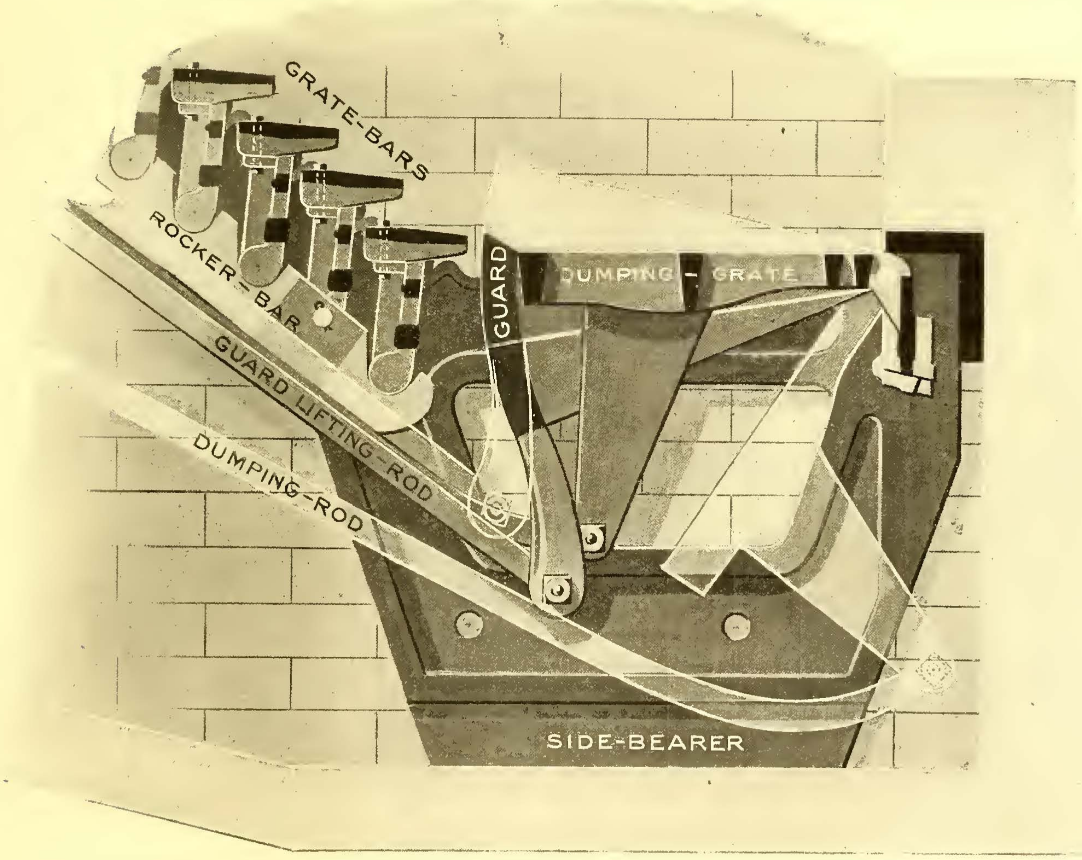
Coal is fed to the inclined grate from the hopper by a reciprocating pusher. which is calculated by the agitator and agitator sector. The grate-bars rock through an arc of 15 degs., assuming alternately the inclined position and the stepped position, illustrated in the cuts, showing details of feed and grate movements. The grate-bars receive their motion from the rocker-bar and connecting rod, and these, with the pusher, are also actuated by the agitator, which receives its motion through the eccentric from a shaft attached to the stoker front, under the hopper. The range of motion of the pusher is regulated by the feed-wheel from no stroke to full stroke, and the amount of coal pushed into the furnace may, therefore, be adjusted according to the demand for steam. The motion of the grate-bars is similarly regulated and controlled by the position of the sheath-nut and lock-nuts on the connecting rod. Each grate-bar is composed of two parts, a vertical web provided with trunnions at each end, which rest in seats in the side bearers, and a fuel-plate, ribbed on its under side, which bolts to the web. These fuel-plates carry the bed of burning coal, and, being wearing parts, are made detachable, with the view of reducing the cost of repairs to a minimum. The webs are perforated with longitudinal slots to disclose the condition of the fire at all times without opening the doors, and free access may be had to all parts of the grate to assist, when necessary, the removal of clinker. These slots also serve an important purpose in furnishing an abundant supply of air for combustion.

Anthracite coal is burned under half of the boilers in the Metropolitan plant. The stokers are fitted with what is termed a guard, which may be raised to prevent the small anthracite coal from sliding when the dumping grate is dropped to discharge the accumulated ash and clinker. On restoring the dumping grate to its normal position, the guard is dropped. The design and construction of the dumping grate and guard are clearly shown in the detailed illustration of this feature, and their operation will be readily understood.

An excellent view of one tier of the boilers equipped with Roney stokers in the Metropolitan Company's station is shown in the large half-tone reproduction. These stokers are operated by small 4 x 4½ Westinghouse engines especially designed for boiler house service. They are of the enclosed type, with all moving parts protected from dust and dirt. The engines run in a bath of oil, so do the worm and worm gear, to which the engine is directly connected; the worm-gear housing, which is completely enclosed, is attached directly to the engine frame and housing. The lubrication is entirely automatic, and this feature cuts down attendance to the minimum, so much so, in fact, that it is not a factor in the distribution of the power house labor. The operation and adjustment require so little skill that they can be successfully taken care of by the ordinary fireman. In this particular plant each floor of the boiler house is divided into four sections. One engine is sufficient to run a section, but a relay is installed as a safeguard against possible accident to driving gear or shafting. Although these engines are small in type they show a low water rate, giving, under good conditions, an economy of 42 lbs. of water per horse-power. Taking



SHOWING UNDER SIDE OF FIRE BED



DETAILS OF DUMPING GRATE AND GUARD—THE SHADED OUTLINE SHOWS POSITION OF GUARD WHEN RAISED AND DUMPING GRATE WHEN DROPPED the average results of several tests of the power required to drive Roney stokers under heavy loads, it is found that to operate stokers for 100 rated boiler hp about 0.1 ihp, or 4.2 lbs. of steam per hour are required. This amount of water is insignificant, as it represents only between 0.1 per cent and 0.2 per cent of the water evaporated by the boiler.

In operation, the entire bed of fire is visible from the under side of the grate, as shown in the cut of the Roney stoker attached to a horizontal boiler. Clinkers can be seen as they form, and may be dislodged without opening the doors. Then, too, if the fire should burn unevenly, it can be detected instantly and corrected without trouble.

The feature which commends this stoker particularly to the layman, as well as the owner of a power plant, is that it insures complete combustion of fuel and consequently eliminates the smoke nuisance. This is accomplished by furnishing sufficient air supply, mingling the air with the volatile gases, maintaining a constant high temperature and a uniform supply of fuel carefully regulated to meet the demand. A coking arch of fire-brick across the furnace covers the upper part of the grate and forms a reverberatory furnace and gas producer, the action of which is to coke the fresh fuel as it enters and release its gases, and these, mingling with the heated air supplied in small streams through the perforated tile above the dead-plate, are quickly burned in the large combustion chamber above the bed of incandescent coke on the lower part of the grate. This method of supplying the coal at the front and coolest portion of the furnace presents conditions most favorable for complete and economical combustion, and in operation closely resembles a large Argand burner, in the ease with which it is regulated and in its smokeless combustion of the hydrocarbons of the coal.

Attention has already been directed to the fact, that while the magnitude of this equipment was a very impressive feature, it was not by any means the most important. This will be appreciated when it is understood how carefully the details have been worked out in every department, and how closely the operation is watched. It will be recalled that M. G. Starrett, the chief engineer of the Metropolitan Street Railway Company, contributed some valuable information upon methods employed by the management, in an article in the STREET RAILWAY JOURNAL for Oct. 5, 1901. Commenting upon these investigations he said: "The operation of a station the size of our Ninth-Sixth Street plant is such a novelty in engineering work, that there are many points about which we ourselves have not yet reached definite conclusions."

FLUE-GAS ANALYSIS, RONEY MECHANICAL STOKERS, METROPOLITAN STREET RAILWAY COMPANY, NEW YORK, JAN. 10 TO FEB. 10, 1902.

Date	Soft Coal					Hard Coal				
	CO	CO_2	O	N	Tem.	CO	CO_2	O	N	Tem.
Jan. 10	0.0	14.1	3.9	82.0	575	0.0	9.2	10.8	80.0	575
11	0 6	15.0	2.2	80.2	500	0.0	11.0	8.6	80.6	530
12	----	----	----	----	----	----	----	----	----	----
13	0.0	12.4	6.7	80.9	540	0.0	11.2	9.0	79.8	615
14	0.0	13.6	5 3	81.1	530	0 0	10.0	10.2	79.8	575
15	0.0	12 0	7.1	80.9	475	0.0	10.3	9.9	79.8	575
16	0.0	13.2	4.9	81.9	540	0.0	13.2	6.4	80.4	745
17	0.0	10 5	8.7	80.8	530	0.0	9.8	10.3	79.7	685
18	1.2	15.0	2.0	81.8	710	0.0	12.6	6.8	80.6	635
19	----	----	----	----	----	----	----	----	----	----
20	0.0	10.5	8.3	81.2	525	0.0	10.4	9.8	79.8	----
21	0.0	13.0	5.6	81.4	510	0.0	12 8	7.2	80.0	545
22	0.0	13.0	5.6	81.4	510	0.0	12.8	7.2	80.0	545
23	.3	14.9	3.1	81.7	525	0.0	13.0	6.8	80.2	685
24	0.0	12.8	5.8	81.4	475	0.0	9.0	10.2	80.8	570
25	----	----	----	----	----	----	----	----	----	----
26	----	----	----	----	----	----	----	----	----	----
27	.5	13.3	3.9	82.3	545	0.0	10.8	9.4	79.8	550
28	0.0	12.8	5.6	81.6	570	0.0	11.8	8.0	80.2	580
29	0.0	13 0	3 2	80.0	745	0.0	10.8	8 9	80.3	540
30	.8	15.4	1.6	82.2	700	0.0	10.4	9.2	80.4	505
31	0.0	12.0	6.4	81.4	560	0.0	9.4	11.0	79.6	520
Feb. 1	0.0	12.0	6.2	81.8	575	0.0	10.4	9.6	80.0	500
2	----	----	----	----	----	----	----	----	----	----
3	.1	13.2	5.6	81.1	500	0.0	8.6	11.5	79.3	540
4	.4	15.6	2.0	82.0	630	0.0	12.2	7.5	80.3	570
5	0.0	12 4	6.0	81.6	515	0.0	9.4	10.6	80.0	550
6	0.0	13.6	4.6	81.8	650	0 0	8.0	12.0	80.0	510
7	0 0	14.4	4.0	81.6	560	0.0	11.0	8.6	80.4	625
8	.4	11.0	6.4	82.2	465	0.0	9.0	10.6	80.4	485
9	----	----	----	----	----	----	----	----	----	----
10	0.0	12.2	6.6	81.2	525	0.0	13 2	6.0	80.8	575

Referring particularly to the analysis of flue gases, he added:

"A station as large as ours makes not only justifiable, but necessary, refinements which have not heretofore been considered as a regular part of station operation. The maintenance of a small chemical laboratory is one of these. We are doing business on such a large scale that such matters as the quality of the coal, and the amount of good fuel that goes up the chimney cannot profitably be neglected.

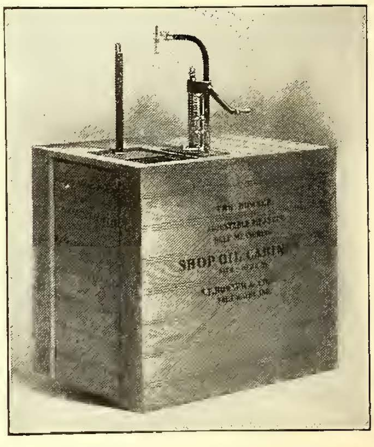
"Flue gas analysis is not worth anything unless samples are taken frequently. So far, we have confined ourselves to taking samples of flue gases from each boiler room once during each shift. The stoker operators in each room are held responsible for the quality of the flue gas coming from that room.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

These tests have been taken regularly since the laboratory was established, and the following figures, from the record book of the Metropolitan station, show the reports from the stoker room for one month, extending from Jan. 10 to and including Feb. 10. It would be well to bear in mind that these records do not show the best results, for the inspector has instructions to select poor fires, where there are any, rather than good ones for analysis.

Bowser Oil Cabinet

The accompanying cut represents the single square cabinet equipped with an adjustable measure and a self-measuring pump, manufactured by S. F. Bowser & Co., of Fort Wayne, Ind. These cabinets are intended for use in electric light and street railway power plants, factories, shops, cotton and woolen mills and engine rooms of large manufacturing establishments. By storing oil in cabinets of this kind instead of leaky barrels, and measuring it for distribution, much waste is prevented, and the danger of fire from oil-soaked floors is eliminated.

The tank which contains the oil is built of galvanized steel, turned, double-seamed and soldered, and is enclosed in a strongly built cabinet. The pump is of metal, full nickel finish, or black enamel, nickel trimmed finish. It measures an exact pint, half-pint or quarter-pint at a stroke, and delivers the oil directly into the oiler or oil can of whatever capacity or shape. The pump is equipped with the "anti-drip" nozzle, which prevents dripping after the pumping motion has ceased and which shuts off the flow of oil instantly. The quantity of oil discharged at a stroke is controlled by a small lever located upon the pump plate upon the top of the tank, which may be regulated by loosening a set screw and moving the quantity stop up for more or down for less. Where a standard size of cans or oilers is in use the pump may be regulated to fill them at one stroke. The cylinder of the pump is of brass, 2½ ins. in diameter and with a 6-in. stroke; the plunger is of gray malleable casting and the valves and valve seats are of full brass construction. The cabinet is provided with a round metal drip pan 7 ins. in diameter, with an opening 1¼ ins. in diameter in the center, protected by a stout wire screen, which prevents dirt from entering the tank. The pump has also a slide drip pan cover, to which is attached an upright metal drip tube ⅞ in. in diameter and notched to fit over the discharge nozzle, which is ⅜-in. in diameter. When cans are being filled the slide drip pan cover is pushed back, and when not in use is pulled forward, covering the drip pan, and if the pump be operated the oil passes down the drip tube and into the tank proper. This arrangement also prevents dirt from entering the cabinet and contaminating the oil.

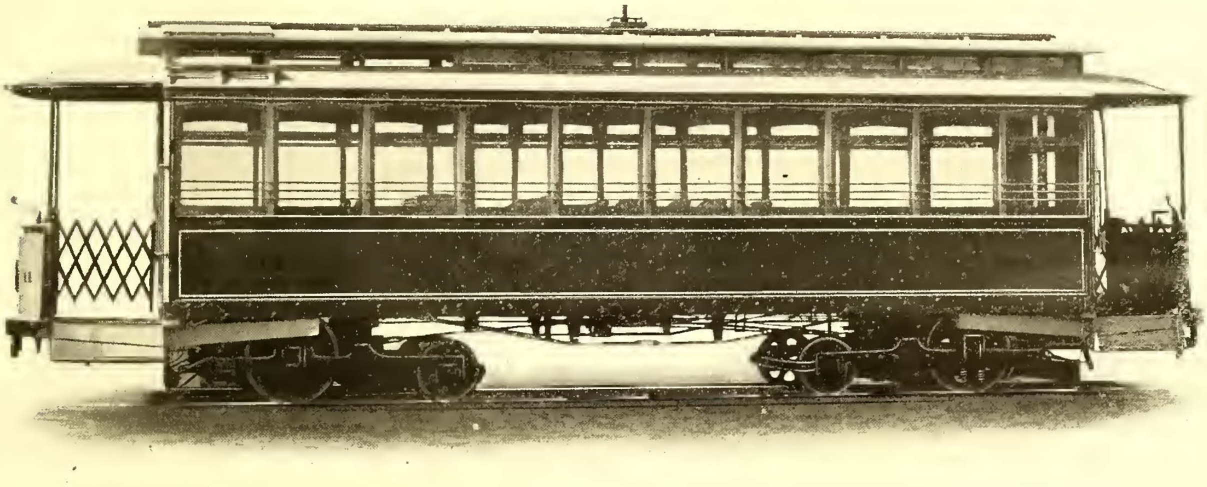


IMPROVED OIL CABINET

In addition to the single square style of cabinet illustrated, this firm manufactures the compartment square cabinet, the single roll-top cabinet and the compartment roll-top cabinet, with capacities ranging from one to five barrels. The compartment cabinets are used where more than one kind of oil is required.

A Handsome Convertible Car

The convertible car illustrated herewith is one of a lot recently constructed by the John Stephenson Company, Elizabeth, N. J., for Porto Rico. It is of some interest to note the fact that the convertible style of construction is becoming generally appreciated, finding favor in warm countries as well as cold ones, and wherever it is used it is winning favor with passengers. Its great value consists in the fact that, with a single equipment, a road is always provided with either open or closed cars at a moment's notice. No change of temperature or weather conditions can come so suddenly as to find the road with the wrong kind of car in service.



HANDSOME CAR FOR SAN JUAN LIGHT & TRANSIT COMPANY

The cars were built for the San Juan Light & Transit Company and are 36 ft. 4 ins. long over the buffers, with 28-ft. bodies. When shipped, platforms and bonnets were removed and placed inside the bodies, which were boxed and shipped entire. Twenty-eight feet is perhaps the best length for general service, and is becoming recognized by railway men as a standard. The bodies have straight sides with a high truss to the window rail. The truss ends go through the sills and are secured to them by anchor plates. The latter have their ends turned up over the end of the sill, making a secure connection. Still further strength is obtained by a truss rod under each of the side sills, and by steel plates 5/8 in. x 8 ins. There are the usual bolsters which are sandwiched with 3/4-in. plates. The body is 7 ft. 8 ins. wide, and is 9 ft. from the bottom of the sill over the roof. The conditions of operation are such as to confine the width over all to this small dimension. The sides are covered with vertical sheathing outside. A matched horizontal ceiling is gained on to the posts and glued as well as nailed. As the outside is also glued the whole side becomes as strong as a single piece of wood with the grains crossed. The lower window sash drop into pockets, and the upper sash slide into the roof. This form of construction presents several advantages, among them being the neat appearance of the roof from the inside. This construction gives a well-proportioned roof and a wider monitor than is possible where both slide into the roof, and avoids excessive weight in the upper part of the car body.

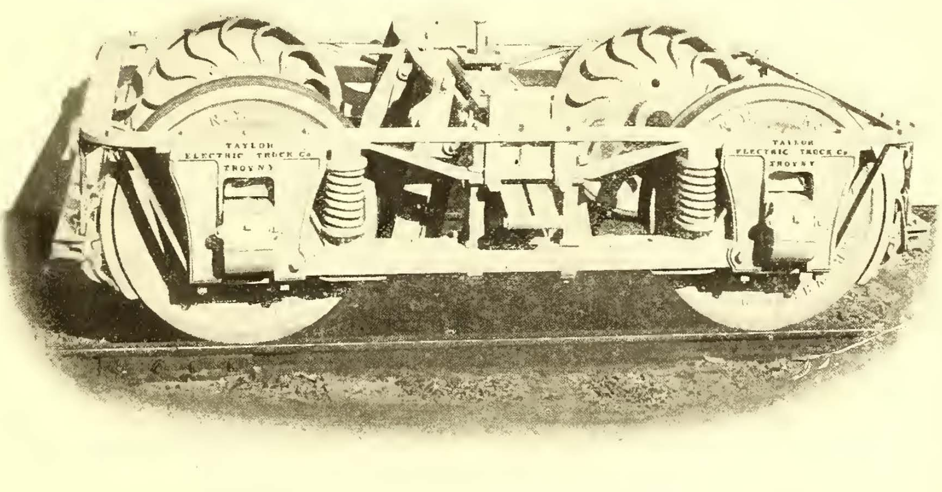
There are sixteen cross seats and four stationary longitudinal seats in the corners. The inside finish is white ash throughout with bronze trimmings and three-ply head linings. Each car is fitted out with bronze trimmings and three-ply with thirteen incandescent electric lamps. As the cars are to be operated in a warm climate, a vestibule was not necessary, and a plain open platform with a street car bonnet is used. The platforms are 4 ft. 2 ins. long. They have folding gates and a single step. The outisde platform sills are plated with steel. The floor is dropped 9 ins. below that of the car. The trucks are of the maximum traction type.

There are several notable departures in these cars from usual practice in construction. One of these is in the floor framing. This has four sills extending the full length of the car, the space between the central pair being utilized for a longitudinal floor pocket. This pocket forms a conduit in which are placed the motor cables, wires, etc. It is formed by placing castings or distance pieces between the sills and placing a flooring underneath them. Practice has shown the great value of a construction which, while it protects the cables and wiring, brake pipes, etc., also affords easy access to them by means of trap doors in the floor. Another unusual feature is the use of a steel-plated truss plank. This is placed at the foot of the posts with the steel next to them. The construction renders the car exceedingly stiff, which stiffness is also increased by the use of a double floor throughout the car.

The details of the finish are of standard patterns. There are ten pivoted ventilators on a side, the windows have three guard rails, and there are the usual sand boxes, gongs, electric signal bells, etc. Each end of the body has a coach bracket signal lamp, and on the right-hand side of each end there is a colored signal light, so wired as to burn with the electric headlight.

Extra Heavy Double Truck

The accompanying illustration shows one of the latest developments in trucks for high-speed electric cars. The long car bodies which are now used in suburban service and are ordinarily run at an extremely high rate of speed around curves as well as upon straight tracks have necessitated certain modifications in the standards laid down by the Master Car Builders' Association, but the M. C. B. lines are incorporated in the best makes of trucks for this service. The Taylor Electric Truck Company, of Troy, N. Y., after a long practical experience in the manufacture of high-grade trucks for heavy service, is now putting on the market the design shown herewith. This truck, as will be seen, conforms very closely to steam railroad practice, at the same time embodying such features of strength and durability as are required by the addition of the extra weight of the motors. The bolster has a swing motion, which combined with the equalizer bar construction makes a very easy-riding truck. The trucks and all wearing parts are made very strong, allowing the attachment of air brakes if desired, and great care is taken to have the trucks in all parts equal to any service, however severe. The trucks are made in two sizes with wheel bases of 5 ft. 10 ins. and 6 ft., and for any gage of track from 3 ft. 6 in. to 5 ft. 2½ ins. They are constructed



HIGH-SPEED TRUCK FOR HEAVY SERVICE

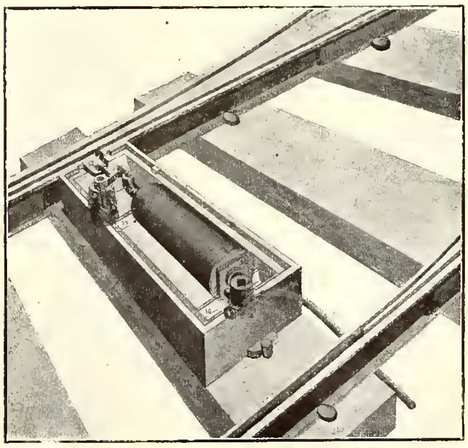
to receive two motors apiece or four motors to a car, and run smoothly around curves of 40-ft. radius. Wheels of any diameter, either of spoke or double-plate pattern, and with treads and flanges to suit the purchaser, are furnished by the company. The weight per set of trucks complete for a car is about 11,000 lbs., the wheels weighing from 500 lbs. to 550 lbs. each. This extra heavy double truck is built practically on the same lines as are contained in the other standard trucks made by the Taylor Electric Truck Company, and embodies the same combination of strength and simplicity of construction which have made the products of this factory popular with both car builders and operating men alike. They have already been placed in use on large numbers of interurban roads operating at high rates of speed.

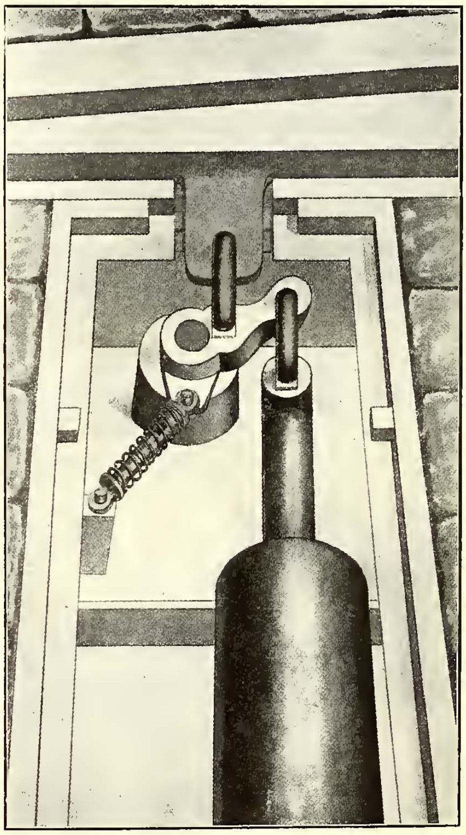
Cheatham Electric Railway Switch

An electric switch, which is the development of several years' practical experience in the operation of trolley roads where the conditions are unusually severe, is illustrated in the accompanying cuts. The demand for such an appliance is especially felt at crossings where there is heavy traffic at certain hours, and in systems where there are numerous branch lines extending from the main line to outlying districts. The running time can be materially improved if the necessity for bringing the car to a stop at every switch is removed, and a considerable saving in the actual cost of power will also be effected. Even when it is not necessary to bring the car to a "dead stop" considerable delay and expense is entailed, as it is generally necessary to slow down so that the motorman can lean out of the window, turn the switch with his rod and return to an upright position before increasing the speed of the car again.

The Cheatham Electric Switching Device Company, of Louisville, claims that the apparatus which it manufactures for this purpose, and which is herewith illustrated, will perform this work satisfactorily from an economical, electrical and mechanical viewpoint. In one test to which it was subjected, namely, the operation of a switch on the St. Louis Traction Company's lines where 750 cars passed daily, its performance was so satisfactory that the railroad company adopted the system for many other different points, and discharged the switchmen formerly employed to attend the crossings.

The construction and operation of the apparatus may be readily understood after an examination of the accompanying cuts and the appended description. Fig. 1 shows the lever connection, stay-spring and tongue in central position, while Fig. 2 shows a portion of the device connected to the switch tongue, which is set for the straight





FIGS. 1 AND 2—SWITCHING APPARATUS IN POSITION AND DETAILS

track, and the coil-spring that holds it tight against either side to prevent passing cars from shifting the tongue as they pass. Fig. 3 shows the trolley pan and circuit-changing box.

The trolley pan consists of two strips of wood having their inner edges beveled and shod with angle iron. The circuit changer is a solenoid magnet having a core armature that rests on plate *A* until magnetized sufficiently to lift it to plate *B*. The trolley pan and circuit changer are connected by the dark wires (Fig. 3) commencing at bolt *D*, and connecting the terminal *K* of solenoid, then leaving terminal *L* and connecting with angle-iron strip *E*. The negative angle-iron strip *C* is connected to the core armature *J* by the white wire, commencing at *C* and passing through the resistance coil *F H*. When a car approaches and the motorman

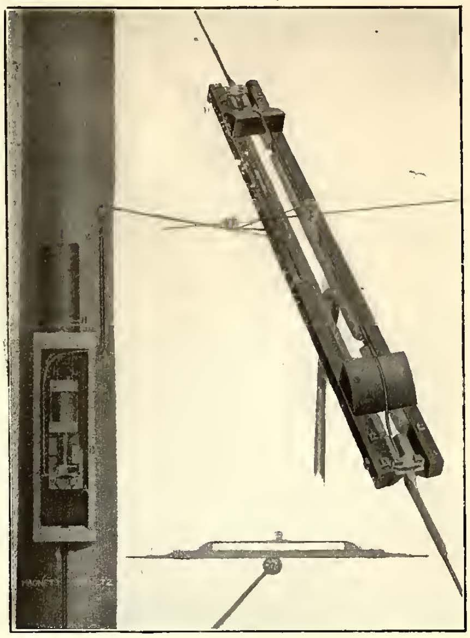


FIG. 3.—TROLLEY PAN AND POLE BOX

is going to keep straight ahead, he invariably shuts the current off, allowing the car to run by its momentum. When the trolley wheel reaches the contact block it connects the angle-iron strips *E C*. Current comes from the trolley wire at *D*, passes through solenoid *K L* and comes back to contact strip *E*, passes through the trolley wheel into contact strip *C* (as indicated by arrows), then it goes down the white wire *C* to armature *J*, and to plate *A* to solenoid *2*, and to ground, thus setting the tongue for the straight track. To set the tongue for the curve, the motorman invariably keeps his current on while the trolley is passing under the trolley pan. In the latter case the current, starting at *D*, passes over the same route as in the first case until it leaves the armature *J*, which is now in contact with plate *B*, instead of *A*, because the car is drawing current from the angle-iron *E* through solenoid *K L*. Instead of going down the plate *A* the current now passes down plate *B* to magnet *1*, which sets the tongue for the curve.

Only enough current passes through the solenoid of the circuit changer in the first instance to supply the ground magnet, but in the second instance the angle-iron *E* has to furnish the ground magnet *I*, as well as the current the car requires. This heavier current, passing through solenoid *K L*, causes the armature *J* to be lifted from post *A* to post *B*. The switch is operated by the motorman having his current on or off while passing under the contact block. Even though the tongue may be in the proper position when the motorman approaches, he must operate it just the same as he would were it not so.

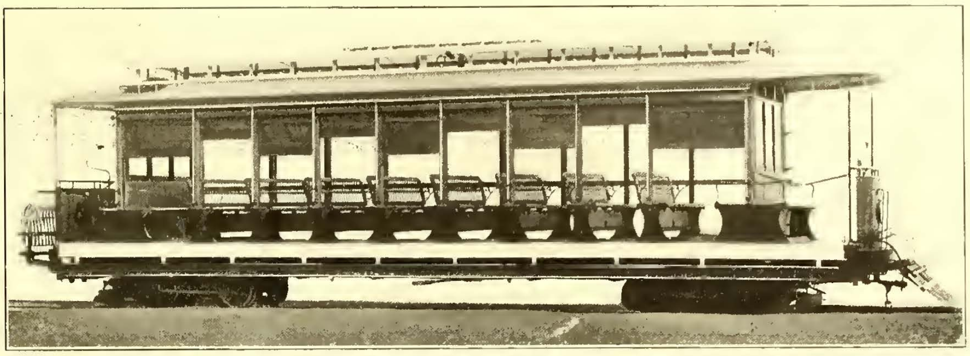
In practice it has been found necessary to give very little attention to this switch. Every two or three weeks the man in charge lifts the small lid of the iron box and scoops out the mud in that end of the box. The entire operation will not take over five minutes. The idea is not to clean the working parts, but to keep the dirt from packing around the outer end of the plunger. It is explained that the mud does not settle around the lever and links, because they are higher than the bottom of the slot or gap in the switch guard. Many railways are in the market for automatic switches and the manufacturers are busy supplying the above described apparatus.

Brill Cars in America and Europe

The J. G. Brill Company, of Philadelphia, has recently shipped forty open cars to the Companhia Carris de Ferro de Lisboa. The accompanying illustration shows the general appearance of these cars. They are typical Brill open cars of the usual strong construction and embody the features for which the firm is noted.

The Portuguese capital is a city of hills, and the cars have been equipped with the "Eureka" maximum traction trucks.

The length of the cars over the crown pieces is 36 ft. 2 3/8 ins., and the width over the sills is 5 ft. 10¼ ins. There are twelve seats, eight of which have reversible backs, furnishing a seating capacity of sixty. Access and egress may be prevented on one side, or both, by guard rails which extend from corner-post to corner-post, and slide behind the grab-handles. When not in use they are held at the top of the posts by Brill patented gravity catches. Leather-covered chains between the corner-posts and the dasher-rails complete the barrier. The bulkheads have three large drop-sashes. Brill patented round-end seat-corner panels permit the roller curtains to be drawn to the floor. Ample protection is thereby afforded during showers. The monitor decks are high and wide, and, with the highly polished bird's-eye maple ceilings, present a light and attractive interior appearance. The cars are also equipped with patented angle-iron bumpers and Dedenda gongs.



NEW OPEN CAR FOR LISBON

The J. G. Brill Company is also shipping fifty more cars to the Metropolitan Street Railroad Company, New York, for its Third Avenue division; thirty-five 12-bench and fifteen combination. They are identical in almost every detail to those of former orders, pretty good evidence that the types and details are successfully meeting the complex requirements of the largest and busiest system in the world.

The open cars are 35 ft. 11 ins. long over the crown pieces, and 6 ft. 9 ins. wide over the sills. The combination cars are 36 ft. 1⅛ ins. long and 6 ft. 5 ins. wide; the length of the closed compartment is 11 ft. 4⅜ ins., and that of the open part 24 ft. 8¾ ins. Both cars are fitted with round-corner seat-end panels, ratchet brake handles, angle-iron bumpers and Dedenda gongs, all of which are Brill patented specialties. The trucks are of the Brill "Eureka" maximum-traction type, the standard double truck for the entire Metropolitan system.

STANDARD COMBINATION CAR, NEW YORK

OPEN CAR FOR METROPOLITAN STREET RAILWAY, NEW YORK

Railway Park Furniture

Every railway manager who operates pleasure grounds in connection with his system understands the difficulty of getting reliable settees, swings, etc., for his parks. The hard service to which these adjuncts to the pleasure grounds are subjected makes it imperative that they should be of the very best quality of material and that the workmanship on them should give them the greatest strength combined with neatness of appearance. The McCormick Manufacturing Company, Des Moines, Ia., has made a specialty of outdoor furniture and the manufacturing of swinging chairs, settees, canopy tops, etc., which have met with approval in many parts of the country. This concern, it may be remembered, had the contract for furnishing seats at the Pan-American Exposition last year, the wearing qualities of its goods having been appreciated by the directors of that exposition. The design of the McCormick furniture is such that patrons of parks where it is used find the comfort in the resting places that it is intended to give, the seats in both swings and settees being so proportioned that they conform to the requirements of the body. All the McCormick furniture is thoroughly painted with good paint and finished with varnish, and will stand exposure to the weather without undue deterioration.

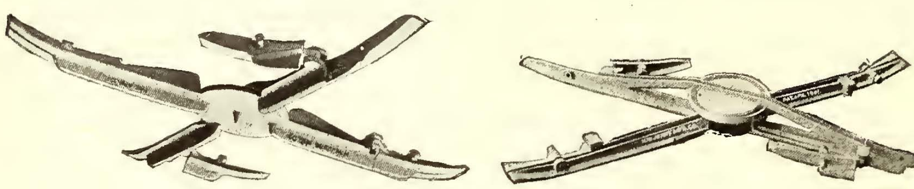
A Trans-Continental Map, with Statistical Analysis

Spencer Trask & Company, bankers, New York City, have just published a map showing the relative positions of the various trans-continental railroad systems and important connections west of Chicago, together with a statistical analysis based upon earnings per mile of road. The character of the work bespeaks the great care exercised in its compilation, and should be of exceptional value to railroad officials, financial men and all classes of investors. The map gives almost at a glance a comprehensive idea of the intricate steam railroad systems of the West and Southwest, and nothing has been spared to make the work genuinely artistic in its presentation.

Some New Type of Overhead Material

There is probably no more important element among the various devices which enter into the construction of an up-to-date overhead trolley line than the overhead crossings. These should permit of a proper interconnection and support of the trolley wires at those points on the system where two lines intersect, and as the crossing of such lines frequently varies from a right angle to an almost parallel relation, it is desirable and most essential that such crossings should be made adjustable, in order that their use may be universal on the system. Another highly important element in the development of a satisfactory device of this character is the matter of weight, which should be as low as possible, and perhaps even more important than this is the manner in which the crossing is connected to the wires and the facility with which it can be placed, as well as the ease with which it can be adjusted for use with various sizes of trolley wire. A great deal of difficulty has also been experienced in the past with uneven underruns in such devices, giving rise to a jumping of the trolley wheel when it strikes the crossing at the point where it leaves the wire.

In the construction of the "New" Philadelphia Crossings, illustrated herewith, these disadvantages have been considered. Two types to meet the two distinct conditions of service are furnished—the uninsulated or metallic crossing and the insulated crossing, for use where it is desired to electrically separate the intersecting trolley wire and yet maintain perfect mechanical continuity and give an even underrun for the trolley wheel. Fig. 1 shows the uninsulated or metallic crossing, a description of which will bring out the general features embodied in both types. The crossing wires first pass through a hinged clamp after passing under a curved flange and then pass over the top of the centrally hinged arms, forming the two parts of the crossing. For the purpose of permanently fixing the wire, its path from one end to the other of the arms is well grooved. The novelty of the hinged clamps at the ends of the arms for holding the trolley wire and firmly fixing the crossing is particularly noteworthy. This is so arranged that it will take sizes from 0 to 0000 inclusive, and the manner in which the trolley wire enters the clamp is such that the trolley wheel as it strikes the curved flange is pressed downward from the wire and is caused to run on its flanged edges across the arm to the other end, where it is allowed to gradually rise and again bring the grooved portion of the wheel into contact with the wire gradually. The absence of solder in these crossings is naturally a great advantage.



FIGS. 1 AND 2.—UNINSULATED AND INSULATED CROSSINGS

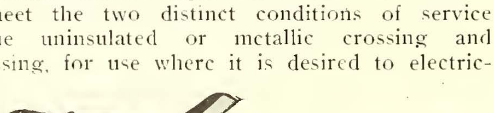


FIG. 3 —SECTION INSULATOR

The insulated crossing is almost as simple. Instead of the two arms coming into metallic contact, one of the arms is fitted with an insulated cylindrical cup, so arranged that the wire connected with that particular arm passes over the top of the arm, but is kept from contact with the metallic portion of the other arm by the insulating cylinder. The two arms are easily separated from one another by the manipulation of two screws, upon the removal of which and the swinging of the guides which they hold in place the two arms are at once separable. The lower arm can then be connected to one trolley wire by removing the cylindrical cup. After replacing this cup and putting the upper arm in position, so that it is properly pivoted thereon, and readjusting the two guides on the lower side of the upper arm, the two parts of the crossing are again in their proper relationship. The other wire is then passed over the other arm and the entire device is ready for use. An important feature of this insulated crossing, which is regarded as highly desirable, is the use of a metallic running surface for the trolley wheel, located at the central portion of the device, but is insulated from both arms. This metallic running surface eliminates wear at this point, and a more even operation is obtained.

The "New" Philadelphia section insulator shown in Fig. 3 has also been brought out, which embodies the same desirable features as regards the even underrun, facility of attachment and use over a range of trolley wire sizes the same as above. The wire passes into clamps in a similar manner to the ends of the crossing arms. generally similar in their arrangement to the ends of the crossing arms. Each of the metallic ends is also provided with an arrangement for feeding in or "jumping" across. The central or insulating portion of this section insulator is made up of ¾-in. thick specially treated fiber, arranged to give a very long break between the two sections.

Although these devices have only been on the market for a very short time, it is reported that they have already found very extensive use and proven highly satisfactory. All of the castings used in the metallic crossing, the insulated crossing and section insulator are malleable iron, galvanized, and all screws and rivets are brass. In case of two wires crossing each other, one of the wires being 0 or 00 and the other 000 or 0000, either round, grooved or figure 8, the crossings above described will accommodate these wires in every case without extra cost or change of parts. These devices are manufactured and sold by the H. W. Johns-Manville Company, New York.

Frank Ridlon Publications

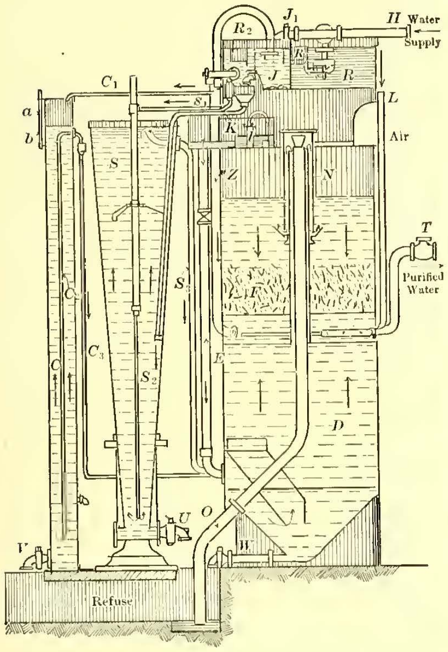
Ridlon's *Representative* appeared for the first time only about three months ago, but its coming is already looked forward to by the many friends of the Frank Ridlon Company, Boston, and every issue receives the close reading which its handsome style and convenient arrangement merits. It seemed as if the first number had created a standard for "house organs" which even the resources of the Ridlon establishment could not maintain, but the second number dispelled all such fancies and street railway men began to think that all the spare brains of the company were being carried about by the *Representative*. It comes, therefore, as something of a shock to receive the new Frank Ridlon catalogue which is being distributed with great liberality to purchasers of street railway supplies. This work represents the highest type of the art of making catalogues and price lists containing everything that it is necessary to know about devices illustrated and presenting them in a form that is convenient to use. It includes, with but few necessary exceptions, only such articles as the company manufactures, carries in stock or controls as agent, and is therefore a practical, useful, working catalogue, the immense labor of preparing which will undoubtedly be highly appreciated by all who receive a copy. The 433 pages are of the best paper and printed with artistic typographical taste, while the handsomely illuminated green vellum binding sets off the work to great advantage. Much valuable information in the way of tables, data and formulae and a telegraphic code are included. The book is completed by a thoroughly cross-referenced index and indices of code words and catalogue numbers, and altogether the Frank Ridlon Catalogue of 1902 will be hard to surpass.

Automatic Feed-Water Purifier

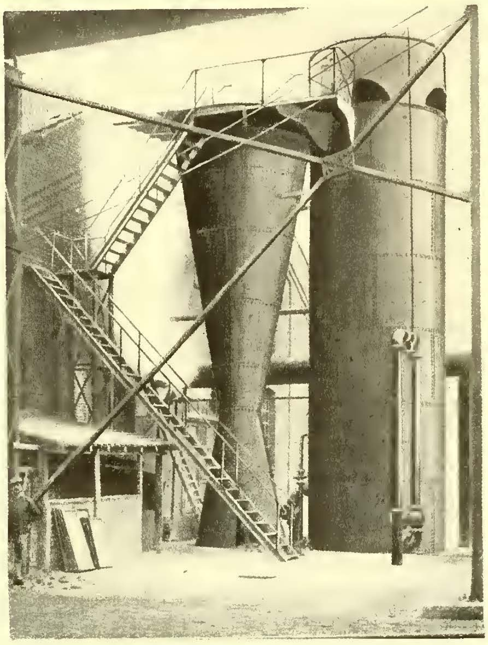
One of the most important features of a street railway power station is the steam-generating plant, and much thought is always bestowed by the designer of the station upon the best methods of arranging the batteries of boilers with relation to the position of the engines and the most economical and efficient distribution of the steam mains, headers, valves, etc. The details of steam engineering have probably received closer attention from students than any other class of practical science, with the exception possibly of electricity, and everything that has been done along this line has had for its object the minimizing of the cost of producing mechanical power from the combustible used. All modern boilers bring either a large number of tubes containing water in close proximity to the grate or else pass the burning gases through tubes surrounded by water, and in this way the heat is transmitted directly through the material of the tube to the water. Any change in the conductivity for heat of the sides of the tube will therefore materially interfere with the steam-producing properties of the boiler.

Unfortunately, but few localities have a water supply that in its natural state can be heated to the boiling point without depositing some foreign matter either contained in solution or as sediment upon the vessel containing it, and in the case of a boiler this matter forms what is commonly known as scale on either the interior or exterior of the tube, as the case may be. This scale decreases to a very great extent the heating effect of the fire, experiments showing that 1-16 in. wastes 13 per cent. of the fuel.

Numerous devices which have combined much ingenuity and the results of chemical research have been employed to overcome



SECTION OF APPARATUS



VIEW OF AN INSTALLATION

the formation of this objectionable deposit. The accompanying illustrations show an apparatus that is intended automatically to purify all kinds of feed-water. No matter what the condition of the water when taken in at the supply pipe, or whether the impurities consist of suspended particles or of foreign matter in solution, it is claimed by the makers that the water which issues from the apparatus will be in perfect condition for the boilers. The process is entirely automatic, the only attention required by the device being the filling of the storage receptacles once a day with the necessary proportions of lime and soda, the only two chemicals used in the system. The purifier consists substantially of an automatically acting lime saturator, shown at the left as a conical pipe, a soda chamber, which is a cylindrical pipelike receptacle, and an automatic filter in the main part of the apparatus. The lime saturator, on account of its downward tapering shape, thoroughly mixes the lime with the incoming water, the water being carried to the base of the cone by an internal pipe and slowly rising to the top through the more densely saturated solution at the bottom. By the time it gets to the wide space at the top, the lime water is perfectly clarified, and leaves the saturator through a pipe which carries it to the bottom of the large cylinder. This portion of the apparatus is known as the reaction chamber, and a concentrated solution from the soda chamber is forced into it through a small pipe. The difference in the methods by which the soda and lime are dissolved is necessitated by the fact that whereas lime will only dissolve in a definite proportion, there is almost no limit to the solubility of soda. It is therefore possible to dissolve a sufficient quantity for twenty-four hours at one time in the small soda chamber and send it into the reaction chamber as required. The soda solution is forced out of the soda chamber by allowing water to flow in through a small regulating valve, the specific gravity of the water above the soda solution being too small to cause the mixing of the two liquids.

Much ingenuity has been shown in the details of the apparatus whereby the correct proportions of the mixture in the reaction chamber are secured. There is a floating valve in a distributing tank at the top, by means of which the level of the water is always kept the same, and the arm is connected to three small valves at an equal height, the first one allowing the inflow of the untreated water, the second for the lime water, and the third for the water which is used to force the soda solution into the reaction chamber. The lime is slaked in a chamber adjoining the distributing tank, and the lime paste resulting is carried to the interior of the conical lime saturator to a point about halfway from the top. The three liquids, namely, the untreated water, the lime water and the soda water, remain in the reaction chamber at the lower part of the large cylinder until the chemical reaction of the salts has been completed and the purified water then passes through a filter, to be discharged at the relief valve perfectly softened and clarified. The sediment that results from the chemical action in the reaction chamber is precipitated to the bottom of this chamber and can be readily drawn off. An automatic washing arrangement, which is provided for the filter, prevents any choking up of the apparatus at this point.

There are two principal advantages claimed for this apparatus outside of the fact that it does its work thoroughly and satisfactorily. One is, that it requires absolutely no attention more than the charging once a day with lime and soda, the removing of sediment and the testing of the water to see that no change in its composition has taken place. These operations can be done in a very few minutes and the apparatus left to itself for the remainder of the day. The other special advantage is that no chemicals other than ordinary lime and soda are used in the process, and that after the apparatus has been installed in a power house the operating company is at liberty to buy these reagents in the open market. Although this purifier has been used to great advantage in a large number of European plants, its introduction into this country is of recent date. The company which controls the rights for the United States is the Automatic Water Purifying Company, of New York, and all sales in this country will be made through this firm or its agents.

Westinghouse Rotaries for Railway Work.

Two rotary converters of 300 kw each, have recently been purchased by the Manchester (N. H.) Traction, Light & Power Company from the Westinghouse Electric & Manufacturing Company. They will be located at Hooksett, N. H., and will deliver power for the operation of the Concord and Manchester branch of the Boston & Maine Railroad, this road having entered into a contract for power with the Manchester Traction, Light & Power Company. The machines are to be supplied with three-phase alternating current, and will deliver direct current at 600 volts. The Westinghouse Company has also sold two rotary converters to the South Covington & Cincinnati Street Railway Company, one being of 200 kw capacity and the other of 400 kw capacity.

An Automatic Oil Filler

The oil bill of a street railway company sometimes assumes such proportions that both the engineering and accounting departments are surprised at the footings. It is impossible to run machinery without lubrication, and it has been found that a poor lubricant is more expensive than one of better quality. By the use of good, clean, pure oil, engines, dynamos and all machinery bearings are kept in good condition after long years of service. It is important, however, that this lubricant should not be used sparingly but in liberal quantities, and it becomes necessary, therefore, for economical working to use the oil over and over again. The apparatus illustrated in the accompanying engraving is made by the American Oil Filter Company, of Philadelphia, Pa., and has been thoroughly tested with all grades of oil. It separates the oil and water automatically and will purify and filter the oil at the same time without any attention whatever, the dirty water being carried off and the filtered oil retained in the tank without a drop of oil being wasted in the operation. The company makes filters in all sizes from ten gallons capacity up to 300 gallons.

NEWS OF THE WEEK

Nebraska Franchise Tax Decision

The Supreme Court of Nebraska has handed down a decision similar to that recently handed down in Illinois, to the effect that street railway, gas, water, electric light and telephone companies must be assessed according to the cash value of the company's stock and bonds. This was in a suit brought by the Omaha Real Estate Exchange to require the City Council to reconvene as a board of equalization and reassess the public service companies.

Toledo Merchants Provide a Passenger Station

The merchants of a certain street in Toledo, Ohio, realizing the advantages of the electric railways as trade producers, have recently entered into an agreement with the five interurban electric railways entering Toledo whereby they will use as a union passenger station a large room which will be furnished by the merchants rent free for a period of three years. A parcel check room will be a feature of the station, and this will be conducted for the benefit of the merchants. Any incoming passenger may rent a box for 5 cents per day and have purchases made in town sent to the station and delivered to the particular box number. Tickets on all the lines will be handled, and there will be a news stand in the station. The Toledo, Bowling Green & Southern, the Toledo & Maumee Valley, the Lake Shore Electric, the Toledo & Monroe and the Toledo & Western are the roads that will use the station, and they bring into the city on an average 5000 passengers per day.

San Francisco and Municipal Ownership

The city officials of San Francisco, who have for some months past been planning to attempt municipal ownership of street railways by purchasing the system of the Geary Street, Park & Ocean Railroad as soon as the franchise of that company should expire, recently asked City Attorney Lane, through the Public Utilities Commissioner of the City Council, for an opinion as to when the franchises of the road expired. It seems that though the city authorities are extremely anxious to attempt municipal ownership, they were not well informed as to when the franchises expire, and the opinion of Mr. Lane is said to have proved a disappointment to them. The problem turned chiefly on the fact that two grants of the desired privilege were made to the promoters of the road, the first on April 13, 1877, and the second on Nov. 6, 1878. The term to be covered was twenty-five years. The apparent object of the second application for the franchise was to give the road builders the right to build a short extension; also to secure a reduction in the car license fee. Until very recently there had never been any question as to the fact that the franchise would lapse on April 13, that date marking twenty-five years from the date of the first grant. Thus municipality ownership in San Francisco will be delayed considerably.

Important Southern Consolidations

The Merchants' Trust Company, of New York, has just completed negotiations by which the Virginia Electric Railway & Development Company, Richmond Traction Company, Richmond Passenger & Power Company, West Hampton Park Railway Company, Virginia Passenger & Power Company and the Richmond & Petersburg Electric Railway Company will be consolidated as the Virginia Passenger & Power Company. The companies that are to be brought under the control of one company embrace all the street railways of Richmond, Manchester and Petersburg and the interurban lines connecting these cities; also the electric light and power business of the several cities and the water rights of the James and Appomatox Rivers. In addition to these properties the consolidated company will also come into possession of large holdings of real estate. The plan of the consolidated company, it is said, provides for the issuance of 5 per cent. bonds that will be used to retire outstanding bonds of the constituent companies, to provide for improvements, etc. Fritz Sitterding, vice-president of the Richmond Passenger & Power Company, will be president of the consolidated company.

At meetings of the stockholders of the Wilmington Seacoast Railroad, Wilmington Street Railway and Wilmington Gas Light Companies, held April 23, a plan of consolidation was adopted by which the three are merged into the Consolidated Railway, Light & Power Company, with Hugh McRae as president, M. F. H. Gouverneur vice-president, and a board of directors composed of George R. French, M. J. Heyer, G. Herbert Smith, W. R. Kenan, J. W. Norwood, Charles P. Boles, Oscar Pearsall, Charles W. Worth, B. V. Grainger, W. L. Peasley, Junius Davis, James H. Chadbourn, Hugh McRae and M. F. H. Gouveneur, of Wilmington, and W. W. Randolph, of New York. The consolidated company proposes at once to convert the Seacoast Railroad, extending from Wilmington to Wrightsville Beach, into an electric railway.

It is announced in New Orleans that the New York Security & Trust Company has purchased the New Orleans & Carrollton Railroad, Light & Power Company, paying $7,195,000. The purchasers already own the New Orleans City Railroad and the Orleans Railroad, and the purchase will give control of nine-tenths of the street car mileage of the city.

The San Francisco Strike Ends

The strike of the employees of the Market Street Railway Company, of San Francisco, which was declared at 6 p. m., Saturday, April 19, was declared off on Sunday, April 27. As previously stated, the demand of the men was for a recognition of the union, a ten-hour working day and 25 cents an hour, an increase of 3 cents per hour over that paid. The company has acceded to all of these demands except that which provides for the recognition of the union. To the latter demand the company has agreed to treat with the union, but has refused to comply with the demand that all employees of the company shall be compelled to join the union. The strike is one that is unique in annals of street railway strikes. With a "labor man" as Mayor there was aroused among the residents of the city a feeling of grave concern as to the steps that would be taken by the strikers and their sympathizers, backed by a "friendly administration." The popular theory that the declaration of the strike would be followed by disorder and riot, with possible bloodshed, was completely exploded, and in deference to all concerned, although the strike lasted a whole week and the city residents were greatly inconvenienced, operations were carried on in a manner that has characterized very few of the recent street railway strikes. The disorder and riot that usually accompany street railway strikes played no part in the San Francisco controversy, and on good authority it is learned that the total damages will not aggregate $100, consisting for the most part of broken car windows, the work of the mischievious small boy, who saw in the strike an opportunity to demonstrate to others the accuracy of his pitching arm. There certainly are instances where strikes are justifiable, but there never was an instance that justified the destruction of property.

Ohioans Plan an Extensive System of Railways to Florida

The Ohioans who for some time past have been working out plans for the development of electric railway in Florida, also for the construction of electric lighting and power plants, and who recently organized the Tampa West Coast & Municipal Railway Company, capitalized at $1,000,000, have made public part of their plans, and from these can be obtained an idea of the magnitude of the operations that are about to be begun. The company proposes to construct from Tampa throughout at least four counties—Hillsboro, Hernando, Pasco and Manatu, on and near the west coast—an electric railway system which will handle freight as well as passengers, and also an electric light system which will provide illumination for Tampa and the numerous towns through which the road will extend. Tampa will of course be the center of operations, and there will be erected in that city—probably in the southern part—the large plant that will supply electricity for railway, power and lighting purposes. In Tampa proper the plan is to build 14 miles of line, but the interurban line will be about 40 miles in length, while the complete system will embrace about 100 miles.

The lines will include five loops, all radiating from the business center of Tampa. The north branch of the system will extend from Tampa to Sulphur Springs; another branch, to be known as the Plant City branch, will extend from Tampa to Plant City;

while the Gulf Coast branch will encircle Old Tampa Bay and other coast points, where it will be subdivided into the following lines: Tampa to Port Tampa Junction; Port Tampa Junction to Port Tampa; Port Tampa Junction to Bay View and New Venice, touching Seven Oaks and intervening points; Bay View and New Venice to St. Petersburg; Bay View and New Venice to Clearwater; Clearwater to St. Petersburg via Largo and Seminole; Clearwater to Tarpon Springs.

To Build Indiana Lines

Interests identified with the Union Traction Company of Indiana have just incorporated the Indianapolis Northern Traction Company, capitalized at $3,500,000. The new company, it is said, has been organized as a consolidation of the Central Traction Company, and the other properties recently purchased in the interest of the Union Traction Company, and will complete the extensive system of lines that will eventually connect Indianapolis, Logansport, Tipton, Kokomo, Peru and various surrounding cities. After the projected lines are completed, so it is said, the system will be turned over to the Union Traction Company. It is said that all plans have been made for financing the company. The directors of the company are: Charles A. Baldwin, Henry Moore, William H. Bloss, Ellis C. Carpenter, Albert S. Richey, Arthur W. Brady and Charles Berry.

Trolley Adjunct for Fire Departments

The Fire Commissioners of Newark, N. J., intend to profit by the experience of Paterson. At the time of the fire in the latter city Newark responded to the call for assistance and sent engines, hose and other equipment to the scene of the fire, but there was a delay of more than two hours occasioned by the lack of facilities for loading the apparatus on the train. Realizing that such a delay is very costly and that a similar emergency is likely to occur at any time, the Fire Commissioners of Newark have written to all the steam and trolley railroads running through Newark and to municipalities west of New York within a radius of 25 miles, requesting them to co-operate to the end that better facilities may be obtained. A number of roads have responded, saying they will be glad to do anything in their power, and several of the municipalities to which letters have been sent have replied, endorsing the plan and promising help. Newark has a number of public institutions outside the limits of the city, and it has been suggested that trolley cars be constructed for the transportation of fire engines and horses. Another suggestion is that the engines be hooked to the trolley lines and hurried along in this manner to suburban points when their service is required.

Expert to Assist Chicago Council Committee

The new committee on local transportation of the Chicago City Council held its first meeting last week and discussed the matter of hiring an expert engineer to assist and advise it in reference to questions coming up in connection with franchise renewals. Such an expert will probably be retained to advise on the following matters:

A plan of street car routes and terminals, especially down town, which will meet in the best manner the need for transportation facilities.

Whether the use of the tunnels should be continued; if so, whether their present locations are the best ones.

Whether there are any practical difficulties in the way of establishing the underground trolley in Chicago, and, if so, how they can best be overcome; also cost of such a system.

Estimates of the actual value of the physical property of the existing companies; what the cost of necessary improvements would be; estimates of probable increase in traffic as a result of better facilities and the city's natural growth; estimates of cost of future maintenance and operation, with allowances for depreciation, and an estimate of effect on receipts of a universal transfer system.

The Railway Company's Side in the Boston Subway Hearing

Ex-Attorney-General A. E. Pillsbury recently stated the position of the Boston Elevated Railway Company with respect to the Washington Street Subway. Considerable interest has been created, even outside of New England, in the proceedings of the Committee on Metropolitan Affairs, which is trying to decide the merits of the various claims made by the political authorities, the public and the railway company. Mr. Pillsbury contended that there is no immediate need for the removal of the surface tracks on Washington Street. He said that if a permanent tenure of a new deep tunnel or subway cannot be given the company, it may be obliged to build on one or another of its elevated locations through the heart of the city, though preferring not to do so, both because of the expense and the injury to real estate.

Continuing, Mr. Pillsbury said that the company was now paying more to the public in taxes than it is paying the stockholders in dividends by the sum of $320,000 a year. Moreover, the fixed charges have increased during the last four years $1,895,984, or 215.4 per cent. Traffic is increasing in nearly twice the ratio of net earnings. He suggested that it is not fair to either the public or the company for the road to take on burdens of additional improvement which shall place the financial success of the business in danger. In fact, he stated that the road has already nearly reached the limit of safety, and that good business judgment demands that further expenditures be deferred until the gross earnings are larger. The road, he said, has already put into construction $2,500,000 more than its original capital, and is under a legal requirement to build an elevated road to Cambridge which will cost not less than $4,000,000. It is therefore confronted with the need of $10,000,000 more capital, which, if acquired, will mean a still greater draft upon the net earnings, and perhaps a reduction of the rate of dividend, which has never exceeded 5¾ per cent, as against 8 per cent allowed by law.

Irrespective of the cost of a new subway for elevated lines, there is a demand for additional equipment and improvements of all sorts, and there are pending 542 suits for property damages, the settlement of which will require an additional outlay. Mr. Pillsbury reviewed briefly the main points in the three bills now before the committee, and explained the need of a direct avenue for the elevated lines through the heart of the city. He made the assertion that, if it were possible to build a Washington Street subway and rent it to a competing company, it would be a public misfortune, since most of the passengers using it would have to pay two fares instead of one.

Firemen's "Strike" on the Chicago City Railway

Last week it was heralded abroad by the daily press that striking firemen in the power houses of the Chicago City Railway had won a great victory for organized labor. The real extent of the strike and victory can best be judged from a narration of the facts of the case.

A short time previous to the strike two firemen who apparently had such important outside duties to perform that they could not look after their company duties properly, and whose attitude toward the company was anything but friendly, were discharged. Soon after this four more firemen on the same shift at the same power house (Fifty-Second Street) expressed dissatisfaction with the action of the company, and were allowed to go also. The claim was soon made by these two men, who had caused the trouble, or their friends, that they were discharged for belonging to the union. Shortly after this the coal teamsters' union took the matter up and threatened to stop hauling coal to the Chicago City Railway power houses unless the two discharged men were taken back. General Manager McCulloch refused to comply with this demand. Later a representative of the firemen's union presented a similar request, and this naturally met the same fate as the first. A little later six men, comprising one eight-hour shift of firemen at the Forty-Ninth Street power house, quit work during the rush hours one evening. This was the extent of the firemen's strike. No other firemen on any other shift or in any of the other power houses went out, although the company has four power houses, all worked by eight-hour shifts. After a temporary delay of some crosstown lines men were put to work in the six strikers' places, and in connection with securing new men and holding old ones wages were advanced from $1.75 to $2.00 a day. This would probably have ended the trouble were it not that the coal teamsters' union, which is very strong in Chicago, took a hand in the fight. At all of its power houses but one the company is dependent on coal hauled by teams. In spite of the fact that Harder & Hafer, who have a contract for furnishing all the coal for the Chicago City Railway, had a contract with the coal teamsters that the teamsters would not strike through sympathy for any other body of workmen, the teamsters refused on the morning of April 23, following the strike of the six firemen, to deliver coal to the Chicago City Railway power plants, and a committee from the firemen's union and coal teamsters' union called on General Manager McCulloch. Captain McCulloch pointed out that the company would get its coal without regard to the coal teamsters if it should come to a fight. However, he believed that a strike would be a bad thing for all concerned, and if a settlement was to be made it was much better to make it at once than after several days. The union representatives asked for the reinstatement of all the discharged and striking firemen, ten in all, and the right of the men to join a union if they chose. As to the main point at issue over which the controversy had arisen, namely, the reinstatement of the two discharged men, Captain McCulloch took the firm stand that the company could not consistently do anything of the kind, and would not consider it for a moment. As to the other firemen they were perfectly free to return if they desired, and the men were free to join a union, provided it did not interfere with their work. The company insisted on the right to employ whom it pleased without regard to unions, to discharge all who are unfaithful and to deal with the men as to the wages they are to receive. After retiring to the directors' room for consultation the two labor committees decided that Captain McCulloch's terms (which let matters go on as before) were acceptable and the "strike" was closed.

New Factory for the Making of Brake-Shoes

The foundry of the Allston Foundry Company, of Boston, Mass., which makes the Compo brake-shoe, was destroyed by fire about three months ago. With characteristic energy W. W. Whitcomb, the president of the company, immediately set about building a new one, and this company now has at Allston, Mass., one of the most complete foundries for the manufacture of brake-shoes in the country. The floor space of the foundry covers more than half an acre. More adjacent land is owned by the company, so that it has unlimited space for expansion. The foundry is equipped with the best appliances that money can buy for the expeditious execution of work. Learning from experience that woodwork is dangerous in a foundry the present plant of the Allston Foundry Company has no woodwork of any kind, and is fireproof throughout.

The interior of the foundry is equipped with the Coburn trolley system for the handling of molten metal. The metal as it comes from the blast furnace is poured into enormous buckets and carried by the trolley to the most distant part of the works, and there poured into small buckets, from which it is emptied into the molds. The minimum of time and the maximum of efficiency of labor is thus secured. In this manner a limited number of employees turn out 30 tons of Compo brake-shoes per day, and as labor is one of the chief items in the manufacture of brake-shoes this company can turn out Compo shoes at as reasonable prices as any rival foundry. When the metal is cooled the shoes are taken to the machine shop, where they are scratched and tumbled and made ready for the insertion of the corks. The corks, which are the advantageous feature of the Compo brake-shoe, are inserted by special machinery built for the company itself. These cork inserts, therefore, are put in position at small expense, and do not materially increase the labor account.

The cork inserts have been found, by large experience in street railway service, to have many advantages over the ordinary shoe. Their effect is to hold more quickly and to brake more uniformly throughout their contact without any objectionable gripping effect of an all-metal shoe. A smooth retardation of the car's motion when the brakes are applied is therefore secured. A want of uniformity in braking and sudden gripping results in flat wheels, and as the elasticity of the cork prevents this gripping and overcomes what is known as "bucking" the Compo brake-shoe is appreciated by the passengers. Only the best metal is used in the manufacture of the Compo shoe, and this fact, together with the cork inserts, avoids chilled and soft iron in the face of the same shoe. The company prefers the use of fine-grained, tough iron of medium hardness for mileage and cork inserts for braking. The foundry at Allston is in charge of F. L. Davis, who directs and superintends the work.

PERSONAL MENTION

MR. F. S. BREED has been appointed superintendent of the Berkshire Street Railway, of Pittsfield, Mass.

MR. C. M. MILLS, formerly electrician for the Northeast Electric Railroad of Kansas City, Mo., has been appointed superintendent of the Bozeman Street Railway, Bozeman, Mont.

MR. F. L. DAME has been appointed general manager of the Union Electric Company, Dubuque, Ia., taking the place of Mr. W. J. Brown, whose resignation as manager took effect April 1.

MR. E. C. HATHAWAY, manager of the Railway & Light Company of America, has been elected vice-president and general manager of the Knoxville Traction Company, of Knoxville, Tenn., to succeed General C. C. Howell, resigned.

MR. J. W. CARTER, assistant general superintendent of the Metropolitan Street Railway Company, has returned from a vacation in Northern Michigan, where he went to improve his health, and returns much benefited by his vacation.

MR. M. J. KENNEDY, superintendent of the Montreal Street Railway, of Montreal, Que., who has been in ill health for some time past, brought on by too close attention to his business, has gone to Europe for a short vacation. Mr. Kennedy is accompanied by Mrs. Kennedy and their son. Mr. George Stubble, the claim agent of the company, will act as superintendent in Mr. Kennedy's absence.

MR. W. M. BICKNELL, formerly of Cleveland and for some time general manager of the Miami & Erie Canal Transportation Company, has been made general manager of the Aurora, Elgin & Chicago Traction Company, and will assume charge May 1. Mr. E. R. Gilbert, at present general manager of the Chicago Electric Traction Company, of Chicago, Ill., will succeed Mr. W. M. Bicknell as general manager of the Miami & Erie Canal Transportation Company.

MR. THOMAS A. LEACH, who has been acting superintendent of Division 1 of the Worcester Consolidated Street Railway Company, of Worcester, Mass., since the resignation of Mr. H. E. Bradford, has been permanently appointed to the position. Mr. Leach's appointment is a reward for faithful service, for he has been in the employ of the company about fifteen years, beginning as a conductor. Mr. Leach has been a street railway man all his life, and before becoming connected with the Worcester Consolidated he was in the employ of the Metropolitan Street Railway Company, of New York.

CONSTRUCTION NOTES

BISBEE, ARIZ.—J. W. McCauley, of Pasadena, Cal., and T. J. Barkley, of Los Angeles, are considering the advisability of constructing an electric railway from Bisbee to Naco. It is estimated that the line would cost $200,000.

STOCKTON, CAL.—The Stockton Electric Railroad has been purchased by W. G. Henshaw, A. S. MacDonald and W. A. Bissell. Mr. Henshaw is heavily interested in the Oakland Transit Company, which controls the Oakland street railway lines. The rolling stock of the Stockton system will be increased and extensions made to various parts of the city. Interurban lines are projected, a line to Lodi being talked of.

BENICIA, CAL.—Electric railway franchises are now held by Messrs. J. W. Hartzell and H. F. Hartzell for street railways in Benicia and Napa, and also for lines through Napa and Solano Counties. They have in all five fifty-year franchises, which have been obtained in less than a year. It is possible that a system of interurban lines will be built.

FRESNO, CAL.—Satisfactory progress is being made in the construction of the Fresno Street Railway. Two miles of road have already been graded, and contracts have been let for grading 5 miles. The system, as now outlined, will consist of 10 miles of road, 5 miles within the city limits and 5 miles through the thickly settled raising section. The company has purchased 61-lb. rails, and the work of laying the track will be begun at once.

DENVER, COL.—The Denver City Tramway Company has applied to the City Council for franchises for the construction of about 10 miles of new line.

WILLIMANTIC, CONN.—The Willimantic Traction Company will probably erect a power plant in this city. The company is to build to Baltic and other places, as has previously been noted, and is rapidly perfecting all its arrangements.

WILMINGTON, DEL.—The street and sewer department has granted the Brandywine Railway Company a franchise to build an electric railway along Sixteenth Street from King Street to the Brandywine, thence to Pine Street, to Twenty-Third Street, to Washington Street, to Thirtieth Street, to Tatnall Street and return to Twenty-Third Street. The company will build and maintain a bridge over the Brandywine at its own risk and expense.

DOVER, DEL.—The incorporators of the Delaware Electric Traction Company, who recently purchased of the Delaware General Electric Railway the proposed electric railway to run through Kent County, a distance of 35 miles, met April 23 and elected the following directors for the ensuing year: J. Frank Allee and Dr. C. R. Layton, of Dover, Del.; S. John Abbott and Dr. George W. Marshal, of Milford, Del.; Dr. Thomas C. More, of Smyrna, Del.; Dr. L. S. Conwell, of Camden, Del. The directors in turn elected the following officers: J. Frank Allee, president; S. John Abbott, vice-president; Dr. Thomas C. Moore, secretary; Dr. Caleb R. Layton, treasurer. A survey of the route from Smyrna to Milford, and from Smyrna to Woodland Beach, the latter place being Lower Delaware's summer resort, will be made, and after its approval the construction will be begun. It is expected that operation will begin soon, and it is estimated that the road will be completed in four months. The proposed line traverses one of the most fertile sections in Delaware, and will offer unparalleled inducements to farmers who are many miles from the railroad as it now stands.