Street Railway Journal

Vol. XVIII. NEW YORK AND CHICAGO, SEPTEMBER 7, 1901 No. 10.

THE SYSTEM OF THE NORFOLK & ATLANTIC TERMINAL COMPANY

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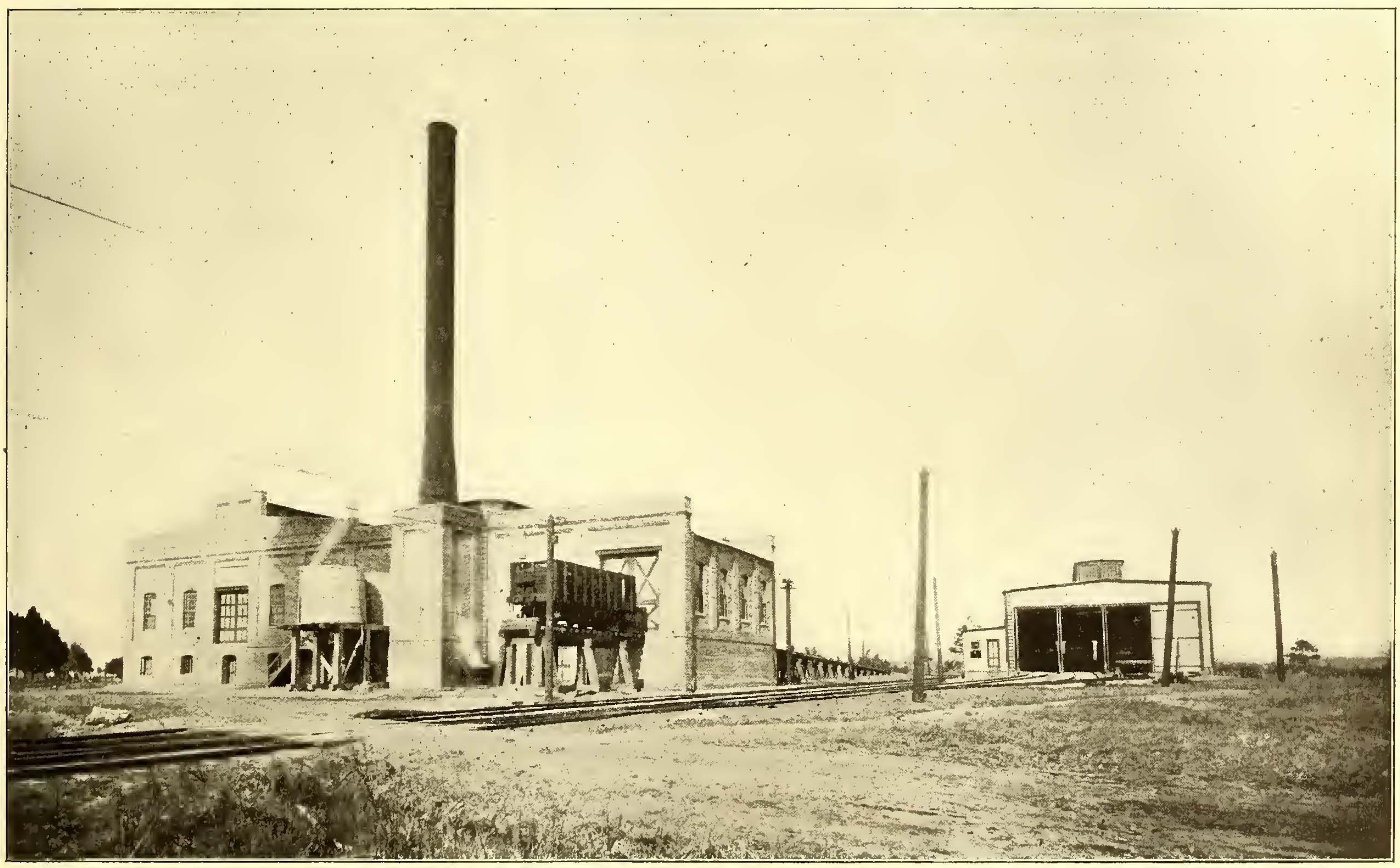
During the past ten years few Southern cities have shown the marked development and commercial activity in proportion to their population as has Norfolk, Va. Norfolk is best known as a seaport city, and possesses in Hampton Roads one of the finest harbors on the Atlantic coast. The entrance from the Atlantic Ocean to Chesapeake Bay and Hampton Roads is between Cape Henry and Cape Charles. An American admiral on the bridge of a battleship remarked, while passing between these capes, "Here lies the gateway of the world." This was many years ago, but the development of the shipping and other industries of Norfolk harbor has long since justified these words. Eastern capital has realized the importance of Norfolk, and appreciated its advantages to the extent that many millions of outside money have found safe and profitable investment in Norfolk and its suburbs.

Norfolk proper has a population of 50,000, and is the commercial center of Portsmouth, Berkley, Newport News, Hampton, Old Point, Lamberts Point and other smaller towns. Her wholesale merchants supply the demands of numerous coast and inland cities in Virginia, North and South Carolina and Maryland.

The situation of Norfolk is such that it is practically surrounded by water, there being but one rail route with a direct connection into the city proper. The New York, Philadelphia & Norfolk Railroad, Southern Railway, Chesapeake & Ohio Railway, Seaboard Air Line Railway, Norfolk & Southern Railroad, Norfolk & Carolina Railroad, Atlantic & Danville Railroad, Atlantic Coast Line Railway and other rail routes are compelled to transfer their freight and passengers by steamers and barges. The numerous vessels necessary for the conduct of this business creates a condition of never ending activity in the harbor.



POWER STATION AND CAR HOUSE AT TANNERS CREEK

The electric railway and lighting properties of Norfolk, and its suburbs, have long since attracted the attention of capitalists, and large sums have been invested in these enterprises, all of which have proven to be gilt-edge propositions.

The latest development in the electric railway line in Norfolk is the system of the Norfolk & Atlantic Terminal

Company, which line possesses some features of unusual interest. The business of this company is divided into four separate and distinct classes: (1) The local 5-cent fare collection, which entitles passengers to a ride on the company's line within a radius of 5 miles; (2), the seashore business which is handled to the company's resort, Piney Beach, at "Norfolk-on-the-Roads," at the terminus of the rail route; (3), the through business which is handled between Norfolk and Old Point Comfort and Newport News by steamers in connection with the railroad, and (4), the handling of package and carload freight. In addition to the above the company conducts a wharf and warehouse business at its deep water terminal.


TERMINAL AT OLD POINT

This system has been in operation for about eight months; the physical condition of the property is first-class in every detail; the rail line consists of 9 miles of double track, laid with 90-lb. rail. On account of a city ordinance it was necessary to use girder rail in the city limits, but beyond the city the line is laid with T-rail, and standard steam construction is closely followed.

The Norfolk & Atlantic Terminal Company's city terminus is at the corner of Plume Street and Atlantic Street, in the heart of the business section, and consists of an elaborate depot, with ample facilities for the handling of trains within an enclosed station. The depot is known as Central Station, and is appropriately named, being centrally located, and the most commodious terminal in the city.

Central Station represents an investment of $150,000, has a frontage of 60 ft. on Plume Street, and extends down Atlantic Street a distance of 300 ft. to City Hall Avenue. It embodies every known feature for the comfort and convenience of the company's patrons. Handsome waiting rooms, toilet rooms for ladies and gentlemen, ample office facilities for the conduct of the company's business, a well-conducted restaurant and café, newspaper stands, cigar stands, barber shop, and, adjoining, but under the same roof, the most complete market in the city, the market occupying a space of 60 ft. x 300 ft. This has been found a great convenience for the suburbanites who patronize the lines of this company.

Household orders are filled at the Metropolitan Market, and delivered aboard the cars for transit to their destination. Tuesdays, Thursdays and Saturdays are known as market days; on these days enormous quantities of packages and baskets are handled over the line to Park Place, Virginia Place, Kensington, Lamberts Point, Atlantic Park, Norfolk-on-the-Roads, Old Point, Hampton and Newport News. While only a nominal charge is made for each individual package, the aggregate amount received nets the company a handsome revenue. For the conduct of this business two combination cars are provided. The company has an agent, with a corps of assistants, who conduct the business transactions at Central Station.

The charges on packages are based on the weight, distance carried and class of goods. A market basket, 5 lbs. to 20 lbs., is carried to any point on the railway for 10 cents; a transfer of this package to Old Point or Newport News by steamer is covered by additional charge of 5 cents. A package of merchandise or other valuable matter is covered by a rate 25 per cent higher than that pertaining to provisions and perishable matter. For a barrel of beer or oil the rate is 25 cents; for a 200-lb. cake of ice the charge is 11 cents. Ice is handled in ton lots at 80 cents per ton. Every freight item is entered on a manifest, which accompanies the shipment, the shipper having received a receipt upon the delivery of the goods to the company. All freight is prepaid, except in the case of a few large shippers, who settle their accounts weekly.

The company provides merchants and other shippers with freight receipt books. These books have a duplicate stub; the shipping clerk fills out both stub and receipt, the driver delivers book to the company's agent, who tears off receipt and files in his office. On the stub left in book he rates the amount of freight paid, and signs his name, thereby designating that the goods were received and were in apparent good order. The net profits from this business will average $10 per day.


DEEP WATER TERMINAL AT PINEY BEACH

On the 5-cent fare collection no effort is made to handle tickets, but on all business to the beach and through business, via steamers, passengers are required to purchase tickets before boarding trains.

The tickets of a dozen railroad and steamship lines are accepted for passage on the trains and steamers of the Norfolk & Atlantic Terminal Company between Norfolk and Old Point and Newport News. At the close of each month these so-called "foreign" coupons are forwarded to auditors of the lines responsible for their issue, who return check covering the canceled coupons received. Old Point Comfort is one of the best known year-around resorts on the Atlantic Coast, and is visited annually by thousands of tourists; the majority of these visitors hold coupons entitling them to a side trip to Norfolk.

A ten-minute local service is maintained between Central Station and Tanners Creek, a fifteen-minute service is operated between Central Station and Norfolk-on-the Roads, Norfolk-on-the-Roads being 4 miles beyond Tanners Creek, while an hourly service is given between Central Station and Old Point Comfort, Hampton and Newport News. This is handled as an express service, trains on these runs being designated by white flags, and make but one stop on a run of 9 miles. The business between Norfolk, Old Point, Hampton and Newport News was for many years controlled by the numerous steamer lines operating between these points. The steamer lines, however, have not been able to withstand the superior inducement afforded to the traveling public by quick service and more frequent trips. The distance between Norfolk and Old Point is 14 miles, Norfolk and Newport News 15 miles. Hourly trips are made from 6 a. m. to 12 o'clock midnight.

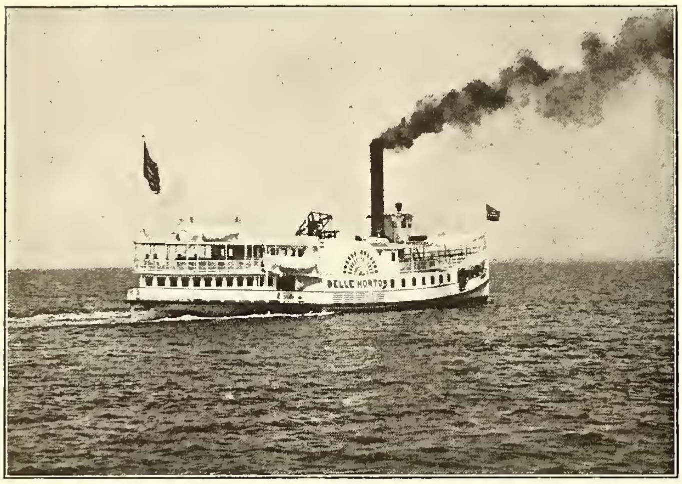
The time consumed by steamers between Norfolk and either of the above-named points is, under the most favorable conditions, one hour; in bad weather the time is more frequently one and a half hours. The time of the Norfolk & Atlantic Terminal Company's express between these points averages fifty minutes.

The rolling stock of this company is all of a high-speed, heavy-weight, double-truck pattern, and on account of the climatic conditions, consists of both open and closed cars. An interesting feature of the equipment is the "Lowenberg convertible car," this being a car which can be converted from an entirely closed car to an entirely open car, or vice versa, within three minutes, without disturbing passengers. Some particulars of this car were published in a recent issue, but other views are presented herewith. The construction of this car is unusually strong and heavy, which gives the car the advantage of additional traction in the handling of double-truck trailers. At certain seasons one end of the car is operated open and one end closed, an air-tight glass partition dividing the two ends, thus permitting smokers and other vigorous persons to avail themselves of the pleasure of an open car, while those inclined to warmer climes can secure any degree of temperature through the the regulation of the electric heaters in the closed compartments.

ELECTRIC FREIGHT CAR


PIER AND WHARF OF THE COMPANY AT NEWPORT NEWS

The smoking compartment afforded by the convertible cars has proven immensely popular with the traveling public. There is now on foot a movement to have passed at the next meeting of the Virginia State Legislature an act requiring all electric railroads to provide separate cars or compartments for white and colored passengers. While this will work a hardship on the strictly city lines, in that it



ONE OF THE STEAMERS OWNED BY THE COMPANY

will require them to constantly haul a trail car for its colored patrons, the double compartments of the convertible car will conform with all requirements of the act.

The rolling stock of the Norfolk & Atlantic Terminal Company consists of twenty-four passenger coaches, six freight cars and one steam locomotive. The motor equipment consists of Westinghouse No. 56 motors, which have been found to be peculiarly adapted to the high speed and heavy service; the trucks consist of McGuire No. 37, and the Brill 27-B. All cars, both motors and trailers, are equipped with the Christensen Engineering Company's automatically governed, electric compressure air brake out-

STANDARD OPEN CAR

fits. Before the installation of the air brake system it was necessary to carry a brakeman on each and every trail car. This was both an expensive and confusing state of affairs, it having proven under practice that a brakeman on the trail car would apply the brake pressure when it was not needed, and as often would fail to apply it when such action was most necessary.

A very flexible and satisfactory car for the handling of freight and other bulky business is the result of a reconstructed standard steam baggage car, an illustration of which is herewith presented. This car was originally 50 ft. long, it was cut in two, and a 12-ft. section taken out of the center. This accounts for the confused lettering, as the car has not been relettered since the change was made. The sills were then spliced, and, with the connection of the camber rods, the result is a car of greater strength than when it was in steam service. An 18-ft. section of this car is entirely enclosed; this is for the protection of perishable freight. The remaining 20 ft. is open on both sides, but for the roof supports. This allows quick handling of ice, brick, cement, lumber or other bulky freight. Teams can back up to the car, and load or unload much more readily than from a closed car. This car is mounted over two of the Brill Company's 27-B high-speed trucks, equipped with Westinghouse 56 motors and air brakes. The automatic M. C. B. couplers remain on this car in order that the equipment of the connecting steam lines can be handled when necessary.

At present the carload freight business is handled by a steam locomotive. On account of the frequent passenger schedule operated, it is not considered good practice to op-

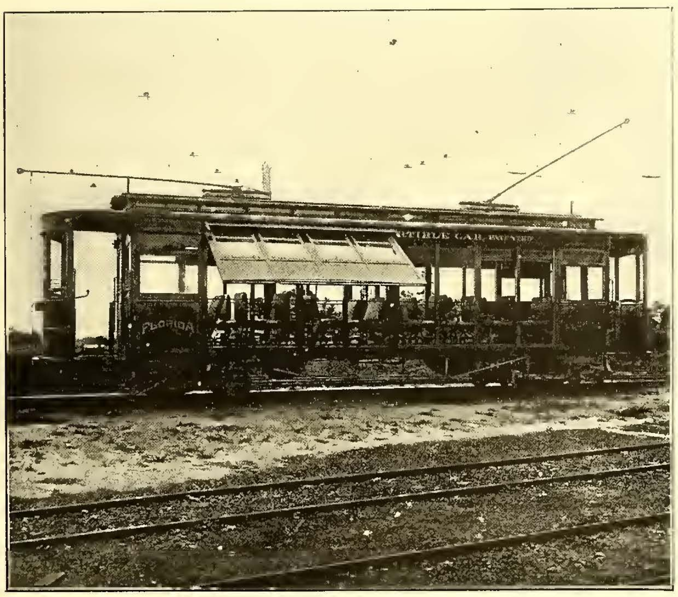
CENTRAL STATION AND CAR HOUSE

erate the steam locomotive during the hours that the passenger schedule is in force. It is, therefore, considered more economical to operate the steam locomotive after midnight than to run the power plant in order that this business might be handled by electric cars. Comparing the cost of an electric locomotive with sufficient power to duplicate the work of the second-hand steam locomotive, the odds were overwhelmingly in favor of the latter. Locomotive engineers and firemen are engaged by the company in other capacities, and are detailed for night work on the steam locomotive from time to time. To secure the service of competent operatives a higher rate of wages is paid for the time made in steam service.

Through the Norfolk & Western Railway this company has a connection with every terminal in the city. Its business is conducted in the same manner, and on the same forms, as that of steam roads. A flat rate of $5 is charged for every loaded car handled over the line of the Norfolk & Atlantic Terminal Company. As many as twenty loaded cars have been moved in one day; the business consists of sand, lumber, cord wood, coal, farm products and all building materials which are used in the extensive building operations now going on at Piney Beach.

The power plant of the Norfolk & Atlantic Terminal Company is situated at Tanners Creek in a massive brick building, 90 ft. x 150 ft. The boiler room is separated from the engine room by a brick fire wall, 24 ins. thick, and the entrance point through this wall is covered by a fireproof iron door. The engines and dynamos are mounted on brick foundations, which are built up 12 ft. above the earth's level, thus allowing a large, light basement floor under the engine room proper. In this basement are located fireproof oil vaults, storerooms, machine shop and neatly furnished bedrooms for the use of the chief engineer and his assistants during emergencies. The coal cars are run on a trestle extending through the boiler room, as shown in the first engraving, and dump the fuel directly in front of the boilers.

The mechanical equipment of this plant consists of 600-hp return tubular boilers, manufactured by the Keeler Company, of Williamsport, Pa. The boilers are fed from thirty-six 4-in. driven wells. All pumps and appliances in the boiler room are of ample size and capacity. The engine equipment consists of two Hamilton Corliss single cylinder, heavy-duty railway engines, directly belted to two Westinghouse railway generators, the combined amperage

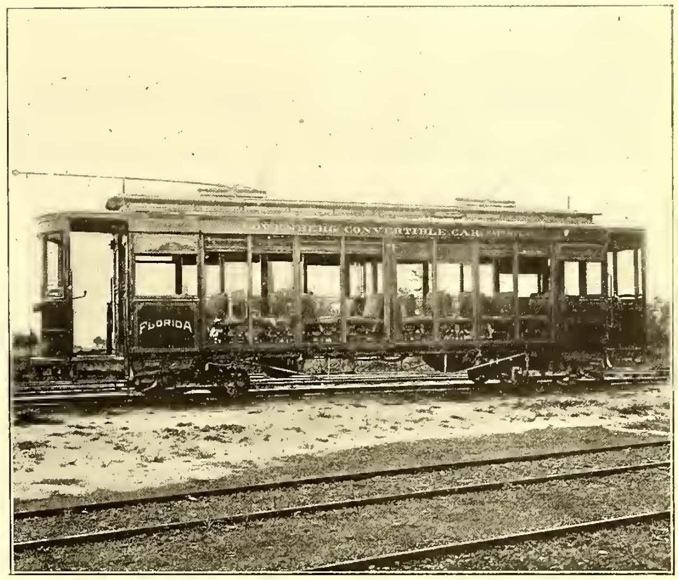


METHOD OF CHANGING CAR

of the two generators being 1000. A 75-hp Erie Ball engine drives a General Electric alternating machine, of 1200-light capacity, for the purpose of producing energy for the illumination of the company's pavilion, theater, etc., at Norfolk-on-the-Roads. The boiler, engine and dynamo foundations are piled, and the piling capped with 4 ft. of concrete, the same applying to all wall lines, and for 16 ft. outside of the same. This precaution was taken to provide foundation for additional machinery, which may be installed from time to time, as the driving of additional piles near the wall lines would result in weakening the same. Water for condensing purposes is drawn from Tanners Creek, through a 15-in. iron pipe line, the lift being about 6 ft. at low water, and 4 ft. at high tide. The business of the company has developed to such an extent that additional power generating machinery will be installed during the coming fall.

The car house is located directly opposite the power house, being a frame building 70 ft. x 350 ft., with a storage capacity for the entire equipment. Store rooms and machine shop are attached to the main building. In the car house there is over 700 ft. of pit room, thus allowing every facility for the inspection and maintenance of the trucks, motors, etc.

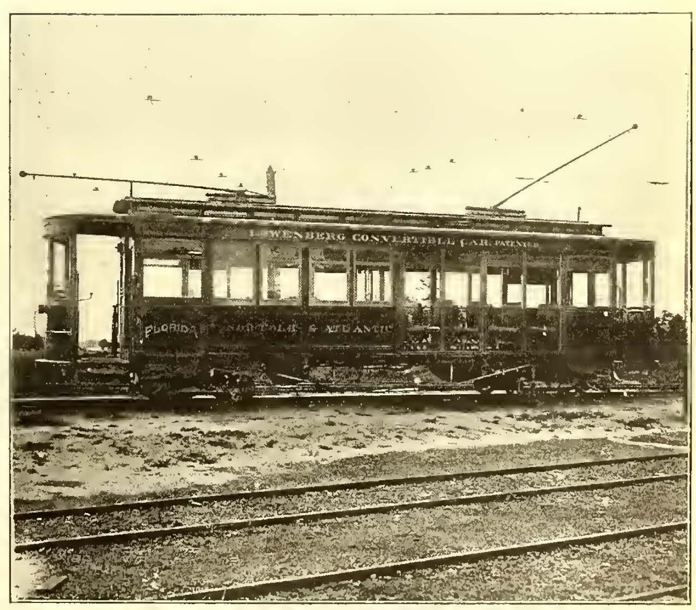
In the construction of this company's line strong opposition was encountered from the Norfolk & Western against crossing five tracks of that company at grade, the result being that the company constructed a double track overhead crossing, 1000 ft. long, the grade over same being a decimal less than 5 per cent. The line is well coppered, and as the trains usually approach the trestle at a



CONVERTIBLE CAR—OPEN

rate of speed approximating 12 miles per hour, little difficulty is encountered in surmounting the grade.

In the construction of the line it was necessary to do a considerable amount of piling and trestle work, the most conspicuous example of which is the drawbridge over Tanners Creek, an illustration of which accompanies this article. This structure is 2000 ft. long, and consists of double-track electric railroad, and a 20-ft. driveway alongside. The entire structure is built as one section, with no railing between the driveway and the tracks, and is covered



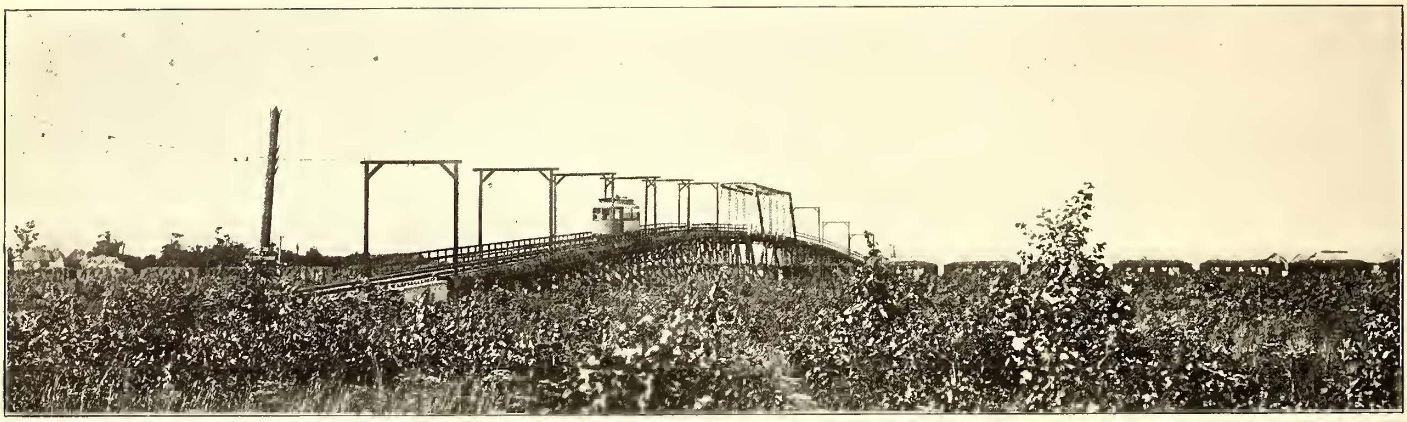
CAR AS IT IS OFTEN RUN—HALF OPEN AND HALF CLOSED

with 2-in. decking. The bents in this structure are 12 ft. between centers, and each line of piles consists of eight creosoted sticks, with 36-in. butts, driven to hard bottom. These piles are surmounted by caps of Georgia heart pine, 12 ins. x 14 ins.; crossing these caps runs six lines of stringers of similar size. Oak ties are laid across the stringers; the rails are spiked to the ties, and the space between the rails decked with 2-in. heart pine, with a groove cut through the pine decking on the inside of the rail, to allow a clearance for the wheel flange.

Tanners Creek is a navigable stream, many vessels passing in and out. In the center of the bridge structure above described is a draw, which is constructed on the pivot pattern. This draw was built by the Union Bridge Company, it is 200 ft. long, and weighs over 200 tons. The handling of the draw allows an opening of 60 ft. in the clear on each side of the draw foundation. The channel at this point is 25 ft. deep. The draw proper is operated by electricity, a 50-hp motor being geared directly onto shafting, which connects with gears and pinions controlling the movement of this mass of iron. The time consumed in opening and closing the draw is about three minutes. The company maintains bridge tenders, who are on duty night and day at this point, a place of residence being provided for them by construction of buildings on the bridge proper.

A 1,000,000 circ. mil submarine cable is laid on the bottom stream to conduct current for the operation of the lower end of the railroad. The private telephone system which is used for the despatching of trains, etc., also crosses Tanners Creek through the agency of a submerged cable. A third cable is provided for the 2000-volt alternating circuit.

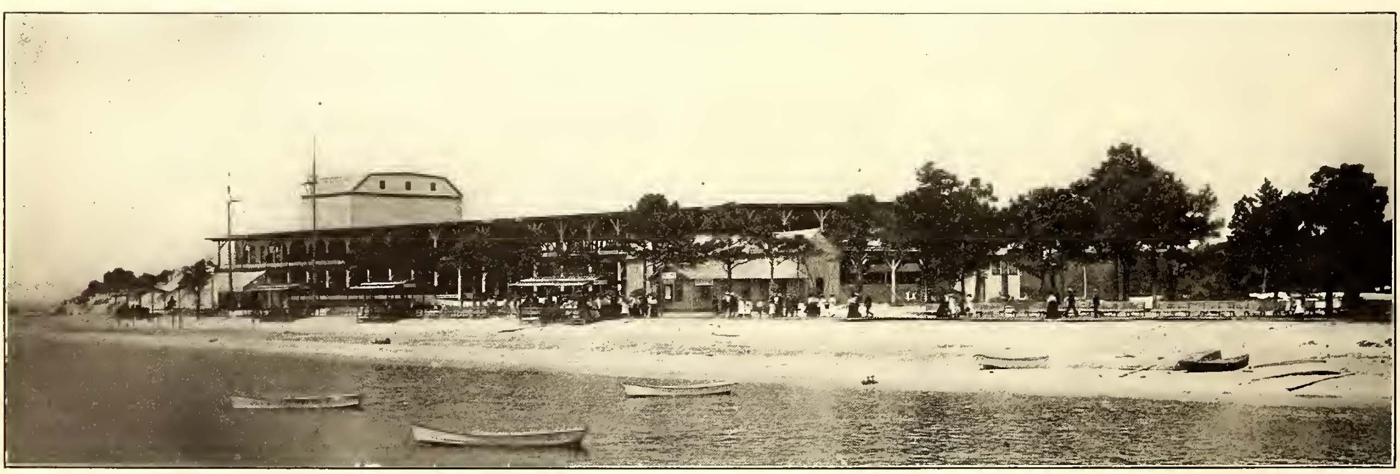
The deep-water terminal of the Norfolk & Atlantic Terminal Company consists of a substantial pier running 1200 ft. from the shore line, where it connects with a five-sided wharf of liberal proportions. The construction of this work is substantially the same as above mentioned for the Tanners Creek Bridge. In the center of the wharf is a building 50 ft. x 150 ft., in one end of which is located waiting rooms, toilets, wharfmaster's office and package room; the remainder of the building consists of the warehouse proper. On the west side of the wharf is a car transfer slip, equipped with all necessary chains, cables and counterweights for lowering the apron of the car-slip to conform with the track level of the transfer barges receiving or discharging cars. Being directly opposite the line of travel of transfer floats doing business in Norfolk harbor, the company is thus permitted to carry on an interchange of cars with the various railroads and steamship companies.



VIADUCT CROSSING FIVE TRACKS OF STEAM RAILROAD

At Newport News the company uses the wharf of the connecting electric railway line, cars of which are run directly to the steamer's side. At Old Point Comfort the company uses the government dock; this dock is maintained by the government and one-half of the maintenance charges are collected from the numerous transportation companies doing business at this point.

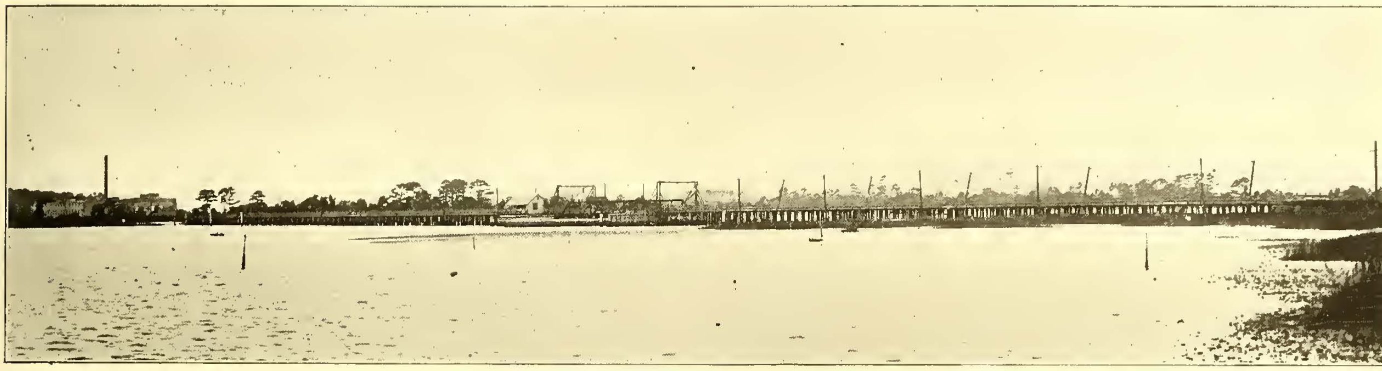
For the conduct of the steam-ferry service the Norfolk & Atlantic Terminal Company operates two staunch ocean-going steamers. The steamer "Norfolk-on-the-Roads" is 125 ft. long, 24 ft. beam and 10-ft. draft, and it is one of the ablest vessels on the Atlantic Coast, her triple-expansion engines developing 1200 hp. The second steamer is the "Belle Horton." Both of these vessels have been elaborately fitted out by the company, and afford every facility for the comfort of the passengers. Both steamers are equipped with electric light plants and searchlights. The café and restaurant of these vessels is conducted on a high plane and at strictly city prices. The operation of these two steamers requires a crew of forty-two men; the vessels are under steam twenty-four hours per day, and carry a complete double crew. During the



PAVILION AT PINEY BEACH

summer excursion months string bands are provided at the expense of the company for the entertainment of its patrons aboard its steamers.

The Norfolk & Atlantic Terminal Company is also the owner of an elaborate pavilion and summer theater, which has within the last thirty days been completed and opened to the public. It is a two-story frame structure 175 ft. x 400 ft., and is entirely open on all sides. For the fall and winter season the ground floor will be enclosed in glass and heated by steam. Under the roof of this enormous structure are located bath houses, restaurants, cafés, ice cream and other refreshment stands and numerous toilet facilities, two extensive ballrooms and the Imperial Theater. The bath houses are modern and up to date, being provided with hot and cold, fresh and salt water and needle showers. A charge of 25 cents is made for bathing suit, private room, shower baths, etc. The Imperial Theater has a stage and all appliances capable of presenting practically any production that goes over the road. The theater proper will seat 2300 persons, with standing room space for 3000 additional persons. Since June 1 vaudeville and other attractions of high class have been presented at this theater, and most liberally patronized by the general public.



BRIDGE 2000 FEET LONG CROSSING TANNERS CREEK

The theatrical enterprise is handled by a salaried manager, the company providing ticket sellers, ticket takers, etc. The payment of 15 cents entitles a person to select a seat in certain portions of the house; an additional fee of 10 cents covers the selection of a seat in a more desirable location and where more elaborate seating facilities are provided. The restaurants, cafés, refreshment stands and other features are leased by the season for a specific sum, thus assuring the company of a stated income each year.

On the beach has been constructed the elaborate "Piney Beach Hotel," at a cost of $250,000. This structure is owned by the Norfolk-Hampton Roads Company, the real estate syndicate which controls 3000 acres of land at Norfolk-on-the-Roads. The grounds of the "Piney Beach Hotel" immediately adjoin the 20 acres which comprise the entire real estate holdings of the Norfolk & Atlantic Terminal Company at Norfolk-on-the-Roads. This hotel is being equipped with every facility for the conduct of a high-class hotel business, and, no doubt, will materially assist in the development of the railroad company's resort.

Norfolk being on the seacoast, is the outlet for thousands of excursionists from interior Virginia and North Carolina who seek a day of pleasure on the sands of Chesapeake Bay and the Atlantic Ocean. An enterprising soliciting agent is constantly on the road to meet incoming excursions and personally conduct them to "America's favorite resort."

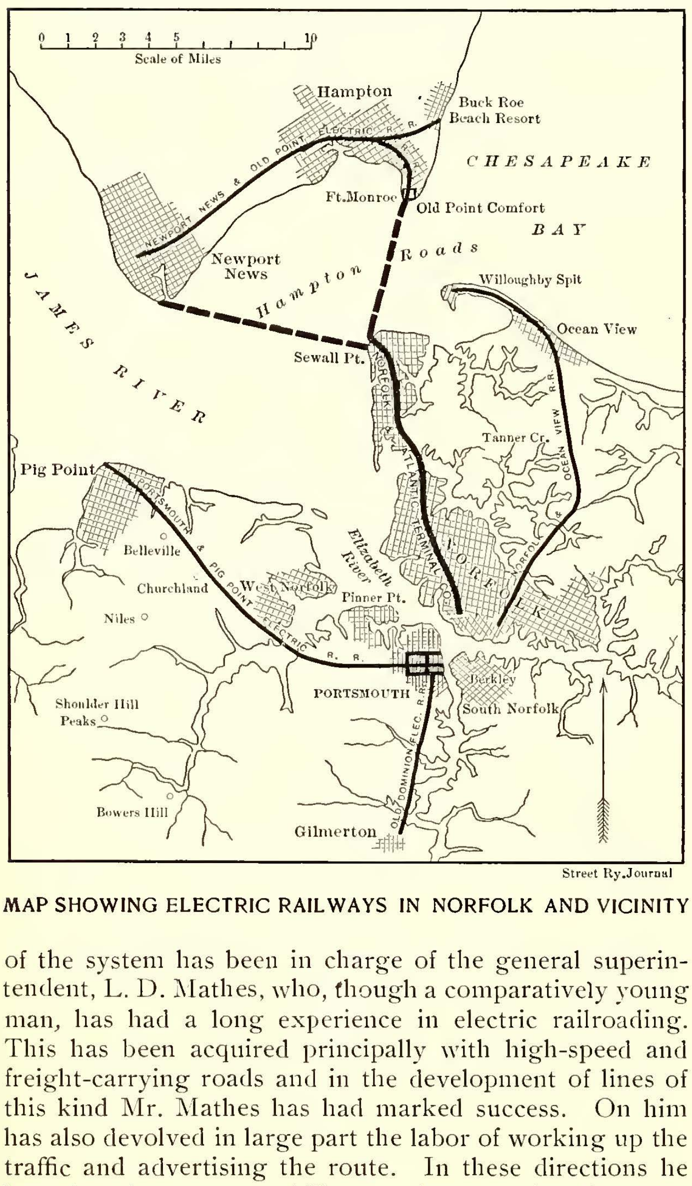
The Norfolk & Atlantic Terminal Company is a liberal advertiser, carrying its schedule in some fourteen daily papers; small local reading notices are scattered through the columns of the journals, calling the attention of the public to the many attractions at Piney Beach and the delights of a trip over the "great double-track historical scenic route." The latter phrase was coined from the fact that the cars of the company run alongside of elaborate breastworks which were erected by the Confederates during the civil war. Several carloads of cannonballs and fragments of exploded artillery have been unearthed and arranged in pyramids for the inspection of tourists. The wharf property of this company is built on the spot at which was fought the memorable battle of the "Monitor" and the "Merrimac." The results from advertising have been most satisfactory.

TYPICAL STATION ALONG LINE OF ROUTE

The entire plant and system of the Norfolk & Atlantic Terminal Company was devised by the J. L. Blackwell Company, Incorporated, of Baltimore, the construction being done under the personal supervision of its chief engineer, J. B. Scott. The general contractors for the entire system were the Sanford & Brooks Company, of Baltimore. To the Blackwell Company, its engineer, Mr. Scott, and the Sanford & Brooks Company, much credit is due for the successful manner in which many difficulties were met and surmounted.

The officers of the Norfolk & Atlantic Terminal Company are: D. Lowenberg, president; H. L. Lowenberg, vice-president and general counsel; Caldwell Hardy, treasurer; Wallington Hardy, secretary, and L. D. Mathes, general superintendent.

The successful construction of the system of this company is due to the tireless energy of D. Lowenberg, the company's president. This gentleman, having entire confidence in the future progress and development of Norfolk, has secured the investment of large sums of money for many important commercial enterprises, and has always been in the lead in any movement which was for the advancement of the city's interest. The practical operation



MAP SHOWING ELECTRIC RAILWAYS IN NORFOLK AND VICINITY

of the system has been in charge of the general superintendent, L. D. Mathes, who, though a comparatively young man, has had a long experience in electric railroading. This has been acquired principally with high-speed and freight-carrying roads and in the development of lines of this kind Mr. Mathes has had marked success. On him has also devolved in large part the labor of working up the traffic and advertising the route. In these directions he has also shown great ability, as the attractive literature published by the company and the many special features introduced to incite interest in tourists testify.

The Atlantic Avenue loop of the Boston Elevated Railway was opened for service Aug. 22. The loop forms a portion of a circuit, which also includes the main line of the elevated between Castle Street and Sullivan Square, upon which are located eleven stations. The time to make the circuit of the loop is twenty minutes.

Street Car Platforms

BY W. E. PARTRIDGE

Since the steam car, horse car and modern electric car have been all evolved, or developed, from the stage coach, it is not surprising that they have many strong points of resemblance. In their details there is much that appears identical. The street railway man, deceived by this identity of appearance, is often misled, and follows steam car practice in his construction; the result is usually an increase of cost, unnecessary weight, and an unsuitability of the construction to the mechanical requirements. It will, therefore, be of some interest to follow the steps which have given such a similarity of appearance with such wide structural differences.

The first American steam cars (see Fig. 1) were coach bodies, each set upon an under frame of its own, which

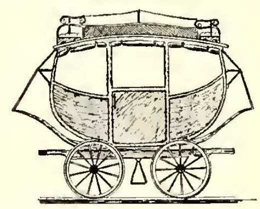


FIG. 1.—EARLY MOHAWK & HUDSON RAILROAD COACH

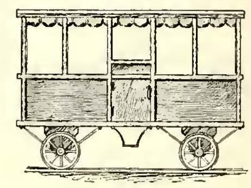


FIG. 2.—EARLY SOUTH CAROLINA PASSENGER CAR

was carried by four wheels; it was a coach fitted to run upon rails. From the single coach body upon a frame mounted upon four wheels to several bodies upon a single frame, and to a long body with side seats, with wheels and axles carried by jaws attached to the body of the vehicle, were some of the changes that followed quickly. In fact, the changes and improvements took place so rapidly during the first few years of American railroad development that it is now difficult to place them in their proper order. It must be remembered that the first locomotive in the country, Peter Cooper's experimental engine, made its maiden run in 1829. It was a car and engine combined. Yet within two years we find the coach body giving way to something more like a modern car. Fig. 2 shows the external form of the cars used on the South Carolina road as early as 1831. It is a considerable remove from the coach form. That these cars were of considerable size, and probably differed from the coach in their interior arrangements, is shown by an order of the directors as follows: "Resolved, That in future not over twenty-five passengers be allowed to go on each car." Judging from the appearance of the passengers in old engravings, it would appear that the seats were longitudinal and probably central.

It was probably within a year of this date that Osgood Bradley, of Worcester, Mass., a coach builder, constructed his first steam cars. The order came from an Eastern road, and when completed they were hauled from Worcester to Boston by ox teams. These cars consisted of three coach bodies set upon a single long frame. They were a distinct step in advance of those on the Mohawk & Hudson Road. They probably seated from thirty-six to forty-eight passengers each.

Strict chronological order is not easily followed in the history of this early work. The first train in America had not completed its first round trip before some of the new conditions of the new method of traveling made themselves apparent. Survivors of that trip told amusing stories of how, by means of fence rails wedged between the carriages, they mitigated those longitudinal shocks which threw them from their seats, and which from that day to this has been the bane of steam railroading.

The second step in car construction appears to have been taken by Ross Winans, of Baltimore. He apparently saw the necessities of the case at once. It seems that his first cars were radical departures from the coach body form. He built a long car, removed the steps from the sides to the ends, made end entrances, and introduced a center aisle with cross seats. At the same time he framed the sides and floors with sufficient strength to resist the longitudinal shocks. He practically gave the steam car its modern form. From this time forward the old-fashioned coach framing was pretty generally abandoned among the leading steam roads.

The first street cars, like the first on steam roads, were coaches having wheels fitted for use on rails. Stephenson, the father of street railway cars, followed the same lines as the steam railway car builders, and at one time used these coach bodies built together. Finally he adopted the omnibus body, lengthening it, and giving it two entrances. The platforms were modifications of the omnibus steps, or, perhaps, more correctly, an expansion of the broad omnibus step into a landing, or platform. Views of these early types of street cars have frequently been published, so that their appearance is familiar to readers of this paper.

From appearance, one might judge the platforms of both classes of cars essentially the same. Both are placed at the ends of the car, and usually have the same form, etc. The steam and street car platforms, however, have little in common beyond the fact that the passengers use them as landings. This, indeed, was their first use. They adhered closely to the function of their prototype, the omnibus step. A complete and radical difference in their

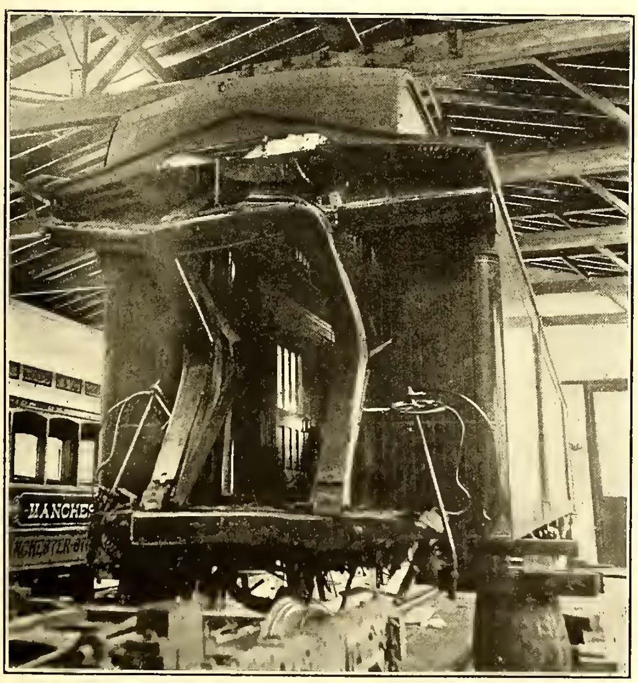
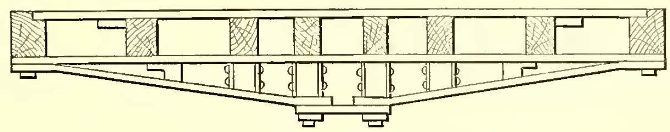


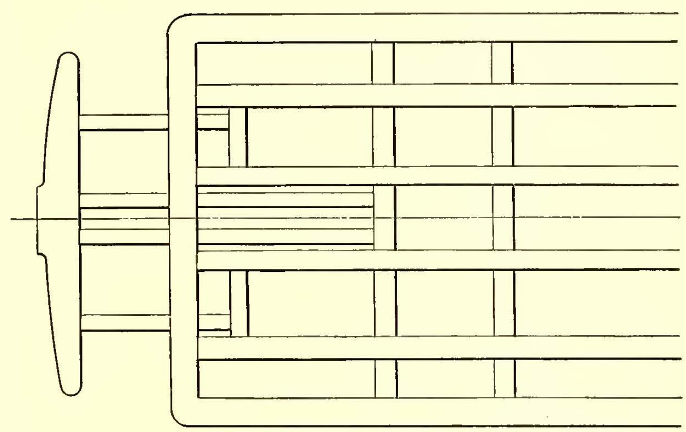
FIG. 4.—STEAM CAR PLATFORM AND VESTIBULE AFTER A COLLISION. CAR BUILT BY THE LACONIA CAR CO.

functions, however, at once became apparent. The steam car platform is practically never loaded, three or four people at most are all that it is called on to carry at any one time; but from the first it became necessary to give it immense longitudinal strength; in the first trains they acted as buffers. As the speed and size of trains increased, the need of strength in this direction increased, until at the present time of the platform and floor frame, its chief duty is that of a battering ram. While it carries the draft "rigging" and sustains the full draw-bar strains produced by heavy engines, its chief strength is to resist endwise shocks. These are often of extreme severity.

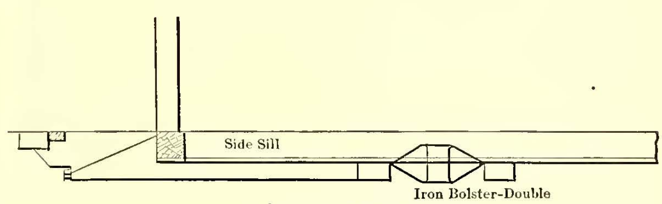
Fig. 3 shows how heavily the small platform of an ordinary day coach is built. The chief idea of the design is longitudinal strength. The timbers are doweled together, the buffers are in line with the sills, and the whole arrangement of the frame shows this idea of providing resistance in a longitudinal direction. Incidentally, there is, of course,



SECTION THROUGH BOLSTER.



PLAN OF PLATFORM AND FLOOR FRAME.



SIDE ELEVATION.

Street Ry. Journal

FIG. 3.—FRAMING OF A MODERN STEAM CAR PLATFORM

a great vertical strength—much is required to carry such a weight.

When the steam coach platform has been made strong enough in a vertical direction to carry its own weight, it has an ample margin for the support of any load that will be placed on it in actual service. Practically no more than half a dozen persons form the heaviest load ever carried by the platform of a steam coach. It is only in use when the car is at rest; when in motion it is rarely occupied by more than two persons, and railroad regulations, as evidenced by the well-known notice, "passengers are not allowed to stand on the platform," do not contemplate even this light weight.

That the steam car platform should be made of enormous strength is a railway axiom which is well illustrated by Fig. 4, and which shows the end of a car built by the Laconia Car Company as it appeared after an accident. A freight and a passenger train came into collision in a fog; the passenger train was making about 40 miles per hour, the freight was going at least 35 miles, and the speed of striking was, therefore, at least 75 miles per hour, possibly a little more, because the engineers, behind time, were trying to make a meeting point. Both locomotives were reduced to scrap, ten of the freight cars next the engine were reduced to kindlings. The car illustrated was next to the passenger engine. The tender of this engine was forced upward by the blow, doing the damage shown. No one was injured in the passenger train, though the passengers were badly shaken up.

The car was sent to the shops of the Laconia Car Company for repairs, where the photograph was taken. The vestibule was the only portion injured, and an officer of the car company stated to the writer that the cost of putting the car in shape for service after the accident did not exceed $100. A less massive construction of platform and end of the car would certainly have entailed a heavy loss of life.

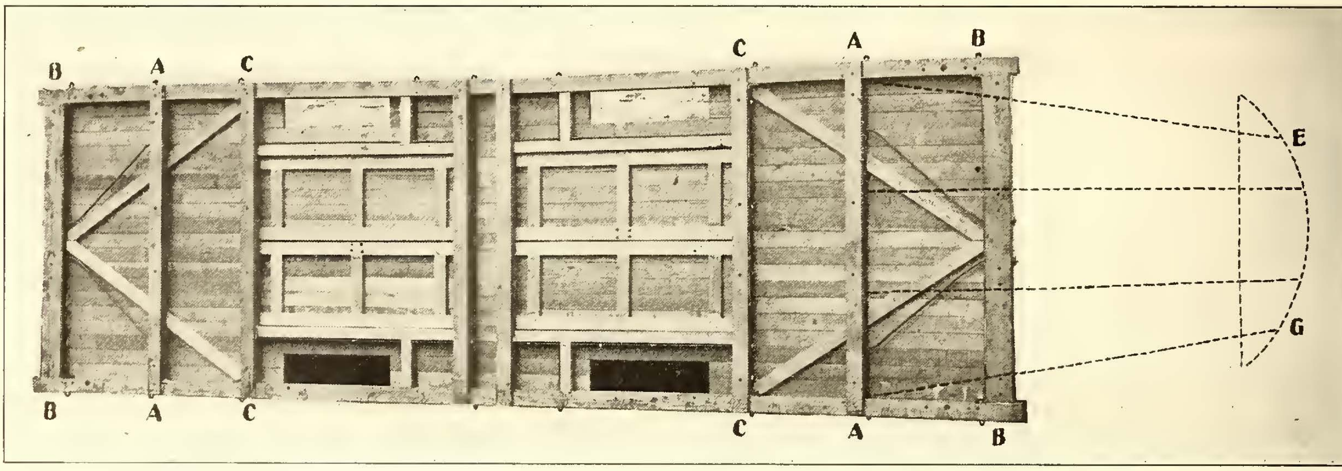


FIG. 5.—THE FLOOR FRAME OF A FOUR-WHEEL ELECTRIC CAR—A COMMON FORM OF CONSTRUCTION

In designing the horse car platform the first idea was the same as in designing that of the steam coach. An enlarged step, or landing, had to be made, in order to give an easy entrance to the body of the car, but a difference in use or function at once became apparent. It became not only convenient, but necessary, to carry passengers on the horse car platform. In this we at once see the radical difference between the two types. In a word, one type is a battering ram, the other a load carrier.

The horse car platform not only had a load to carry, but had to support it under very unfavorable conditions of leverage. It had to be carried by one edge, at a considerable distance from the point of support, the wheel. The weight was carried at the outer end of a long lever. Both horse and electric cars are alike in this difficulty; in fact, the electric car suffers more than the horse car on account of the higher speed, greater size and larger loads.

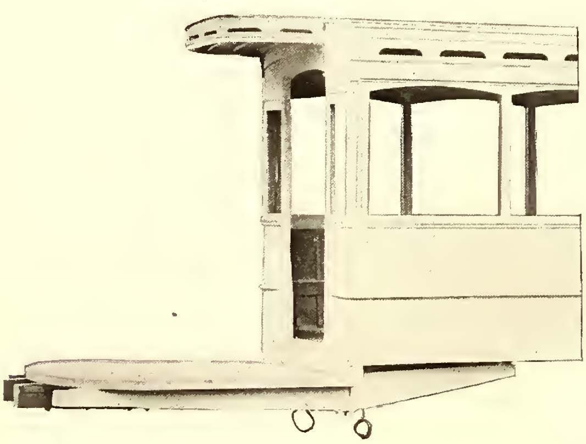


FIG. 6.—THE PLATFORM TIMBERS

The difficulty of supporting the platform is increased by several conditions. The end of the street car platform is subject to violent vertical motions, which may be suddenly arrested in a downward direction. In the horse car this, of course, brought a severe strain upon the platform timbers, as well as on their fastenings. As there are only a few light timbers in the horse car floor, the difficulty of finding a secure anchorage is aggravated. That a loss of platforms was not a more common accident appears to have been the result of exceedingly good workmanship on the part of the early builders.

Modern electric cars are built to carry a large platform load, consisting sometimes of twenty to thirty persons, or a weight of, say 4500 lbs. To accommodate this number in the old horse car days, not only the platform, but both steps would have been loaded, and one person would probably have been found perched upon the pull-iron. The total number, however, would not have been more than eighteen or twenty. The mechanical task of providing means to carry, say 3000 lbs., on the platforms of a vehicle whose total weight could not exceed 5000 lbs. will command the respect of the mechanical engineer.

While heavy vertical loads had to be carried, the horse car had no buffing strains to take care of. The horse car had no longitudinal strength beyond that required for the very slight shocks it received in the street. When the platform was strong enough to carry its loads, it had all the longitudinal strength necessary. The power of longitudinal resistance in both horse and electric street cars is measured by the strength of the connections by which the platform timbers are fastened to the sills and "crossings." This is, of course, very much less than that of the sills and crossings themselves. The platform timbers are not usually shouldered against the timbers, so that the bolts and stirrups are the chief provision against buffing.

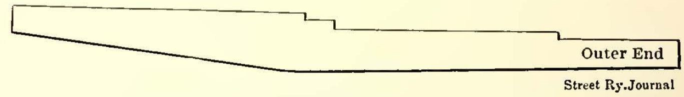


FIG. 7.—OUTLINE OF A PLATFORM TIMBER OR KNEE, SHOWING THE MOST USUAL FORM

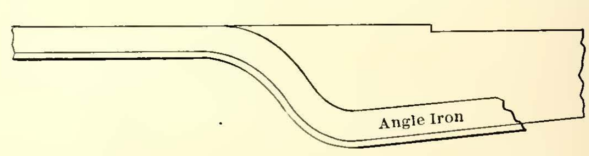


FIG. 8.—A PLATFORM TIMBER CUT OFF AT THE BEARING. THE LOAD IS CARRIED BY THE ANGLE IRON. THIS ENGRAVING SHOWS THE UNAVOIDABLE CONDITION OF SUPPORT SOMETIMES NECESSARY

Horse and electric cars are designed in this respect along the same lines; their platforms are weight carriers.

Neither type is intended to withstand lengthwise blows, nor to have buffing to do in the ordinary course of operation. In the rare cases where electric cars are run in trains, the buffing is a small matter, because there are no heavy locomotives to be coupled. Most of the cars are self-propelled, so that only emergencies must be provided for.

In American practice, at least, we can not discuss the advisability of carrying passengers on our street and elevated car platforms. That has been decided for the railway manager by the public. The platforms must be loaded when there are crowds to be carried; the platform must be made safe to carry them. The weight of these loads will be measured by the number of persons that can be packed within the platform railings.

On the other hand, the steam railroad man can keep passengers off from his platforms when his cars are in motion, but he has to resist shocks in the ordinary course of operation which are like collisions. He must be prepared to make his cars secure against telescoping when they run off the track or when other trains run into them.

Since steam and street car builders have such diverse mechanical objects to attain, it is natural and proper for them to design along radically different lines. Since, so far as the comfort and convenience of the passenger is concerned, the platforms require to be alike, it is quite proper that their form and appearance are very similar. In the electric car platform it is not the actual load which gives the greatest trouble to the designers. In the four-wheel cars especially, the pitching, or galloping, intensifies the strains, easily doubling those which the load itself would bring upon the platform. As speeds are increased, the greater becomes the difficulty. Even with the steady motion of the eight-wheel car it is not always easy to sustain the platform. The permanent loads are constantly increasing; controllers are much heavier than formerly, often reaching 1200 lbs. or 1500 lbs., while sand-boxes and other necessary pieces of apparatus are added to the weight which has to be carried at the outer ends of the platform timbers.

In Fig. 5 we have a bottom view of the floor frame of a four-wheel electric car. It is the standard Brill construction, and may be taken as fairly typical. The transverse strength of the crossing *C* and that of the end sill *B* practically measure the longitudinal resistance of the car. That

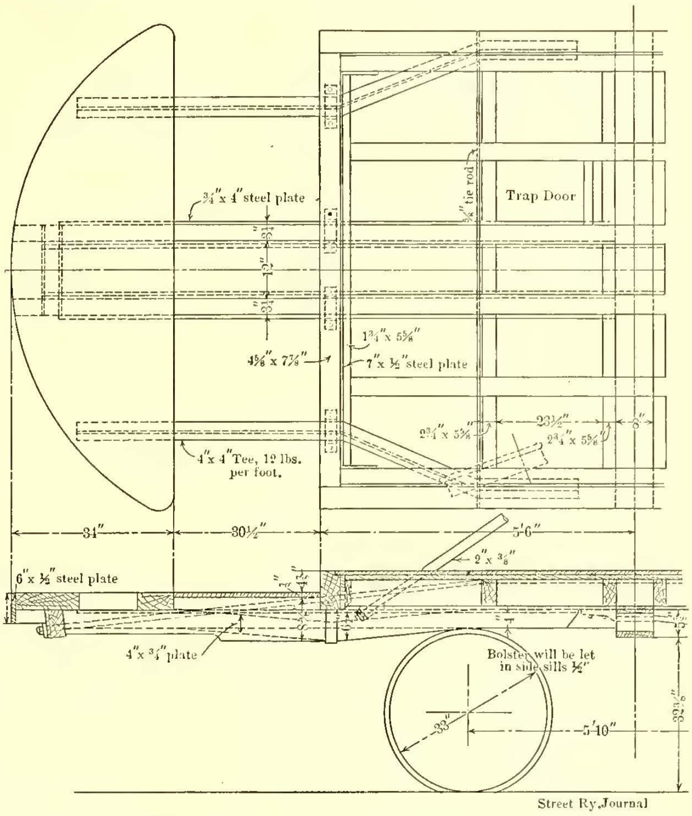


FIG. 9.—STANDARD PLATFORM FRAMING OF THE JEWETT CAR CO. BOTH STIRRUPS AND STRAPS ARE COMMON FORMS OF CONSTRUCTION FOR HOLDING TIMBERS

is the strength to resist collisions. The strength of the end sill is somewhat increased by the diagonal braces, which run from its center to the side sills at *CC*, where a second crossing is placed. The whole longitudinal strength of the structure is inconsiderable, depending, as it does, entirely on the side sills. Compare this with the platform of a steam coach or a Pullman, in which case the structure is its own load. In spite of the fact that it is only an enlarged step, it can resist the impact of a 100,000-lb. locomotive when coupling.

The electric car platform is supported by platform timbers, often called knees, of the general shape shown in Fig. 7. These are cantilevers, which are hung near their centers from the end sills, with their inner ends resting against a cross timber. Usually there are two at the center of the platform and one on each side. As the load is distributed along the outer ends of these cantilevers, the whole of the strain, amounting usually to twice the load, is taken by the end sill and end of the car. When the inboard and outboard ends of the cantilever are equal, the

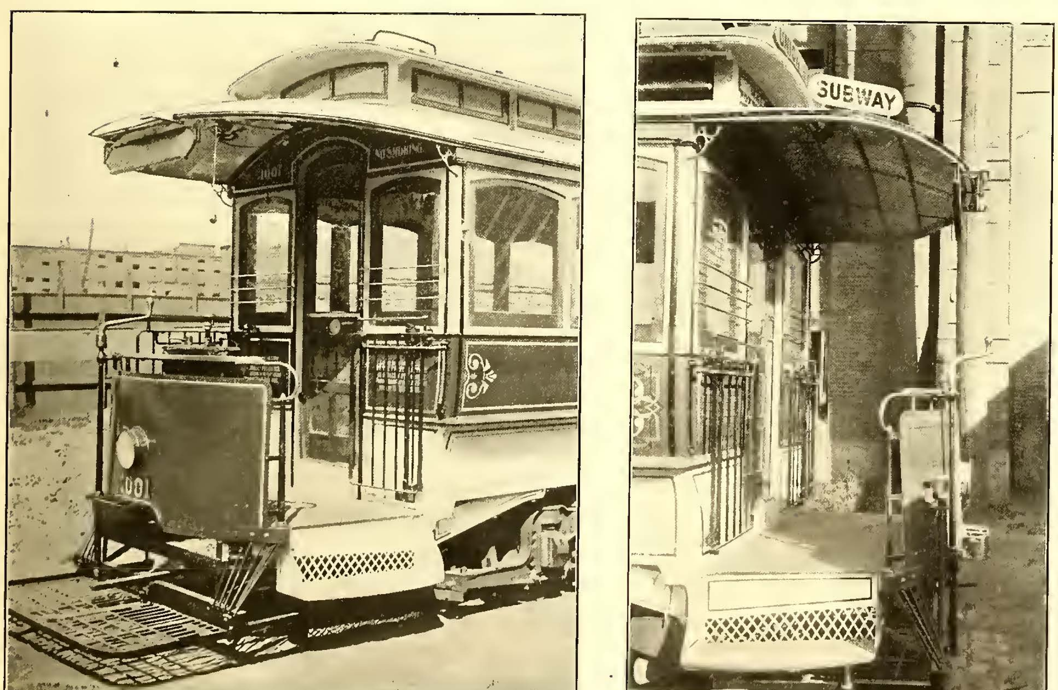


FIG. 10.—TWO VIEWS SHOWING PLATFORM OF A BOSTON CAR

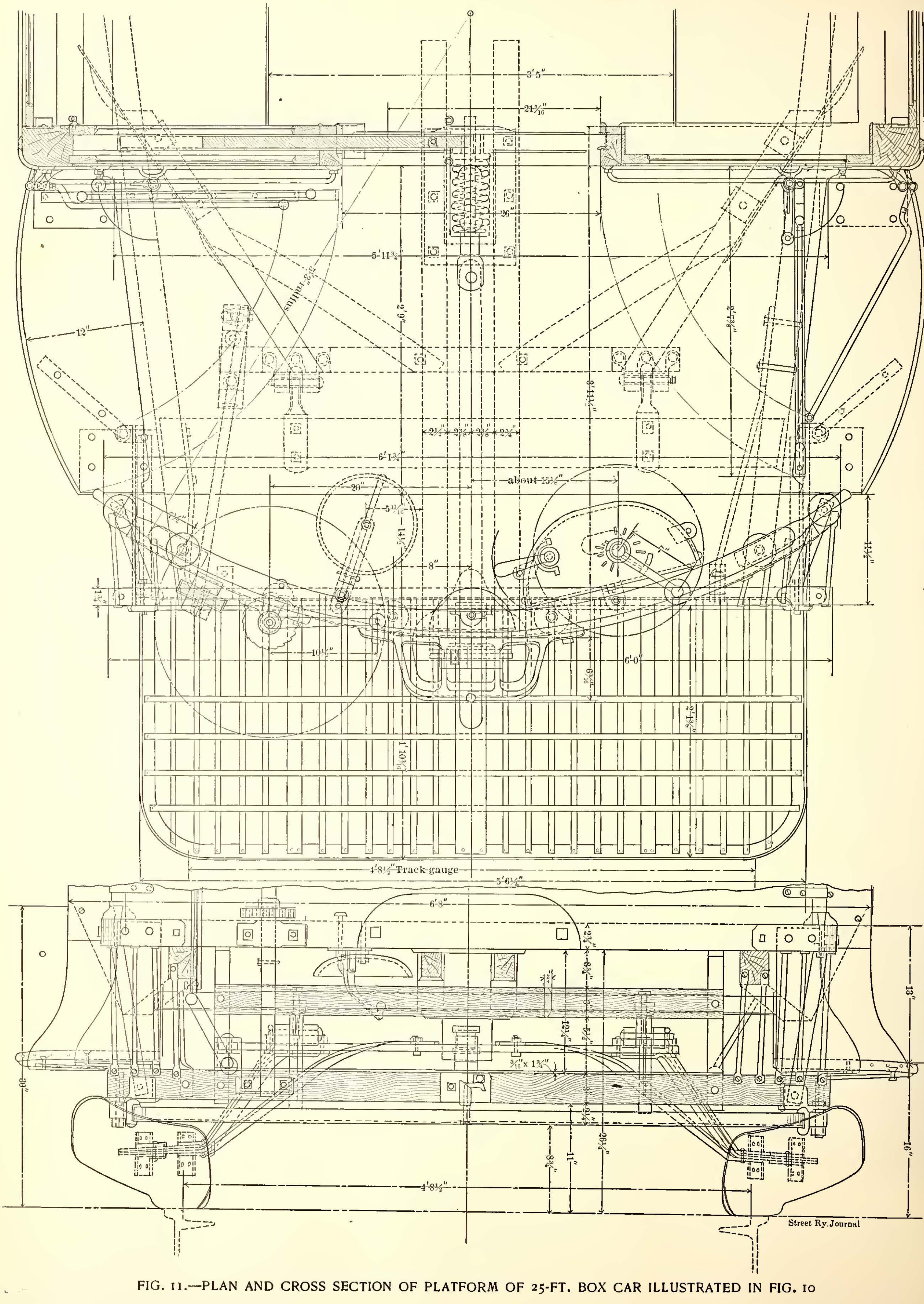


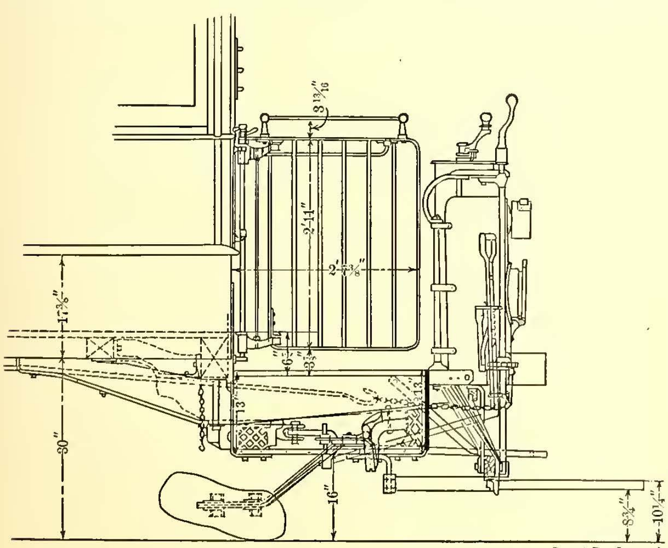
FIG. 11.—PLAN AND CROSS SECTION OF PLATFORM OF 25-FT. BOX CAR ILLUSTRATED IN FIG. 10

upward thrust against the crossing is equal to that of the load. This arrangement is comparatively favorable, but, unfortunately, this condition of things can not always be obtained. The outer arm is often prolonged, and the inner arm shortened until the strain on the end sill may be three, or even four, times the load, while the crossing gets an upward thrust of from one and a half to three times as much. The tie-rods on each side of the door, the door-posts and the whole end frame of the car are called into service in sustaining the strains of the platform load. Fig. 8 shows a platform timber cut off at the bearing. The load is carried by the angle-iron, and the cut shows the unfavorable conditions of support sometimes necessary.

It is the fact that the leverage is in favor of the load against the framing that makes heavy controllers, sand-boxes and the like, so objectionable, placed, as they are, on the outer ends of the platform timbers. A 1200-lb. controller in its usual position may bring a standing load of 4800 lbs. on the end framing of a car. It would do even more than this when the inner ends of the timbers were unusually short, as is often the case. When in motion on a rough track, sudden changes in the movement of the body may easily double this.

The first method of holding up the timber was to use a single bolt; this went through the end sill and the platform timber. It was amply strong, but the hole in the timber was so large as to reduce the strength by about one-half. Breakages were common. This form of construction was given up for the double bolts, now almost universally in use. They support a stirrup and leave the timber untouched, but have the disadvantage of weakening the end sill. In spite of excessive loading, failures of platforms by actually breaking down have been somewhat rare since the adoption of the present method of holding up the timbers.

In the engraving showing the standard platform of the Jewett Car Company (Fig. 9) it will be noticed that the platform timbers have a shoulder which bears against the end sill, as well as one against the "crossing." As there are two center sills by which the end sill is supported



LONGITUDINAL SECTION OF PLATFORM SHOWN IN FIG. 11

longitudinally, no harm can come from this construction. When, however, the floor frame has only the side sills, this method of framing would not be altogether desirable. The endwise resistance of the end of a car framed without center sills is small, and it is considered better practice to allow the platform to be forced off in case of accident than to sacrifice the end sill, as would be the case if the platform were too strongly secured. The construction shown seems to be well adapted for elevated railway cars, since it combines strength longitudinally with load-carrying capacity. The elevated service subjects the cars used in it to many of the shocks and dangers of steam railway work.

Platforms for electric street cars are usually dropped 7 ins. to 9 ins. below the level of the car floor. The reason for this is found in the large motors and large driving wheels which make it necessary to carry the car body much higher than that of the old horse car. It is desirable on the score of safety to have the passenger reach the car and obtain footing with a single step. This step should, for the sake of children, women and the infirm, be as low as possible. By dropping the platform below the floor we, in effect, bring the floor down within an easy step of the head of the rail; the platform becomes a landing, and the interior of the car is reached by two steps, although only one is needed to obtain a secure footing on the car. The passenger gets safely on to the platform and the car can start as soon as he has mounted the first step. The construction of this platform is of the simplest character. There are four horizontal timbers, or platform knees. On the forward or outside ends of these there is a broad timber or crown piece, which, in old horse-car days, corresponded to the platform end sill or buffer beam of the steam roads. With the changed conditions belonging to electric traction, the construction has somewhat changed. The cars are now higher, and with the increase of speed there are more collisions with the wagons and trucks on the street. To protect the dasher, the platform is now carried from 10 ins. to 14 ins. beyond the dasher and the ends of the projecting timbers covered with an iron buffer plate. This appears to be, on the whole, the most sensible arrangement. The projection of the buffer beyond the dasher keeps the hubs of vehicles from injuring it. Occasionally the crown piece, or platform end sill, is carried out beyond the dasher; other constructors leave the timbers open. The platform floor is about 4 ft. 6 ins. from the car body to the dasher; a greater length than this produces too much over-hang, and less does not provide sufficient space. For these reasons most electric cars of the present date will be found to have platforms of about these dimensions.

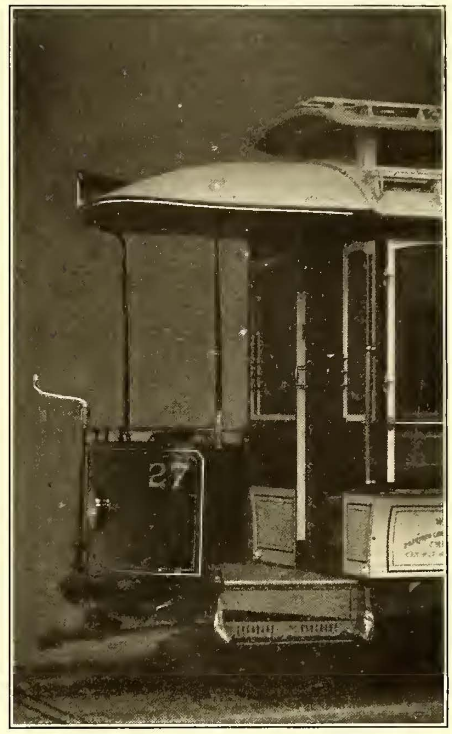


FIG. 12.—THE ACCELERATOR TYPE OF DOOR AND PLATFORM AS BUILT BY THE BROWNELL CAR COMPANY

If controllers could be placed elsewhere than on the platform, a considerable gain in space could be made, and a great strain taken from the timbers.

Usually there are openings on each side which are reached by a single step. The riser is from 12 ins. to 14 ins. The dasher rail is commonly covered so as to present a smooth surface. At each end of the dasher there are platform hood supports. Nominally they are to prevent the hood from sagging; practically they are an effective form of grab handle. If the hood should sag more rapidly than the platform they would no doubt arrest it and give support. Usually the platform goes down more rapidly than the hood, and the latter of course has to look out for itself. Many builders, with a view to this, make a slip-joint between the bracket and the rod, to prevent the platform from carrying the hood down when springing under heavy loads.

The strength of a platform to resist blows coming upon its front end, or crown piece, deserves careful attention. Too great strength is far from desirable. Nothing is gained by making the platform as strong as the end of the car; on the contrary, there is such a thing as having too strong an attachment between platform and body. It is much better in the case of a heavy blow to have the platform driven off or under the car than to have, as sometimes happens, the whole end sill broken out and torn away, not only from the side sill, but from the door posts

FIG. 14.—A FRENCH CAR WITH ENTRANCE AT THE REAR CORNER

FIG. 16.—A FRENCH CAR WITH STEPS AT THE END CORNER OF PLATFORM

FIG. 17.—A FRENCH CAR WITH STEPS AT THE SIDE CORNER OF PLATFORM

and end panels as well. Such an accident is costly to repair. Unfortunately they have been too frequent in the past for economy. In such cases the platform takes no harm whatever. The wiser course is to make the attachment of the platform of less strength, not butting the timber against the sills or crossing. This would allow the platform to break away, or be destroyed without injuring the body.

It is a safe rule, when building hoods, vestibules, or bodies, to make the design so light that in case of accident these members will yield without injuring the body of the car, or causing expensive repairs. It hardly pays to make them so strong that nothing but a collision at high speed will injure them. Such a construction is possible, but it is too heavy and too costly to be good practice.

Builders often attempt to make hood platforms and vestibules so strong that they can resist any shocks that may come to them, but the construction is so expensive it is questionable whether it will pay interest on the investment. Generally an inspection of repair-shop accounts will show that it is best to make a sacrifice of the unimportant members.

The mechanic in any line who has repairs to attend to is constantly tempted to increase the strength of the parts most frequently breaking. He desires to reduce the trouble and expense of his repairs. This increase of strength may be easily carried too far, as in the case of hoods and platforms. An easily repaired member, like a hood, in breaking saves other parts of the car which are more costly to repair. It is well to remember that a "breaking piece" is often good economy, saving something more costly.

In Fig. 10 we have two views of the platform used on the surface cars in Boston. In many respects it is typical. The brake handle is set outside the dasher, as is the handle controlling the scrapers. There is nothing to obstruct the floor space or be in the way of the passenger save the controller and the gates, the latter folding flat against the body of the car. The whole arrangement is practically the same as that of the old-fashioned horse car, except for the buffer. This is a casting bolted upon the front side of the crown piece or end sill of the platform. The second view shows the other side of the same platform, and gives the arrangement of the brake spindle, etc. In both of these engravings a sort of cow-catcher, or fender, with radiating bars, will be seen. The real usefulness of this appears to be in carrying the horizontal fender which, in the first view, is shown projecting in front of the platform and in the second is pushed back out of the way under the platform.

The construction of this platform, simple as it seems to be, is not so in reality. This will be seen from the diagrams in Fig. 11, which show plans, elevation and side views of the platform. While in external appearance this platform is practically standard, the framing is not of the usual pattern. The platform is covered by the outside timbers shown, those in the center not going back of the end sill and acting as draft timbers without carrying weight. As the platform is quite short, only 3 ft. 11½ ins., the deep timbers at the edge are ample for the work. They are often strengthened by steel plates or angles.

It is a question whether the brake-shaft should be inside or outside the dasher. Outside it gives more room for the passenger and inside it is out of the way of hubs of the vehicles, and so has greater protection. The projection of the fender and the buffer iron are so great that the outside position is generally considered best.

The absence of hood supports brings up the question of their value. Probably this can be settled by a consideration of their usefulness as grab-handles. The hood can, of course, take care of itself, but the value of the hood support to the passenger standing near the step is undoubted, and on the score of safety is well worth what it costs. On account of the spring of the platform there should always be a slip joint at the top to prevent its ever acting as a platform support.

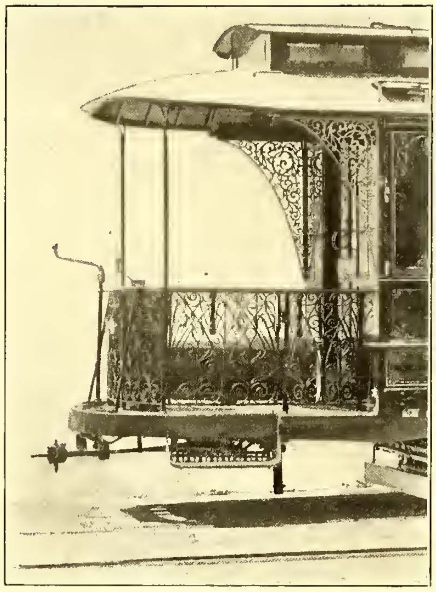


FIG. 18.—PLATFORM OF A PARLOR CAR WITH ICE BOX ALSO USED AS A SEAT

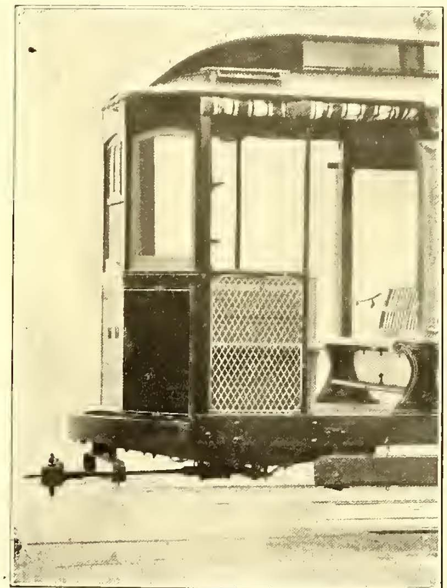


FIG. 19—CABLE CAR WITH A SEAT EACH SIDE OF THE GRIPMAN ON THE PLATFORM

An important modification of the simple open platform is often made when local conditions permit, by removing one of the steps and carrying the rail and dasher round to the body of the car. This closes one side of the platform and increases the standing room materially. Fig. 12 shows this type of platform as built by the Brownell Car Company, of St. Louis. In this case the advantage of the arrangement is still further increased by placing the door at one side of the center near the step. The usefulness of the Brownell accelerator is undoubted. Yet few improvements in car construction have ever had more wordy opposition. The curious feature in regard to it is that the idea has taken a strong hold upon street railway men. Its influence can be seen in the arrangement of the car platforms on many of the largest lines in the country. The whole arrangement is not employed, but, as shown in Fig. 13, which is of another make of car, the door is brought as near the step as possible, and often this is combined with a platform closed on one side.

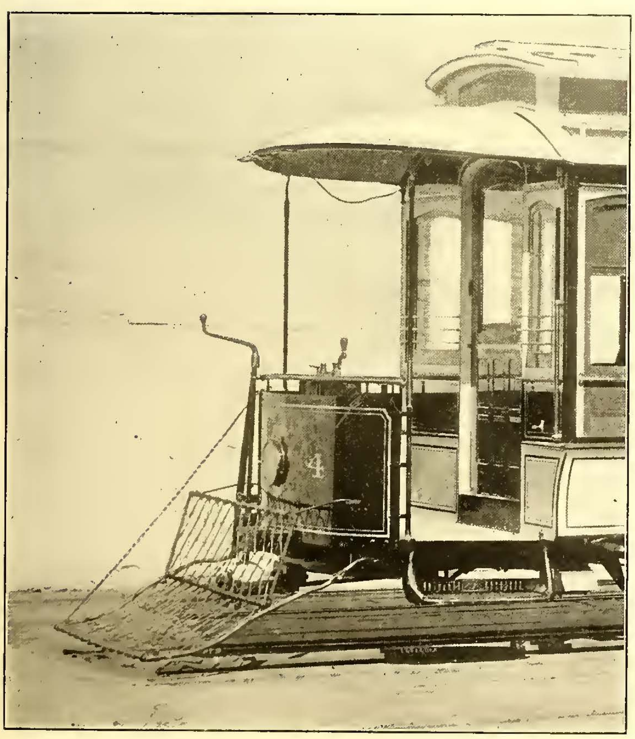


FIG. 13.—SIMPLE PLATFORM WITH THE ACCELERATOR ARRANGEMENT OF DOOR, PLATFORM AND STEPS

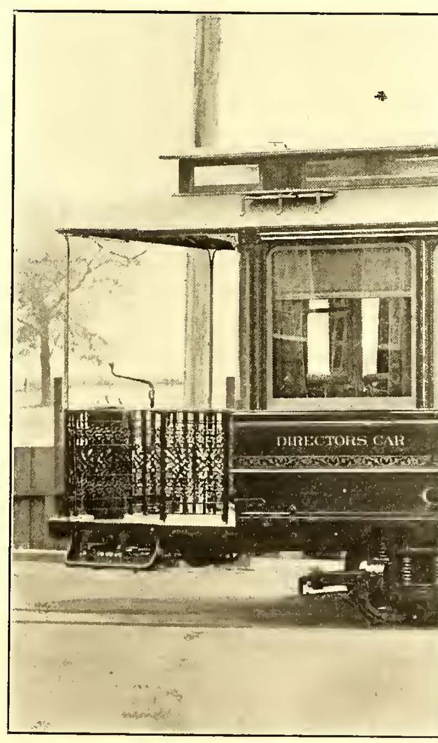


FIG. 15.—CONEY ISLAND & BROOKLYN PARLOR CAR, STEPS AT THE CORNER

On many lines where the cars run on loops, as in Cleveland, Ohio, the left-hand side of both front and rear platforms is closed. This gives an entrance to the car, both front and in the rear, but only on the right-hand side. The closing of one side of a platform greatly increases its capacity. The passengers on that side are out of the way of those entering and leaving, and are more comfortable than they would be if they had to make way for those passing. The area of the step is practically added to that of the platform floor. By closing one side of the car in this way there can be no accidents from getting off or on the wrong side. The manager is always certain that the entrances are right as regards the other track.

There are two modifications of this idea, one of them is the closing of diagonally opposite openings, so that the car may run in either direction, the other provides no forward entrance at all, and the rear platform is closed on one side. Both of these ideas presuppose that the rear entrance only can be used. Where crowds have to be handled at terminals both platforms should be used, or the cars will be greatly delayed. One entrance to a platform is about as good as two, because in the latter case two opposing streams meet and are delayed in entering the door.

With large cars the necessity for two entrances is strongly felt. They may be said to be absolutely necessary not only for convenience but for commercial reasons. With but one entrance, loading at parks and terminals becomes so slow that an increase of rolling stock is forced upon the managers.

In passing from the simple standard platforms complexity and diversity becomes so great that a rational classification seems out of the question. Roughly, they may be divided into the long and the short. Even then there is another great class, neither long nor short, which has many interesting features, but the following types may be considered to be representative. Many of these have been largely the results of varying conditions, but there have been many departures from standard types, resulting solely from the whims of managers or directors. In some cases the municipal rules and regulations have something to do with it.

The French car on the Versailles line has a very long platform (Fig. 14), with the gate situated at the corner. The entrance is by two steps. In this case there is not only ample room on the car, but ample time to load and unload passengers. Under the circumstances the location is just what would be expected. Confronted with similar conditions, we find a Yankee doing precisely the same thing. When he builds a parlor car the passengers have ample time, there is to be no crowding, and we find that the steps are placed at the platform corner, as may be seen in Fig. 15, which shows a parlor car built by the Brills for the Coney Island & Brooklyn road.

Figs. 16 and 17 show two French cars of different design, but in both of them the entrance to the platform is at one corner. There is, of course, a certain advantage in such a location when a vehicle comes to a full stop whenever a passenger enters or leaves; like a rear entrance, it is convenient for both sides of the street. In Fig. 17 the steps are almost at the platform end.

The long platform introduces another set of conditions. If there is so much space outside the end of the car, why not make it available for the comfort and pleasure of the passenger? In the parlor car just mentioned, as well as in others of the same class (see Fig. 18), the long platform at one end is fitted with an ice chest, which is also used for a seat. The seat idea for platforms has taken many forms, and has been developed so that in some cases the platform is no longer to be recognized.

One of the early uses of the platform for carrying a regular seat was found in the old cable grip cars, as well as the open cable cars. One of these is shown in Fig. 19. On each side of the gripman's box a seat was placed, thus utilizing a portion of the platform.

Fig. 20 shows a still more peculiar arrangement, which was used on one of the early electric cars. Here the passengers at the forward end were almost completely enclosed, while a considerable space was nicely utilized. This type of car, we think, was built by the Brills for Cleveland some years ago. Foreigners naturally manage such things in a somewhat different manner, as may be seen from Fig. 21, where, on the very long platform, there are two seats. This car was built by Jackson & Sharp for a French railway in Paris. These long platforms have their entrances practically at one corner.

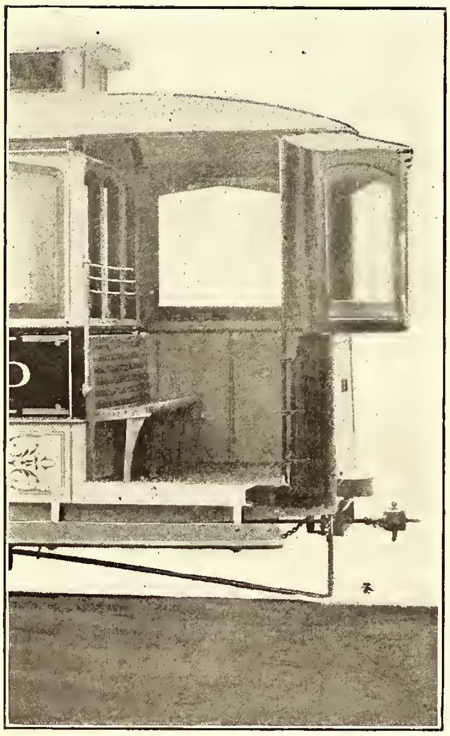


FIG. 20.—ELECTRIC CAR WITH A VESTIBULE NEARLY ENCLOSED AND A SEAT ON THE PLATFORM

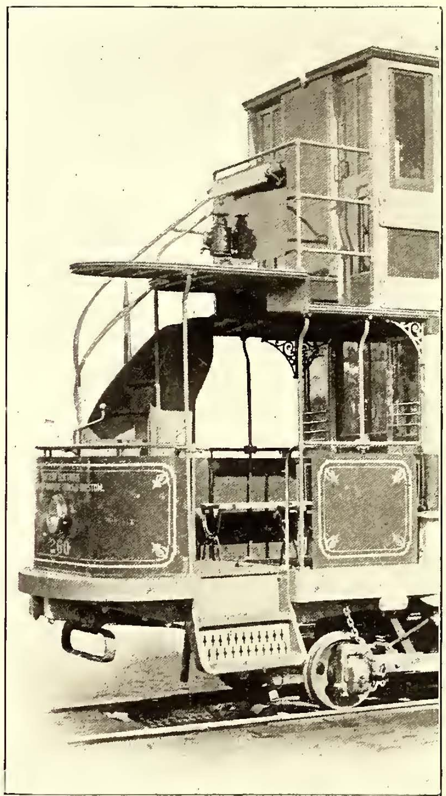


FIG. 21.—A DOUBLE-DECK FRENCH CAR HAVING A VERY LONG PLATFORM CARRYING TWO SEATS UPON IT

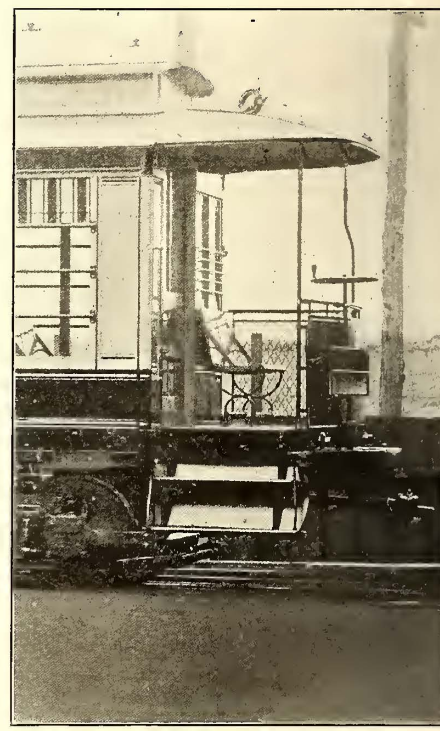


FIG. 22.—PLATFORM SEAT ON A HIGH-SPEED ELECTRIC CAR

High-speed electric cars are now and then fitted up in the same way, and in such weather as has prevailed during the summer of 1901 these platform seats have been at a premium (see Fig. 22). The front end of a high-speed electric car is shown fitted up with a seat on the left-hand side of the door. This was very conveniently done, since the door was placed at one side of the center, and the entrance to the platform was from one side only. In such weather as that which has prevailed during the present season such seats are eagerly sought for.

The Fond du Lac Street Railway & Light Company, of Fond du Lac., Wis., has issued a vest pocket book of rules for the use of its employees. The book is neatly bound, and contains complete instructions in regard to operating cars, rules of deportment governing conductors and motormen and also directions of what to do in case of an accident. Each motorman and conductor will be supplied with one of these books for ready reference.

Train Movement Signalling on the Boston Elevated Railway

BY HOWARD S. KNOWLTON

The rapid transit problems in Boston are of peculiar interest and individuality. The complicated geography of the city, its distorted network of narrow, crooked streets and concentration of business interests in a peninsula scarcely 4 miles in length of boundary, are serious obstacles to high-speed car movement. Congestion on surface tracks reigns supreme in the heart of the business district during morning and evening rush hours, and the full benefit of the magnificent street car system is seldom obtained at any time of day east of Copley Square in the Back Bay, north of Dover Street, South End, or south of Thompson Square, Charlestown.

In New York, Chicago and Brooklyn the elevated roads are practically independent of the competing surface lines beneath. In Boston, surface and elevated systems work together under one controlling directorate, the Boston Elevated Railway Company. Interests are merged in one, through the lease of the West End Street Railway Company to the elevated.

Fig. 1 shows an outline sketch of the elevated division, with block signals, in diagram form. The relation of these to train movements will be considered herein.

The main line, so called, between Sullivan Square, Charlestown, and Dudley Street, Roxbury, via the Tremont Street Subway, was opened for traffic at 5:30 a. m. Monday, June 10, 1901. The Atlantic Avenue Loop will begin business by Sept. 1 if possible. An extension to Townsend Street, south of Dudley Street, toward Forest Hills is already designed and soon to be constructed. When completed, train movements may take place over the following twenty routes:

TABLE I.

B. E. RY. CO., ELEVATED DIVISION.—ROUTES OF TRAINS

No.	From	To	Via	Markers		Miles
				Right	Left	
1001	Sullivan Sq.	Dudley St.	Subway S.	Green	White	5 199
1002	Dudley St.	Sullivan Sq.	" N.	Red	"	4.877
1002A	Townsend St.	" "	" N.	"	"	5.740
1003	Sullivan Sq.	Dudley St.	Atlantic S.	Green	Red	5.735
1004	Dudley St.	Sullivan Sq.	" N.	Red	"	5.4
1004A	Townsend St.	" "	" N.	"	"	6.263
1005	Sullivan Sq.	" "	Sub. S., Atl N.	"	Green	7.31
1006	Dudley St.	Dudley St.	Atl. N., Sub. S.	Green	"	7.397
1006A	Townsend St.	"	" "	"	"	8 26
1007	Sullivan Sq.	Sullivan Sq.	" S, N.	Red	Yellow	7.314
1008	Dudley St.	Dudley St.	Sub. N., Atl. S.	Green	"	7.396
1008A	Townsend St.	"	" "	"	"	8.259
1009	North Station	North Station	" S., N.	White	Green	4.108
1010	" "	" "	Atl S., Sub. N.	"	Yellow	4.098
1011	Sullivan Sq.	Townsend St.	Subway S.	Yellow	White	5.88
1012	Dudley St.	"	Atl. N., Sub. S.	"	Green	8.078
1012A	Townsend St.	"	" "	"	"	8.941
1013	Sullivan Sq.	"	Atlantic S.	"	Red	6 416
1014	Dudley St.	"	Sub. N., Atl. S.	"	Yellow	8 077
1014A	Townsend St.	"	" "	"	"	8.94
Sp.	Special Train Movements			White	White	....

Traffic in Boston is largely radial. The daily suburban movement pours a stream of nearly half a million souls into the congested district enclosed by the subway and Atlantic Avenue Loop. The morning rush is more distributed, the evening peak load being far in excess, at its maximum. The elevated proper is chiefly concerned with this mighty ebb and flow, its through traffic being of relatively less importance. None the less, the running time between Roxbury and Charlestown has been more than cut in two since trains began to operate, twenty-two minutes being an easy elevated schedule, as against often forty-five minutes or fifty minutes on the surface, or a schedule speed of 13.3 miles per hour against about 7 miles. Practice trains frequently made the run in less than nineteen minutes, while an express special, with a clear track, might easily cover the northbound route, 1002, in sixteen minutes, if station stops were omited. The conditions of alignment and grade, however, are so severe that reasonable care of equipment and passengers' comfort demand at present a slower through schedule than the trains might be forced to give. The subway approaches are each 5 per cent grades several hundred feet long, and curves of 90-ft. radius are frequent in the interior. The longest stretch of tangent track on the system is less than .28 mile.

The fundamental operating problem of the elevated di-

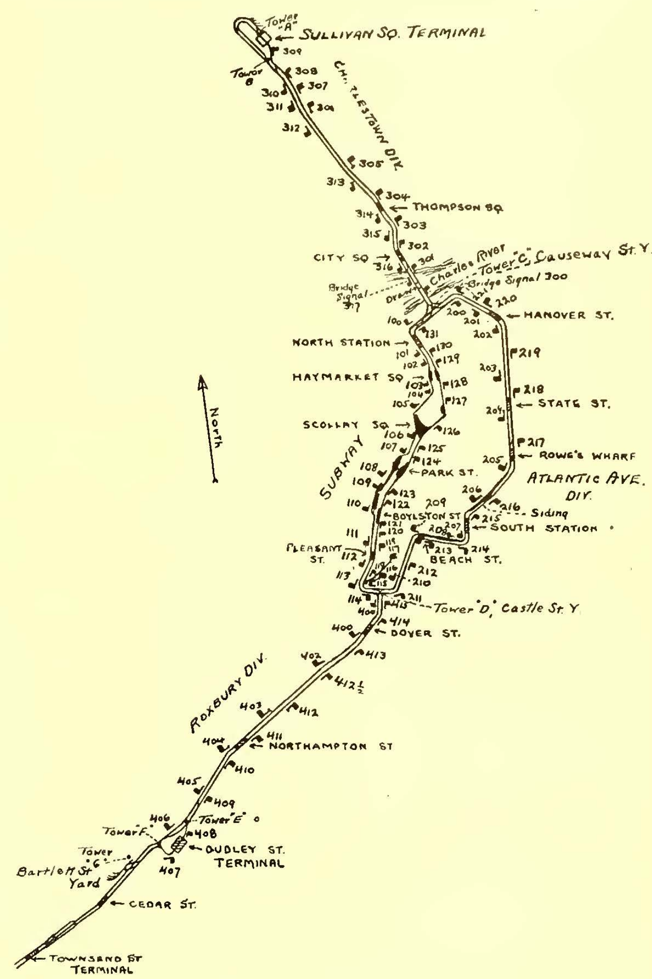


FIG. 1.—BOSTON ELEVATED RAILWAY BLOCK SIGNALS

vision is to provide rapid transit from the business center to terminals at Sullivan Square, Dudley Street and Townsend Street. Similarly, the projected Cambridge line will furnish high-speed service to Harvard Square. From these terminals as distributing centers free transfers on the same platform level are given to surface cars on incline approaches, which enable the passenger to continue his ride in the same general direction at relatively high speed, averaging, perhaps, 10 miles per hour, through less crowded thoroughfares to the uttermost suburban regions. Often this second movement is over a reserved right of way in the middle of a boulevard, permitting maximum speeds of over 20 miles per hour, which is good work for surface cars. At all important elevated way stations free transfers are mutually exchanged between the overhead trains and street cars beneath. Thus the elevated proper constitutes an express trunk line, operating at speeds of 30 miles to 45 miles per hour, maximum, while local traffic is distributed and collected by the lighter and slower trolley cars below.

In most practical engineering problems which deal with uncertain factors the solution finally adopted is the result of a series of judicious compromises, in which expert judgment recognizes the proportional value of the various ends sought and harmonizes the conflicting elements to a maximum degree of commercial success. Thus Fig. 1 shows a relatively greater distance between stations on the north and south ends, compared with the middle elevated loop. The local result is that sections like the south end and middle parts of Charlestown are not as closely in touch with the high-speed service. This local disadvantage is more than offset by the saving of time which fewer stops entail for the vast suburban districts of Malden, Everett, Medford and Somerville on the north and Roxbury and Dorchester on the South. Table II. shows the distances between consecutive stations. The difficulties which arose in the equipment choice will be apparent when the average distance between subway stations is compared with that on other sections of the elevated. Out of nine runs between subway stations proper a symmetrical speed-time diagram is possible only between three, Boylston to Park, Park to Scollay, and Adams to Haymarket. The complications which the subway curves introduce into the trajectory of a Boyer recorder pencil are without the scope of this article. In order to insure uniform handling of trains, operating signs marked "series," "multiple," "coast," "apply air" and "release air" have been placed along the entire line for motormen's use.

Table II.

B. E. Ry. Co., Elevated Division—Distance Between Consecutive Stations

Southbound Station	Feet	Northbound Station	Feet
Sullivan Sq. to		Dudley St. to	
Thompson Sq.	5,604	Northampton St.	3,091
City Sq.	1,391	Dover St.	4,188
North Station	2,911	Pleasant St.	2,517
Haymarket Sq.	1,029	Boylston St.	1,419
Scollay Sq.	1,500	Park St.	1,335
Park St.	1,580	Scollay Sq.	1,440
Boylston St.	1,080	Adams Sq.	770
Pleasant St.	1,730	Haymarket Sq.	990
Dover St.	2,507	North Station	1,072
Northampton St.	4,182	City Sq.	2,887
Dudley St.	3,936	Thompson Sq.	1,390
		Sullivan Sq.	4,654
City Sq. to		Dover St. to	
Battery	4,116	Beach St.	3,399
State St.	2,613	South Station	1,519
Rowes' Wharf	998	Rowes' Wharf	2,517
South Station	2,507	State St.	998
Beach St.	1,486	Battery	2,631
Dover St.	3,437	City Sq.	4,121
Beach St. to		Battery to	
Pleasant St.	3,941	North Station	3,163
Pleasant St. to		North Station to	
Beach St.	3,941	Battery	3,064
Northampton St. to		Townsend St. to	
Cedar St.	5,639	Cedar St.	1,895
Townsend St.	1,895	Dudley St.	2,659

Park Street station is the traffic focus of the entire system, with its more than 350 miles of track, 7000 employees and 120,000 car-miles per day. Every nineteen hours the elevated system total pours into this station more than 100,000 people, and its traffic is surpassed by less than six other railway stations in the world. It is impossible to predict the effect of Atlantic Avenue operation in relieving this congestion. The use of the loop principle in car movements at Park Street enables a fifteen-second headway to be maintained in the evening rush, which is the only time in the day when crowding is serious.

With the entire through high-speed traffic of the city of Boston concentrated upon one double line of track, the importance of preserving regular intervals in train spacing can not be overestimated. The absence or presence of platform congestion, outside of rush hours, is an accurate index of the train frequency and directly proportional thereto. To maintain such a service of three-car trains two minutes apart, from early morning to late evening, requires an equipment of the highest type, and a perfection in detail that few, if any, steam roads can excel. With trains weighing over 90 tons operating on close headway at speeds far in excess of previous elevated practice, every possible safeguard is essential. The management of the Boston Elevated aimed to build the best road which money could buy, and but one trip over the line is necessary to show their success.

Next to the air brake, the block signal is the most

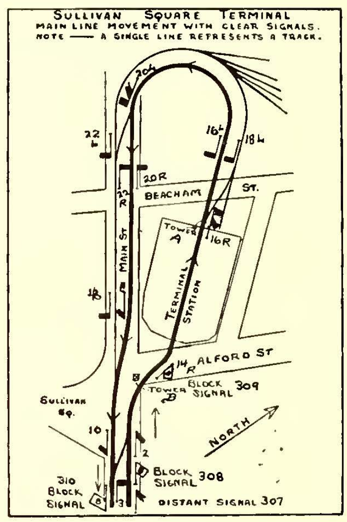


FIG. 2

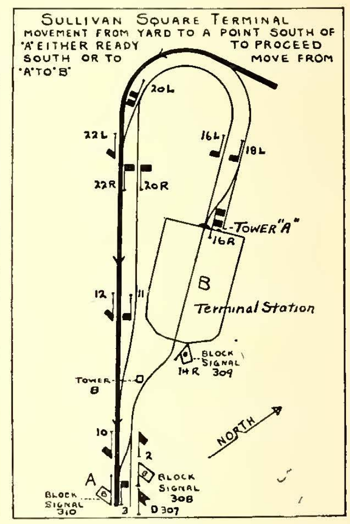


FIG. 3

powerful factor of operating safety which the road possesses. The installation is complete in both interlocking and automatic features.

All signals are of the semaphore pattern, consisting of a fixed post and movable arm, indicating danger when horizontal, and safety when inclined 60 degs. Signals are located to the right and above governed tracks. A block is defined as a section of track lying between two signals, one of which permits train entrance, the other, exit. Red and green lights indicate danger and safety, respectively, at night, the arm movement bringing the proper colored spectacle glass before a lantern suspended behind the signal. Permissive blocking is not in force. All trains come to a dead stop at a danger signal. The block signals are spaced along the line at varying distances, as sketched in Fig. 1, permitting a minimum train interval of one minute, as laid out. It is evident that the longest blocks are located on the high-speed sections of the line. Subway speed being low, the blocks are very short.

The operation of the block signals is automatic. An approaching train finds the signal at safety if the block it governs is clear ahead. The signal is held in this position by compressed air at 90 lbs. pressure per square inch through a relay-operated electromagnet which controls the valves. One rail of the track is divided into insulated sections at the entrance to each block, and both rails constitute a track circuit bridged by the signal relay. Directly a train enters the block the wheels short-circuit the signal relay, cutting the current therefrom, and hence interrupting the air supply. The semaphore arm goes to danger by gravity, and should a motorman run past a danger signal the emergency air brakes of his train are applied by an automatic trip located between the ties, which works in harmony with the signal. This trip is raised when the signal is at danger, and opens a valve in the train line pipe striking an arm on the car as it runs by. Every car is equipped with this valve, and, as a result, the insulating joint is placed at least 180 ft. beyond each signal, so that a four-car train can pass the trip before its front wheels set the signal at danger. The block signals have plain red blades, and are not supplied with distant signals, except at a few special points where sharp curves make it essential that an indication of the following block signal's position be given. These "distant" or "caution" signals have a swallow-tailed yellow blade, which indicates "caution, proceed slowly," when horizontal with yellow light, and "safety, proceed at full usual speed," when inclined, with green light. They are not fitted with trips, and can be passed at a speed of 8 miles per hour if displaying caution. These signals simply act as indicators, and stops are not necessary as on a road like the Pennsylvania, where speeds reach 70 miles per hour in express service.

Block signals are placed at all stations, and no train can leave until the block ahead is clear. Similarly, the rear end of a train is protected, with the additional precaution of a flagman being sent back at every unusual stop. An overlap of 180 ft. exists on every block, as no signal can go clear until the rear wheels of the train ahead have passed the insulating joint in the track beyond the following signal.

At all junctions, yards and important special work, the signals are operated from the towers located there, and are of the interlocking type, nominally kept in the danger position and set clear by an operator on the approach of a train whose destination and route is determined by the markers or colored lights shown in Table I., the right-hand marker being over the motorman's head. The color

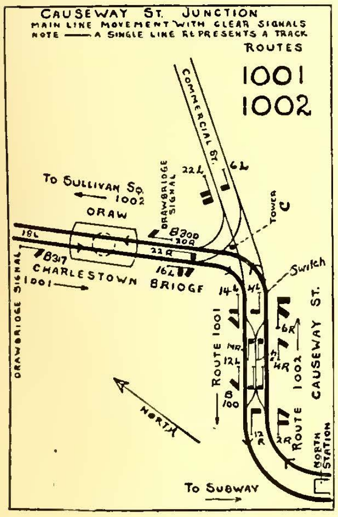


FIG. 4

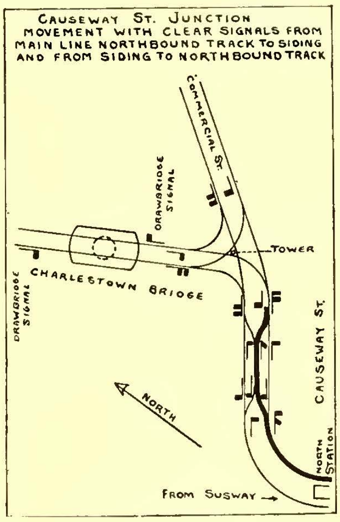


FIG. 4A

scheme of these markers is most simple, and the entire twenty routes can be built up from it. Thus, the right-hand marker always indicates destination, and is green, red, yellow or white, according as a train is bound for Dudley Street, Sullivan Square, Townsend Street or "special." The left-hand marker shows route, and for simple straight-through runs, like 1001, 1004, etc., is white for subway trains and red for Atlantic. Combination runs, involving loop service around Atlantic and through subway, with a movement on either Roxbury or Charlestown ends, are green for subway south, Atlantic north, and yellow for subway north, Atlantic south. Such are runs 1005, 1006, 1014a, etc.

These runs are useful in clearing up subway congestion and giving service between the two great Union stations, north and south, while effecting the inward and outward movement so important in rush hours. Runs like 1001 and 1003 provide for through high-speed travel between the various terminals.

The interlocking signals are electrically controlled by levers in the tower machines, and are moved by compressed air. . They are similar in appearance to the block signals, except for a vertical white stripe on the blade's

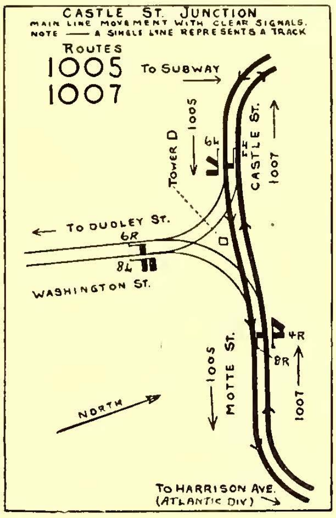


FIG. 5

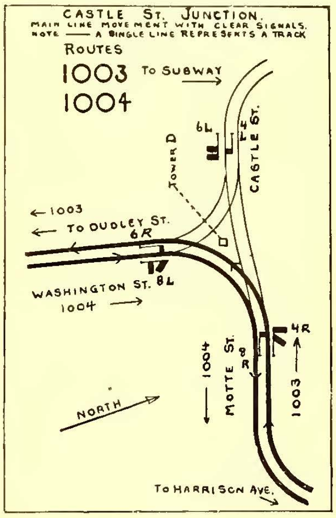


FIG. 6

front. The installation was made by the Union Switch & Signal Company, of Swissvale, Pa., and is an unexcelled object lesson in train-movement control.

At all diverging routes a double-arm signal is placed at the side of the track. The top arm invariably governs the movement to the right, and the lower arm, movement to the left. Since interlocking is such interconstruction of switches and signals that conflicting or colliding routes may never be set up, it is impossible for any signals to be given that could cause an accident. Only one arm of a double or triple-arm signal can be inclined "clear" at any given time. Wherever double-arm signals control tracks that cross each other, only one route may be set up at once.

Fig. 2 shows signals set for the main-line route through Sullivan Square terminal. At Alford Street the northbound track enters the station. The train discharges and receives its passengers on the same level with the incline operating surface cars, and on receiving signal to start, passes out through the yard over the heavy-lined track, receiving clear signals as follows: "Lower arm 16 R, lower arm 20 L, clear 11, clear 10, clear block signal 310 at yard limit," and so south on main line into the city proper. Signal 18 L is a back-up, dwarf semaphore, and so interlocked that it could not be set at safety with either arm of 16 R inclined. Signal 16 L likewise is a back-up indicator, and does not govern trains in forward movement, as it is at the left side of the track. Movements on the west siding and in the yard can take place as far as Signal 12 without conflict, if the operator in Tower A desires. Signal 12 is the fouling point of the main line and siding. Signal 22 L is nominally kept at danger, but can be set clear in this case, as the interlocking only blocks collision routes. Signals 20 R and 22 R are back-ups, dwarf pattern; 20 R can not be set clear for a reverse movement unless both arms of 20 L are at danger. Only the most important interlocking signals are fitted with trips, or "automatic stops."

Fig. 3 shows a movement south from the car house at Sullivan Square. The interlocking here permits a train movement into the station on the northbound track coming from Thompson Square and out as far as Signal 11, the fouling point, if the towerman desires. Signal 2 protects a train in taking the crossover south of Alford Street, and it is wired up in the circuit of Block Signal 308, which goes to danger when the switch is set for the cross movement. Block Signal 309 is semi-automatic, and protects the rear end of a train standing in the terminal. It must be set clear by Tower A after a train leaves the station, and can

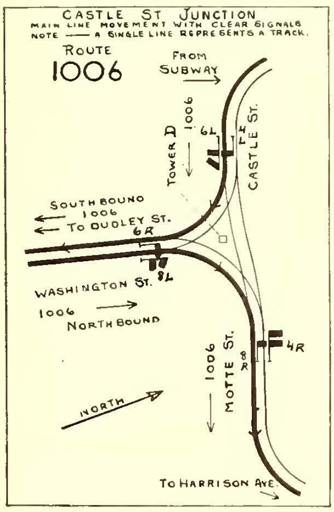


FIG. 7

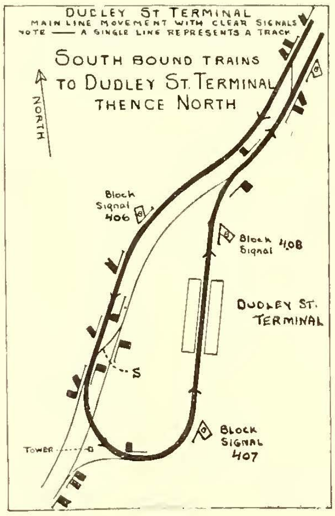


FIG. 8

not be thrown "clear" as long as a train occupies the track inside the house.

In Fig. 3 a back-up movement from Signal 11 to the terminal could be set up without conflict, or a yard movement past Signal 18 L into the station, the arm, of course, being inclined. The interlocking makes it impossible to throw the switch between 20 L and 22 L with the route

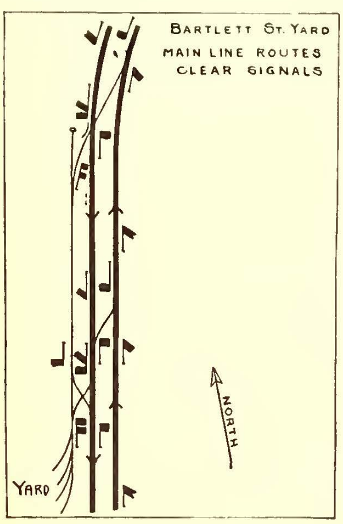


FIG. 9

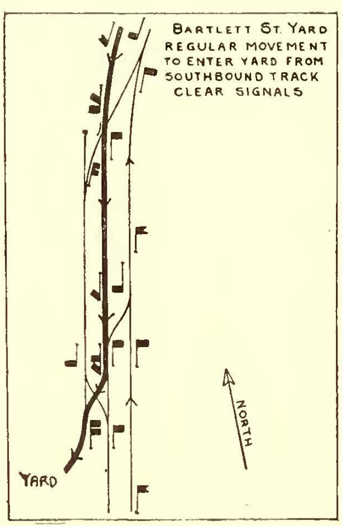


FIG. 10

shown set up, and the top arm of Signal 20 L must remain at danger, as shown.

Fig. 4 shows Causeway Street Y, with direct routes set up between Charlestown and subway. Signals B 300 and B 317 are operated from Tower C. Here, as before, the top arm of a double-arm signal governs route to the right, and coming from City Square to the subway, southbound, the indications are: "B 316 clear, B 317 clear, top arm 16 L, top arm 14 L, clear 12 L, or B 100," a semi-automatic signal, thence to north station.

Going north, "top arm 2 R, clear 4 R, lower arm 6 R, clear B 300, across drawbridge to City Square." The drawbridge is electrically locked by Tower C. Atlantic Avenue trains pass up Commercial Street. If the operator in Tower C notes by the marker lights that the train coming from the subway is to go via Atlantic Avenue, he first throws 6 R to danger, resets the switch marked on diagram, at the Y, after which he throws the top arm of 6 R clear, and the route is complete for movement. With such a route set up, the top arm of 22 L could be set clear for movement into Charlestown from Commercial Street, but the lower arm could not be thrown to safety, as it is interlocked with 14 L, already set clear. All these changes at interlocking points are a matter of a few seconds, and trains pass through such special work at 10 miles per hour with perfect safety. It requires sharp work by towermen, however, to distinguish instantly the train markers and set up the routes without delaying traffic. Records are kept of all passing trains and times, and the entire line is connected by telegraph and telephone, so that towermen and stationmen are in closest touch with the headquarters at Sullivan Square. The middle siding on Causeway Street is of use in holding a relay train in readiness to relieve congestion in the subway and to provide a by-pass track in case a breakdown occurs within the interlocking limits be-

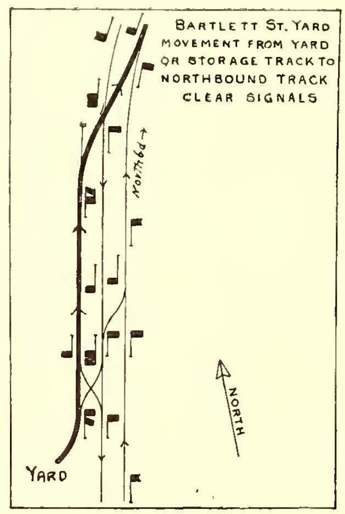


FIG. 11

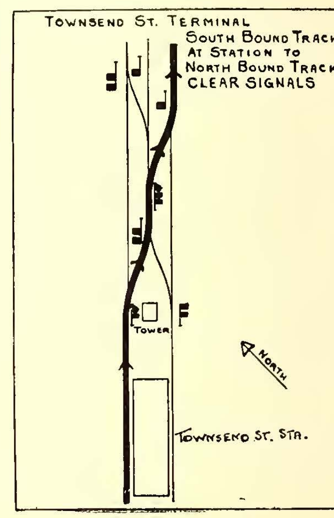


FIG. 12

tween 14 L and B 100, 2 R and 6 R. The combinations of train movements which this interlocking permits are most interesting, and appear from close study of Fig. 4 to provide for nearly every emergency that can arise. Fig. 4 *A* shows use of siding, a train entering from north station.

Fig. 5 shows the simplest interlocking on the system, Tower D, Castle Street Y. Signals are set for movement between the subway and Atlantic Avenue via Harrison Avenue. With this setting of signals any northbound train coming from Dudley Street must be held at 8 L.

Fig. 6 shows movement between Atlantic Avenue and Dudley Street. A southbound train coming from the subway could proceed only to 6 L.

Fig. 7 illustrates the setting of signals for Route 1006, Dudley Street to Dudley Street via Atlantic Avenue and subway. Obviously, a movement from Harrison Avenue to the subway over Motte and Castle Streets could be set up without conflict, top arm 4 R being inclined. Signals between tracks are back-up dwarfs.

Fig. 8 shows main line route through Dudley Street terminal. The fundamental principle of "top arm governing right-hand movement" appears frequently here. Distant signal at left center of sketch regulates the approach of a train to the siding cross-over S. Rear end of any train standing in the terminal is protected by Block Signal 407. South of Dudley Street the tracks extend to Bartlett Street yard and Guild Street car house, and are planned to continue to Townsend Street. The west siding at Dudley Street terminal is largely used as a hospital for crippled trains. An inspection pit is beneath the track. Bearing in mind that no signal controls a train unless the arm projects to the right on approaching its front side, the flexibility of movements possible is at once apparent.

Fig. 9, Bartlett Street yard, is amply equipped with signals. It is difficult to conceive of a complete tie-up of trains with the abundance of cross-overs used. The main line signals to Townsend Street are shown set up, and the simple principles laid down before permit easy comprehension of the interlocking layout. The diagram is in the main correct, although slight changes may be necessary in operating.

Fig. 10 shows a movement into the car house from the southbound track, while Fig. 11 exhibits a yard movement to main line northbound.

Townsend Street terminal will have a middle siding, and Fig. 12 illustrates a movement upon it. Here a train passes from southbound to northbound track, and is governed by the only triple-arm signal on the elevated. The second arm controls the middle siding, and the lowest arm, movement from middle siding to southbound track.

A typical round trip is shown in Table III., taken by stop-watch, as representative of the running time possibilities.

TABLE III.

TYPICAL ROUND TRIP, B. E. RY. "L" DIVISION, MOTOR 059, JULY 4, 1901

Route 1001 Station	Time Total.	Time Net.	Stop.
Sullivan Sq	9 28 a.m.	Start to Stop	
	Min. Sec.	Min. Sec.	Secs.
City Sq	3 00 3 15	3 00	15
North Station	5 28 5 51	2 13	23
Haymarket Sq	6 40 6 54	0 49	14
Scollay Sq	8 06 8 36	1 12	30
Park St	9 45 10 25	1 09	40
Boylston St	11 20 11 38	55	18
Pleasant St	13 16 14 04	1 38	48
Dover St	15 46 16 01	1 42	15
Northampton St	17 40 17 53	1 39	13
Dudley St	21 08 22 12	*3 16	1 64
1002			
Northampton St	23 46 24 02	1 34	16
Dover St	25 47 26 06	1 45	19
Pleasant St	27 49 28 27	1 43	38
Boylston St	29 38 29 57	1 11	19
Park St	30 45 31 10	48	25
Scollay Sq	32 16 33 11	1 06	55
Adams Sq	33 55 34 11	44	16
Haymarket Sq	35 00 35 14	49	14
North Station	36 00 36 24	46	24
City Sq	38 18 38 37	1 54	19
Sullivan Sq	41 55 43 15	3 18	1 20

* Delayed by signal.

The cost of such a signal system is naturally considerable, but it fades to insignificance if the interest on the investment is set against the damages which would be paid by the company after one serious collision. Whatever success has attended electric street railway practice in the past, the writer firmly believes that the day is coming when no high-speed line can legally operate without block signals or a rigid system of train despatching. The welfare of company and passengers, and the operating superintendent's peace of mind, will only be conserved by the progressive use of every safety device which scientific railway operation proves reliable. The days of the slow horse car, with its mossy bag of hay and its kerosene lamps, are long since passed, and the high-speed problems of heavy electric traction can be solved only by adherence to the best steam railway practice which the world affords, coupled with that progressive employment of advanced methods and exact analysis which reduces railway operation to a precise science.

How to Make Non-Paying Roads Pay

BY H. S. COOPER

X. Some More Standardization and Waste

It would seem to be a self-evident conclusion that it would be cheaper to have a repair, or renewal part, fit at once than to have to make it fit, and yet a great many roads—and some manufacturers—do not seem to realize this point clearly and fully. Instead of having templets, or jigs, by which to drill holes, cut slots, or keyseats, or finish up contours, it is a common practice to "fit" each piece to its special place, or to make that special place fit the piece, a course that necessitates extra labor, prevents the interchangeability of similar or similarly used parts, and does away with the benefit derivable from the lessened cost of exactly similar parts in quantity. Many do not even fit to a regular size or to fixed dimensions, such as a drawing or blue-print, but trust to the inexact dimensions of an old worn-out part or to luck, files, cold chisels and main strength.

This is true, not only as regards finished metallic parts, such as journals and brasses, but also as to woodwork, car-body fittings, truck and track repairs, pole and line materials, repairs to large machinery and buildings. A very short time ago a prominent car-wheel maker told the writer that until very recently it was unusual for him to receive orders for wheels or axles from the small and medium-sized roads, which were accompanied by drawings, or even full specifications, as to exact bore of wheel, exact location on axle, exact distance between hubs, or even the exact gage. Either the axles with old wheels on them were sent along, with instructions to "replace with new wheels of same size and kind," or, if a new axle was wanted, it was ordered for "such and such make of truck and motor," while new wheels would be asked to be sent "same as you furnish to such and such a road!" This shows a tender trustfulness in the standardization capabilities of the truck and motor manufacturers and a flattering confidence in the omniscience of the wheel manufacturer, which he did not seem to appreciate, as he always sent such parties a blank dimensioned form and sketch to fill in before he filled such orders.

Only a few days ago the writer saw on an open car in one of the large cities of this State a bronze grab-handle in which the lower bolt and screw-holes had been drilled and plugged with brass plugs, and new holes drilled and used underneath them, thus very materially weakening the handle at this point. An inquiry at the car house led to the information that, owing to the stock-keeper having allowed his stock of these handles to run out, some needed handles had been cast at a local brass foundry, using an old one as a pattern, and the bolt and screw-holes were drilled where the old holes showed in the castings. The fact of there being any shrinkage in a bronze casting nearly 2 ft. long was entirely ignored or forgotten, and in consequence, as the bolt and screw-holes on the car-posts were "fixed facts," the holes first drilled in the handle were plugged and new holes drilled by measurements from the car-posts. Had all work in this shop been done to drawing, dimensions or templets, such a botch could not have occurred, and this botch may be the occasion, on some crowded day, of a grab-handle accident that is not a fake one.

Beyond the standardizing of repair and renewal parts, and as a very necessary complement to it, should come the standardizing or limiting of wear or lost motion. Even where very good inspection is maintained, it is too often the case that the amount of wear advisable on wearing or mutually wearing parts is left to the judgment of the inspectors, instead of being fixed and standardized, and in very many cases the "safety limit," or point of ultimate wear, is not even rigidly fixed or insisted on. Many a burned-out armature, field or brush holder, many a bent journal or broken axle, many a cracked wheel or derailed car, is due to the neglect of these absolutely necessary precautions.

As an instance, take the case of some common revolving wearing part, such as the journal of a car axle and its reciprocal wearing part, the brass, or bearing. These, on a 4-in. axle, would be, say, 3 ins. in diameter when new, and, even when wearing perfectly evenly, the diameter of the fixed part—the journal—is constantly getting smaller, and a brass of the original size soon ceases to be a fit. To obviate this, the methods adopted are generally three:

1. To put in a brass of the original size and let the journal "wear it to a bearing," a proceeding generally accompanied by squeaking, smoke, smell, "jacking-up" of car and anointing with oil and "dope."

2. To put in a brass from intermediate sizes kept in stock and varying in sizes 1-32 in. or 1-64 in., putting in the size next above the average diameter of the journal at the time of renewal. This is a much better proceeding than the former, but necessitates the keeping in stock of an unnecessary number of brasses, many sizes of which may prove unavailable in practice.

3. To put in a brass, which is specially bored at that time to fit as near as can be ascertained the average diameter of the journal. This reduces the number of brasses to be kept in stock at any one time, but it causes an unnecessary amount of expensive machine work, often unnecessarily delays the use of the car, and, while it probably makes the best fit of the three methods, it can, in this, as well as other respects, be bettered.

That better way is to predetermine, by experiment or otherwise, the maximum amount of wear which may be allowed on any journal before it is necessary, when replacing brasses, to use one of a smaller diameter of bore than its predecessor originally had, and when either journal on an axle reaches, or almost reaches, this predetermined diameter on any point in its length, to take the axle out, "true up" both journals to that size and put it back with brasses to fit. This operation to be repeated on the same principle when it again reaches the next predetermined point of maximum wear, and so on until it reaches the diameter determined on as a safety limit, when it is discarded.

As an example, suppose that on the above 4-in. axle it has been determined that the journals can be allowed to wear $\frac{1}{8}$ in. smaller in diameter before a brass having a smaller diameter of bore is needed, and also that the journals may be allowed to run until the diameter is $2\frac{1}{2}$ ins. before the axle is discarded. In this case it will be allowed to wear until it is *almost* $2\frac{7}{8}$ ins. in diameter, and any brasses previously replaced will have been of the original size, 3 ins. diameter of bore. Both journals will now be trued up to $2\frac{7}{8}$ ins., fitted with $2\frac{7}{8}$ ins. brasses from stock, and this operation repeated as they successively reach $2\frac{3}{4}$ ins. and $2\frac{5}{8}$ ins., and when they reach the next $\frac{1}{8}$ in. smaller, *i. e.*, $2\frac{1}{2}$ ins., the axle is discarded. This method will necessitate the keeping of only four sizes of brasses in stock, 3 ins., $2\frac{7}{8}$ ins., $2\frac{3}{4}$ ins. and $2\frac{5}{8}$ ins., all of which sizes will be a "fit" when they are used. It, of course, also necessitates the taking out of the axle and truing it up three times, and to those who have not personally tried this method this may seem a waste of labor, and the turning down of the journal may also seem a waste of valuable wearing surface. Long experience, both of himself and of others, has, however, proved to the writer that in the end it is a great economy; journals so treated have worn longer and run truer and cooler than under any other system. This also enables the carrying of a smaller stock of brasses, and, as these are bored "standard" and in quantity, they cost less apiece and are often in such good shape when taken out with the axle that they may be rebored and used for the next larger size. This system also enables a more critical inspection for the "little rift" that presages a broken axle or wheel, tends to keep the axle better in alignment, and so save both rail and wheel, and gives better and more accurate data on which to base selection of the brass most suitable for the special service.

This principle of a predetermined standard maximum wear is applicable to all wearing or mutually wearing parts, and should be applied not only to cars, but to all machinery, apparatus or materials subject to wear. A maximum—or minimum—amount of wear or lost motion should be definitely determined and fixed for all of these; when they attain—or almost attain—it, they should be made exact to it or to their original size, by work or replacement. The renewal or replacing parts or labor are thus reduced to a known minimum, and an exactness of fit at all times and the condition of the working parts and their approach to the safety limit is absolutely known and determined.

In actual practice the dimensions and wear as given on the axle above will not be correct; they are simply given as a concrete example of the principle. In the most of street railway machinery and appliances, where the factor of safety is—or should be—very large on the wearing parts, there is no actual virtue in certain exact sizes short of the "safety point;" 2 55-64 ins.. or 2.865 ins. would probably be as good as $2\frac{7}{8}$ ins. on the above journal size; the point is, that there should be some standard, predetermined wear limit and safety limit to all wearing parts. It is certainly easier to fit to rule and caliper than to guess an old worn part, and it is certainly safer to see what is being done than to go it blind!

Waste; not the stuff that is—in so many places—aptly named; not that stringy, fuzzy material of many odd uses, and which is given to mysterious loss and incendiary propensities; the "waste" here meant is that spoken of in that old apothegm: "Waste not, want not!" Waste, in large or small ways, is usually one of the crying sins of the non-paying or poorly paying property, and is very often largely responsible for those very conditions. It is as insidious a destroyer as depreciation, and is more to be feared than it, as it attacks not only materials, but labor and effort as well; it is an active devil, seldom a passive one, and can put on all sorts of disguises; in fact, it sometimes masquerades under the guise of economy, especially when it is desirable to declare a dividend on the stock or make a showing to the stockholders. No one, from the president to the track greaser; no thing, from the smoke out of the top of the smokestack to the dirt out of the bottom of the pole-holes, is free from its attack, and that attack is always on the weak and easy side; it is so much easier to waste than to save; it is so much easier to run in a groove and let things go than to pull out and *make* them go! "A penny saved is a penny earned" is only part of the truth; "a penny saved is a penny plus (the effort and the experience) earned" would be truer, and in no business is this better shown than in one of the complexities of the street railway business, and to no one is it brought home so surely as to the managing head. Order, care, discipline and responsibility must be his watchwords; judicious and systematic checks and constant and critical attention and inspection must be his weapons if he expects successfully to attack this untiring and protean enemy. Nothing must be called too small or too petty to engage his attention at some time or other, for it is by the spigot and the small cracks that the barrel gets empty. Either by his own eyes or by those of trusted subordinates should every item and detail of the property be seen and considered over and over each season, and once in awhile it should be *his* eyes, and none other, that should take a look at everything, and that "once in awhile" should not be at regular and known periods, either! He must inspect himself, as well as others, for his opinions or hobbies may be as wasteful as anything else on the property. Especially must he watch the labor, that most elusive of all costly materials. Material may be recovered, but labor wasted is lost "for keeps." Also must he carefully examine all "economies," especially if suggested by interested or untechnical persons—or boards of directors; the wolf "waste" has done a lot of damage under the fleeces "retrenchment" and "economy," before his fur showed through. Constant watchfulness of even the most minute details; the placing of responsibility in due share on every employee, official or subordinate; a positive, mutual and reciprocal check on such responsibility, a reproof or a punishment for waste, a commendation or a reward for saving—these are the practical weapons with which to fight this enemy. But it must be remembered that it is like other devils, immortal; it is often conquered, but never killed!

Interurban Electric Railways in Ohio

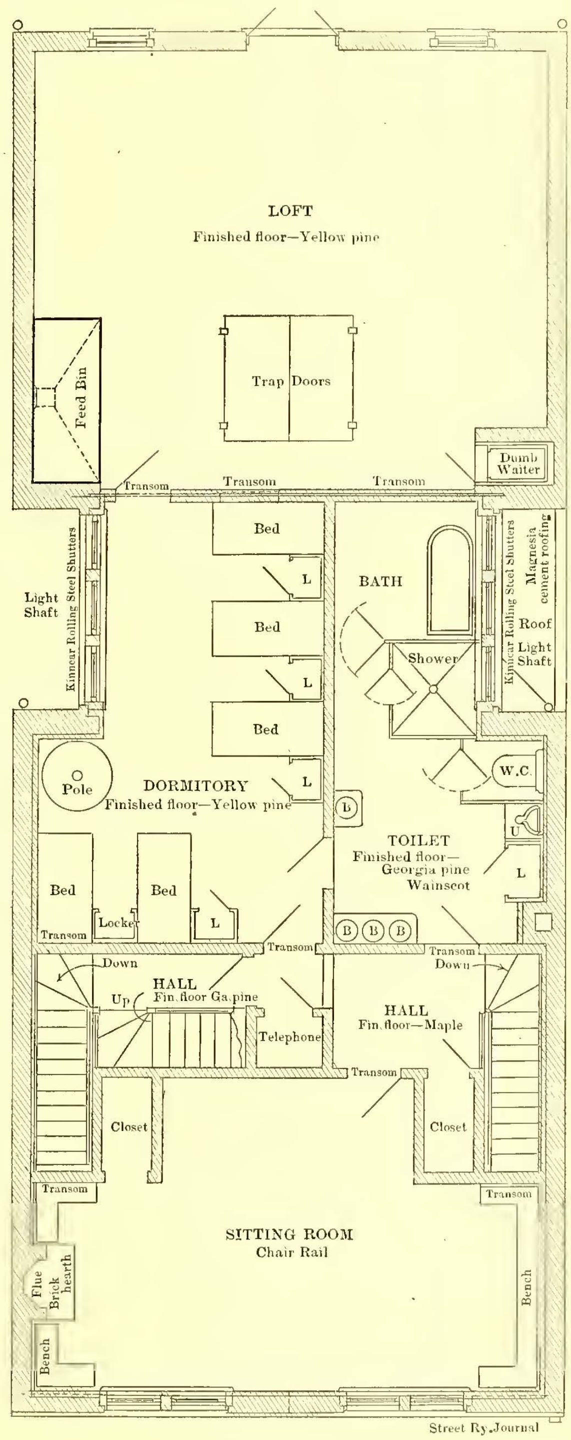
In the extended article on this subject in the August issue of the STREET RAILWAY JOURNAL two corrections should be made. In the reference to the Pomeroy-Middleport Railway, given as No. 98 in the article, Percy M. Chandler and John Blair MacAfee, of Philadelphia, should have been named as owning a controlling interest in the stock instead of Judge D. A. Russell, of Pomeroy. Mr. MacAfee, personally, also owns a majority of the bonds. The correct name of the company is the Ohio River Electric Railway & Power Company.

In the description of the Columbus situation it should have been stated that the Columbus, Grove City & Southwestern Railway and the Columbus & Southern Electric Railway Company are not in a sense parallel projects, as they leave Columbus in different directions, though both are ultimately planning at present to connect Columbus with Washington. The Columbus & Southern is now grading its line, having begun at Washington.

General Manager R. L. Andrews, of the Cleveland & Eastern Railway, recently conducted a peculiar trolley party over the company's line. The participants included many of the early settlers of Huntsburg, an isolated town near Chardon, the terminus of the road. It is said that not one of the participants had ever been in Cleveland, or ridden in a street car.

The Emergency Repair Wagon Service of the Brooklyn Rapid Transit

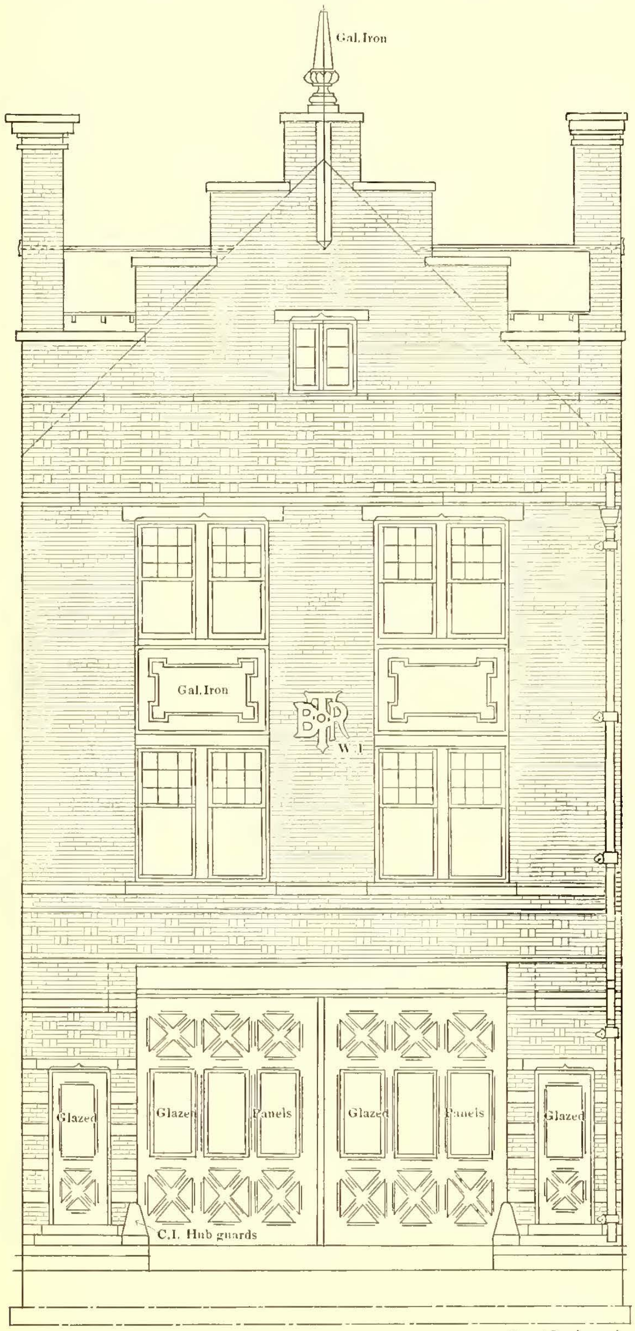
The Brooklyn Rapid Transit Company is soon to have a most efficient emergency service. The large amount of territory covered by this company's lines necessitates the placing of emergency stations at a large number of points, and the system which is to be installed will be closely



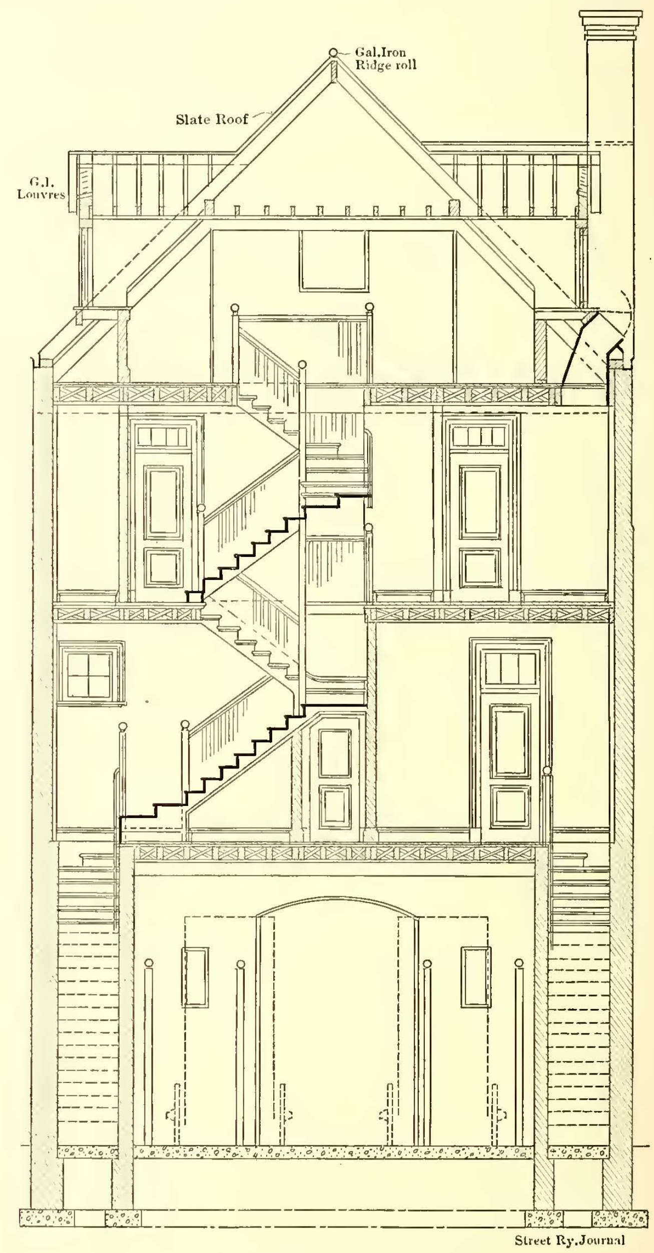
PLAN OF SECOND FLOOR OF EMERGENCY SRATION

allied to that now in common use for the fire department. The buildings are, in fact, modeled more or less after the fire engine house construction, and, as the accompanying engravings show, have the same facilities for rapidly harnessing the horses and getting the men to the emergency wagon. The repair service of a large street railway is one of its most important features. While accidents are sure to happen on the best-regulated roads, the rapidity with which repairs are made will reflect upon the management in a manner which is apparent to the entire population. It is for this reason, therefore, that such great care has been taken by the various railroad companies to put them in a position where they can quickly get their repair wagons to the scene of an accident or breakdown.

The Brooklyn company has gone a step further in the development of emergency stations than any other in designing the building illustrated herewith. As will be seen from the engraving, it will consist of a three-story structure divided in a manner which is convenient alike to men and horses. The one illustrated will be the first of this type to be constructed, and will be located between Marcy Avenue and Nostrand Avenue, on the south side of Flushing Avenue. The material used will be brick, and, as shown, every attempt has been made to make the exterior appearance as pleasing to the eye as possible. The first floor is large enough to provide in ample manner for at least two emergency and repair wagons, as well as being high enough to admit of storing a tower wagon therein. Stalls are placed at the rear of the building, two on each side of the rear door, so that four horses may be held in readiness. The floor is made of cement, and will therefore be easy to keep clean. As seen from the front elevation, there are two distinct entrances, one on each side of the building. The one on the left is for the use of the foreman's family, the upper story of the building being laid out as a flat with all the modern sanitary conveniences. The other entrance is intended for the use of the crew, which will consist of four men. The plan of the second floor shows the arrangement of the living apartments for the crew, and illustrates the manner in which the stairway for the upper apartment is kept entirely distinct from the occupants of the second story. At the head of each bed is a locker similar to that used in army posts, wherein the men can store their belongings. The height of these lockers is about the same as a common table. In the corner of the dormitory is a round hole cut through the floor, similar to that used in the modern fire engine house. Through this hole runs a brass pole, upon which the men rapidly descend to the apparatus room below. In front of the dormitory is a comfortable sitting room provided with benches and tables, where the men can make themselves comfortable during their inactive periods. This sitting room will have quite an attractive appearance. Considerable care has been given to the design of the lavatory arrangements and a large amount of space set apart for shower baths, etc.

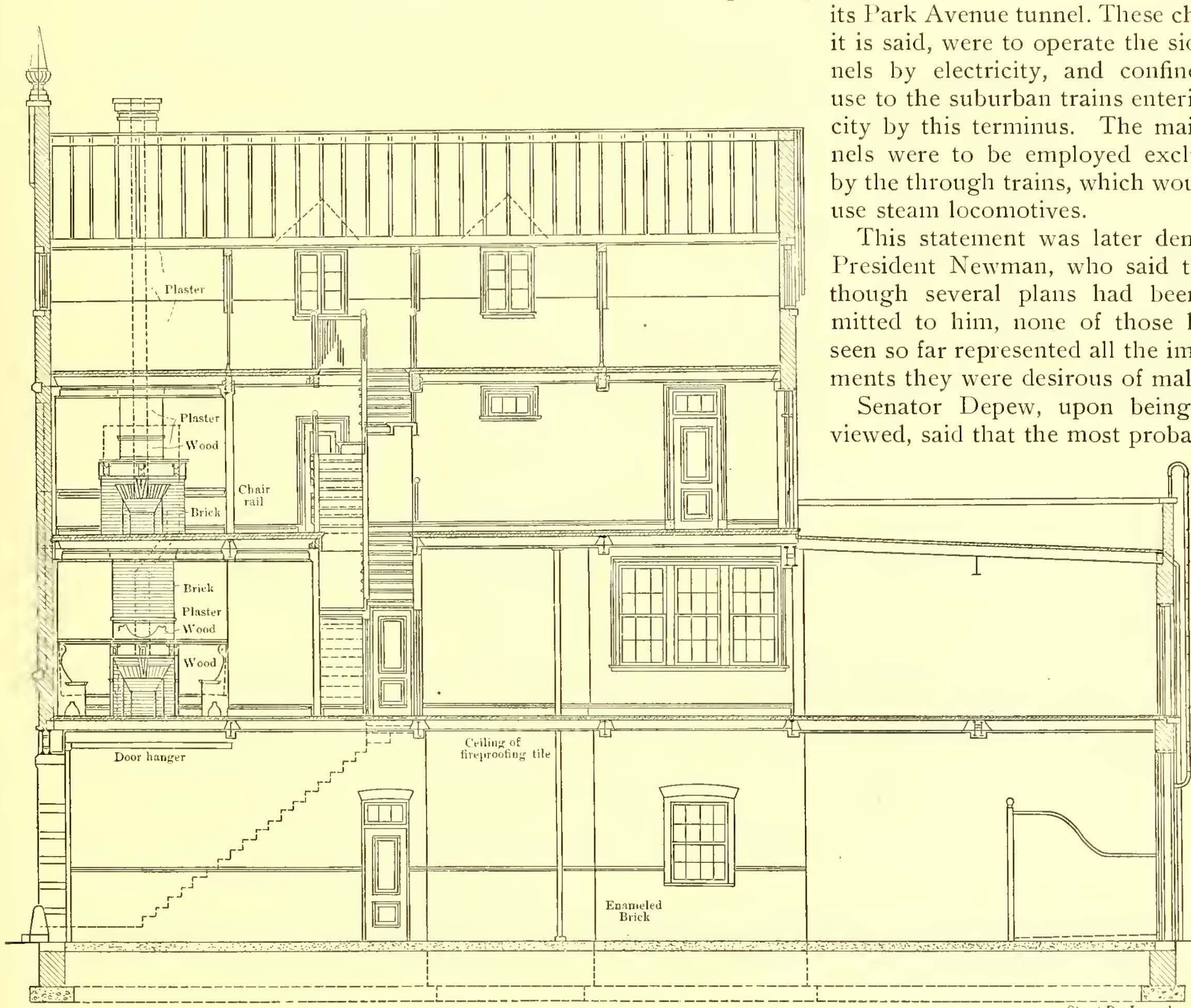


FRONT ELEVATION OF STATION



CROSS SECTION OF STATION

The apartments which will be provided for the foreman's family on the upper floor have been designed in a way which leaves little to be desired in the way of convenience and roominess. The front part is divided into two large square rooms, the dining-room and the parlor connected by folding doors. In the parlor is a handsome open fireplace. There will be on this floor two bedrooms, a kitchen and pantry. A dumbwaiter will connect with the lower floor, the same as in ordinary apartment houses. The fireplaces in both the parlor of the foreman's apartment and the sitting room in the men's quarters will be fitted with gas logs. Speaking tubes connect the various floors. The attic will be at the disposal of the foreman's family if they desire to make use of it. The loft over the rear end of the building is used for the storing of hay and other supplies, and connects with the lower floor by trap doors. This lower portion is only two stories in height, the roof of it being on a level with the floor of the foreman's living apartments. This roof, therefore, can be utilized by the foreman's family for drying clothes, etc. Descending from the end of the roof is a ladder fire-escape, which gives access to the yard at the rear. Every precaution, however, has been taken to make the construction entirely fireproof. The windows in the light-wells are fitted with fireproof doors, and on the mullion windows are placed steel rolling shutters made by the Kinnear Manufacturing Company. The floors and ceilings are all of fire-resisting material.



LONGITUDINAL SECTION OF STATION

As previously mentioned in these pages, it is soon expected to operate automobile emergency wagons. These wagons will, it is thought, be able to reach the scene of trouble quicker than would ones drawn by horses, and will be much more economical to maintain than would be horse vehicles. The company expects to receive the first of these emergency wagons within a few weeks. Thanks are due to D. R. Collin, the architect of the company and designer of the building, for the above description and accompanying drawings.

New York Central Tunnel Improvements

According to the New York *Sun* of Aug. 27, the management of the New York Central Railroad Company had decided upon a plan to relieve the conditions existing in its Park Avenue tunnel. These changes, it is said, were to operate the side tunnels by electricity, and confine their use to the suburban trains entering the city by this terminus. The main tunnels were to be employed exclusively by the through trains, which would still use steam locomotives.

This statement was later denied by President Newman, who said that although several plans had been submitted to him, none of those he had seen so far represented all the improvements they were desirous of making.

Senator Depew, upon being interviewed, said that the most probable solution was the proposal to depress the tracks for suburban trains and run them in a loop through a tunnel underneath the Grand Central Station by electricity. He said the matter was in the hands of President Newman, who was to submit a decision at the board's next meeting, in December. These recommendations would surely be adopted.

The Market Street Railway Company, of San Francisco, is planning to use oil as fuel, and has just completed the erection for this purpose of an enormous oil tank to hold 1,260,000 gallons of California liquid fuel. This tank stands near the electric power house at Fourteenth Street and Bryant Street. It is 90 ft. in diameter and 31 ft. high, and is of steel. The oil is purchased from the Monte Cristo Oil Company, which is said to have a three years' contract to supply oil, the price to be in neighborhood of 30 cents a barrel at the wells, with transportation charges of 42 or more cents added.

STREET RAILWAY JOURNAL

SEPTEMBER 7, 1901.

PUBLISHED WEEKLY BY

THE STREET RAILWAY PUBLISHING COMPANY

Main Office:

NEW YORK, Beard Building, 120 Liberty Street.

Chicago Office: Monadnock Block.

Philadelphia Office: 929 Chestnut Street.

London Office: Hastings House, Norfolk St., Strand.

Long Distance Telephone, "New York, 4044 Cortlandt."

Cable Address, "Stryjourn, New York."—Lieber's Code used.

TERMS OF SUBSCRIPTION.

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

Single copies, first issue of each month, 35 cents; other issues, 5 cents.

To all Countries outside of the United States, Canada and Mexico..... { $6.00 / £1 5 0 / M25 / 31fr

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

Entered as second-class matter at the New York Post Office.

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The crying need for better urban transportation is well demonstrated in the present condition of the four great commercial capitals of the world. London, as is well known, has now several underground roads in operation, and Parliament is besieged for rights to construct others. Paris has recently completed its first road of this kind, and the traffic on it has been so great that immediate extensions are under way. Berlin is being equipped with an extensive underground and elevated railway system, some views of which are published in this issue, while New York will have its rejuvenated elevated lines electrically equipped within a year, and its subway in operation probably by 1904. All the underground roads are practically the development of the last seven or eight years, and were rendered possible by electricity, which allows a system of haulage not producing combustion in the tunnel. In this connection it is interesting to note that the number of independent projects in London now before Parliament has induced that body to consider whether any uniform policy governing the granting of the necessary rights should be adopted to govern the action of the regular committees in granting franchises. This subject was referred to a joint select committee of the House of Lords and House of Commons, and their report has just been issued. It is needless to say that a great deal of testimony was given before the committee, much of it, by the way, by Americans, and the conclusions occupy nearly two columns in the London *Times*. They lay down general and special provisions as to the best methods of construction and operation, some of which are extremely interesting in view of the study given by the committee to that subject. Among them we notice a discussion of the best method of operating the termini, whether on sub-tracks or loops. On this topic the committee says:

Which system should be adopted in each case is a question for the Parliamentary Committee to which the bill is referred. But while the advantages to the working of the line by loops are obvious, and in outside districts there can be no objection to them, the committee thinks that very great caution should be exercised by a committee in sanctioning them in the heart of the city, on the ground of the large amount of space occupied to the possible exclusion of future railways. They have the less hesitation in making this recommendation, as the mutiple-motor system, by which much time is saved in shunting at terminal stations, appears likely to be adopted in future.

In view of the enormous extent which the underground railway system of London will occupy, it is interesting that the committee should give such a practical endorsement of the multiple-unit system of operating trains, and should reject the proposed method of establishing loops at the city ends of the underground railways, present or proposed, in London, and thus inferentially condemn the use of electric locomotives.

Two of the papers read at the recent Buffalo meeting of the American Institute of Electrical Engineers have a most lively interest for electric railway men. These papers by Messrs. Berg and Armstrong are closely allied in theme, although not in treatment, and they may be regarded as supplementary to each other. These gentlemen have practically appeared in the joint role of defenders of the faith against the polyphase motor heresy. Their support of orthodox canons is all the more striking because both of them are familiar with polyphase work in general, and even in this instance they are not prepared to abandon it so long as rotary converters are available. Mr. Berg's paper deals directly with the problem of the supply of power to long electric roads, and his notes upon the apparatus employed for that purpose are decidedly instructive. The strong opinions held by the author on the topic of low frequency for such alternating supply system are hardly in keeping with his progressive attitude in respect to some other matters. For ourselves, we have never been able to discover any sacred or esoteric significance in the use of 25 cycles, a frequency which forbids the successful use of incandescent lamps without offering any commensurate compensating advantages. Those of our readers who are practically operating rotary converters at 60 cycles or thereabouts will smile, we fancy, at the stress laid by Mr. Berg on his favorite low frequency.

* * *

In another particular we find Mr. Berg at variance with the opinions and practice of some distinguished engineers, although for the special case of very large steam-driven alternators there is at least a color of plausibility in Mr. Berg's contention. The matter to which we refer here is the question of armature reaction, involving inherent regulation of the machine. Mr. Stillwell in his very striking paper at the same meeting on the work at Niagara emphasized strongly the value of good inherent regulation, and noted that the recent Niagara generators are deliberately built with a much lower armature reaction than those first installed. Mr. Berg holds that high armature reaction is desirable. Where doctors disagree in this fashion it perhaps is rash for comparative laymen to offer suggestions, but we would mildly insinuate that a little further study of the hunting question would probably enable Messrs. Stillwell and Berg to meet on a common ground, and that probably not very far from the position now held by the former. Mr. Berg's discussion of hunting, by the way, is extremely interesting reading, although we are inclined to the opinion that experience shows rotary converters to be even more subject to the occurrence of this unpleasant phenomenon than synchronous motors. The frequency of hunting, even on systems driven by water-wheels, would suggest that the electromagnetic cause is far more serious than the occasional trouble superinduced by improper governing of the prime mover. The subject is worth a great deal more study than has yet been accorded it, and we fancy that with the proper understanding of this matter the direct-current generator, driven by an induction motor, will utterly disappear, except for entirely trivial uses. Its very existence is a confession of inability to deal with the hunting problem, and we do not think that it is likely to take a serious place in railway practice.

* * *

The part of Mr. Berg's paper which is of greatest interest, however, to the electric traction engineer is that in which the use of alternating-current polyphase motors for the operation of the trains is considered. A case such as frequently occurs in practice is assumed, and then very carefully worked out by the author, showing, first, the energy required and cost of plant for a transmission to rotary converter sub-stations; second, the care of feeders for the polyphase motor with rheostatic control, and, finally, again the same factors for the same plant, operated by polyphase motors with the so-called concatenated control. It has frequently been assumed that in all but exact computations the great advantage to be gained by the installations of sub-stations without moving machinery and requiring no attendants would offset the disadvantage by reason of low efficiency or insufficient power factors in the polyphase motors. Mr. Berg shows that at least, so far as energy is concerned, under his assumed conditions, the polyphase motors are somewhat at a disadvantage, aside from all questions of two working conductors instead of one, and difficulties in getting proper control of the speed.

* * *

One trouble connected with the polyphase motor might have been more forcibly brought out with great advantage. The polyphase induction motor, being essentially a constant speed machine, is not only somewhat difficult to run at reduced speeds, but also can not be called on for a spurt in case of a necessity for making up time. This weakness of the motor we regard as in some instances worthy of very serious consideration. The case assumed for the consideration referred to is one which might very easily occur in practice, to wit, an urban or suburban road not running in the streets, but dealing with a heavy service, such as might be found on an elevated or underground structure. Stations are assumed practically every half mile, together with the use of 180-ton trains, and a schedule speed of 15 miles an hour, corresponding to a maximum speed of a little less than double this figure. Bearing in mind the fact that all energy given to the train which has to be consumed in braking is substantially lost energy, it is easy enough to understand that quick acceleration, followed by coasting, is desirable, if it can be secured without too great initial expenditure of power. On Mr. Berg's figures the direct-current motors, with series-parallel control, have a very material advantage in this respect. Starting under heavy loads is the weakest point of polyphase induction motors, and the service of such a line as Mr. Berg assumes is practically a series of starts under severe traction conditions. It is very little wonder that in this comparatively common practical case the induction motor is apparently not a shining success. On the other hand, it does not appear to us that the characteristic curves assumed for the alternating-current motor are those which, in practice, would be given a machine intended for this very severe service in starting. It will pay even at some further expense in construction to design the polyphase motors, as continuous-current motors frequently have to be designed, for rapid acceleration at the start, and subordinate the method of control to securing efficient work in acceleration. A little practical experience in running polyphase motors for traction would undoubtedly bring them considerably nearer to the continuous-current motors than Mr. Berg's figures indicate, yet it must be remembered that there has not yet, up to the present time, been devised any method of polyphase motor control which is a fair equivalent for the series-parallel connection now almost universally used for direct-current motors. Whether a method of speed regulation can be devised to meet this difficulty is an open question not by any means decided in the affirmative.

* * *

With respect to the cost of installation, Mr. Berg's figures lean strongly toward the transmission to sub-stations with rotary converters. As he very justly states, continuous-current motor equipments have been so far standardized in this country that they can be furnished more economically than alternating-current equipments. Whether this would be true if the two classes of machinery were used in approximately equal amounts is another matter, but we incline to the opinion that, with American costs of labor, the advantage would still lie rather with the continuous-current machinery. With the costs of labor obtaining abroad, the reverse might hold, and at all events, in the matter of price, the Ganz proposition for the great London underground work, still under consideration abroad, stands in sinister rebuttal of the figures produced in the paper under discussion, and until that proposition and its working are pretty thoroughly analyzed, it will be unsafe to predicate the greater cost of the alternating apparatus, at least under foreign conditions of manufacture. Mr. Berg has done a good service in pointing out distinctly the way in which the difficulties of polyphase motor work may be met under conditions ordinarily to be found in practice, and emphasizes the necessity of caution in considering polyphase motors for heavy traction.

* * *

Mr. Armstrong approaches the subject from the general operative standpoint, rather than in the detail marshalled by his colleague, discussing the practical difficulties of collection of current in urban work, and the heavy output entailed by the nearly constant speed of the polyphase motors operating on heavy grades. We are inclined to differ with him on the probable cost of repairs to induction motors, as these machines have proved themselves singularly free from deterioration, even when running with air-gaps so much smaller than those used in direct-current practice, as apparently to threaten immediate difficulties. Mr. Armstrong's conclusion is that the polyphase motor must find its place, if anywhere, in the long-distance, high-speed work with comparatively few stops. To his practical suggestions we might add a little with respect to a case for which polyphase motors at first sight look very attractive, that is, long and lightly loaded lines requiring a comparatively small amount of power. Undoubtedly the alternating distribution is attractive in such cases, but if the service is really light, and likely so to continue, a point may be reached where the amount of copper required for the supply of continuous current at 600 volts or so is relatively so small as to give standard equipments the advantage. It does not answer as a mechanical proposition to install very small trolley wires, and where the trolley wire itself is large, a comparatively small amount of feeder copper is ample to carry the required current over the distances involved, there may be more practical loss than gain in a transmission at high potential.

* * *

With all this it must be realized that the subject of speed control in polyphase induction motors is one which has not been thoroughly threshed out; but such motors have come into use, and have been used almost entirely for ordinary stationary motor work at practically constant speed, and there has been applied to the problem no such stimulus as that which has produced the series-parallel controller, and the multiple-unit system in continuous-current traction. As the field develops and more serious work is devoted to the adaptation of polyphase motors for traction, some of the difficulties which are probably urged against such use are likely to be in part at least removed. We can not exactly forget that the series-parallel control was tried and abandoned as impracticable several years before. Persistent experiment, in the face of apparently insurmountable obstacles, brought it to its present stage of development. The foreign polyphase roads are worth watching most attentively, and when their times comes, if it does come, we in America will obtain gratis the results of the labors abroad. For the present, we think the warning note sounded by Messrs. Berg and Armstrong will probably serve to check too impetuous action on the strength of the foreign experiments.

Protection Against Noise

Has the public or the property owner any enforcible right to a quiet street? And, if so, what is the extent and the limitations of that right? These are questions which have been called forth by modern means of conveyance, particularly the steam and gasolene automobile, and even by the electric trolley.

That the abutting property owner has easements of "light, air and access" is fundamental, and a street can not be defined without either negatively or affirmatively recognizing these easements. The extent of the easements no one can accurately state. Courts have differed, and still differ, when they are asked whether a trolley pole, a telegraph pole, a change of grade of part of the street, an elevated railroad structure or a steam railroad, take away any part of the easement of light, air or access.

But when we pass to the question of noise we are met with the fundamental difficulty that this old common law easement of light, air and access does not necessarily recognize the rights of the ear, to comparative peace and quietness; light for the eye, air for the nose and lungs, access for the feet and body, the street must provide to the property owner who has built his residence upon it. Perhaps this omission was caused by the fact that in ancient times the rights of the ear were not invaded by any street uses, and so did not need to be protected by even the assertion that they existed or by any judicial or legislative definition of them.

In the elevated railroad litigation in New York the lower courts decided that the easement of the abutting property owner was impaired by the noise of the engines and trains of the road. But this conclusion was reversed by the court of last resort in the American Bank Note Company's case, although the court admitted that the noise, as well as the impairment of "light, air and access," depreciated the value of the property in a substantial sum. It held that the property owner had no easement except light, air and access, and noise was none of these. At the same time, it was held that noise was an element of recoverable past damages, because the trespass committed by the road before acquiring the easements by condemnation included all incidental injuries inflicted.

These legal considerations and decisions do not afford much comfort to those who are fearful lest our streets are about to be invaded with rattling, puffing machinery, driving, in all sorts of ways, vehicles of every type, from the tricycle, with a coughing gasolene motor, to the enormous steam-propelled truck, filling every city street with the din of an elongated machine shop or engine room, and rendering the quiet home uninhabitable for any but the deaf or strong and healthy persons of a philosophic turn of mind.

These fears are not altogether unfounded. The experience of some cities in France warrants them. But for the comfort of those who entertain them we can say something. Public opinion will do much, especially when the law falters or is balky. It can drive an obnoxious gasolene motor from the streets without resort to the courts. It can compel the enactment and enforcement of city ordinances regulating not alone the rate of speed, but also the size and weight of vehicles, and the amount of noise they will be allowed to make. Even the common law recognizes noise, when it is loud enough, as a nuisance, even if it refuses to recognize quietness as an easement pertaining to a street. It is certainly true, too, that the American manufacturer (whether rightly or wrongly, we shall not stop to inquire) believes that the American public will not buy an automobile that announces its approach with the clamor that is the accompaniment of the French gasolene machine.

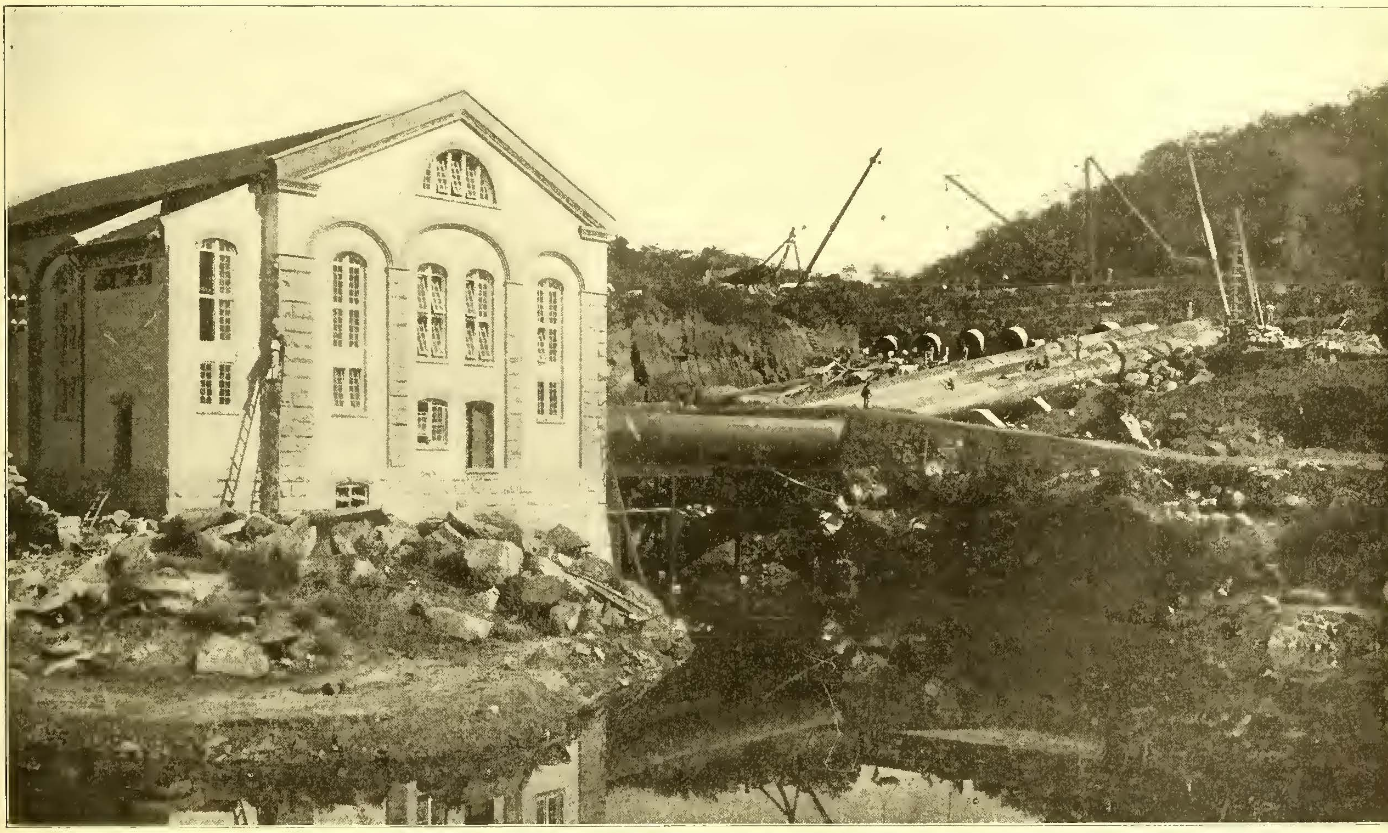
One, and probably the greatest factor, in the problem that makes for its solution is the financial interest the maker, and especially the user, has in producing and operating as noiseless a machine as possible; for the statistics show that the most expensive accidents caused by automobiles, for which the owners are held liable in many cases, are those caused by the running away of horses frightened by the noise of the clamorous machine. Perhaps the first thing yet to be learned by the American manufacturer and the American public is that true economy will not consider price, size or weight, if any element of safety, including absence of noise, is to be sacrificed.

The System of the Sao Paulo Tramway, Light & Power Company, Ltd.

On Nov. 15, 1899, the Empire of Brazil ceased to exist and the Republic of the United States of Brazil was formed, the twenty provinces of the Empire becoming autonomous and sovereign States of the Union under a constitution founded on that of the United States of America. Since that time there has been no evidence of any desire for a change in the system of government then established or of any wavering in the maintenance of the integrity of the Union. The change was one upon which the heart of the country had long been set, and was peaceful and bloodless. Monarchy in America had run its course. The psychological moment for the institution of a republic had arrived and it was created almost without a disturbing circumstance. In the North when we hear of any disorders in any of the Southern Republics we scarcely appreciate that these are confined almost exclusively to the Central American States and those bordering thereon, and that Brazil usually first learns of these events through New York, so much nearer to our own than to the Brazilian capitals, being the seat of them. How many of us with our boasted enterprise know that Brazil is a country of about 20,000,000 inhabitants with an area equal to our own; that it furnishes 66 2/3 per cent of the world's supply of coffee, 55 per cent of its rubber and a large percentage of its sugar, tobacco, and other prime necessities, and that it has not only the most stable government in South America, but one which is more likely than that of most European countries to suffer revolutionary changes.

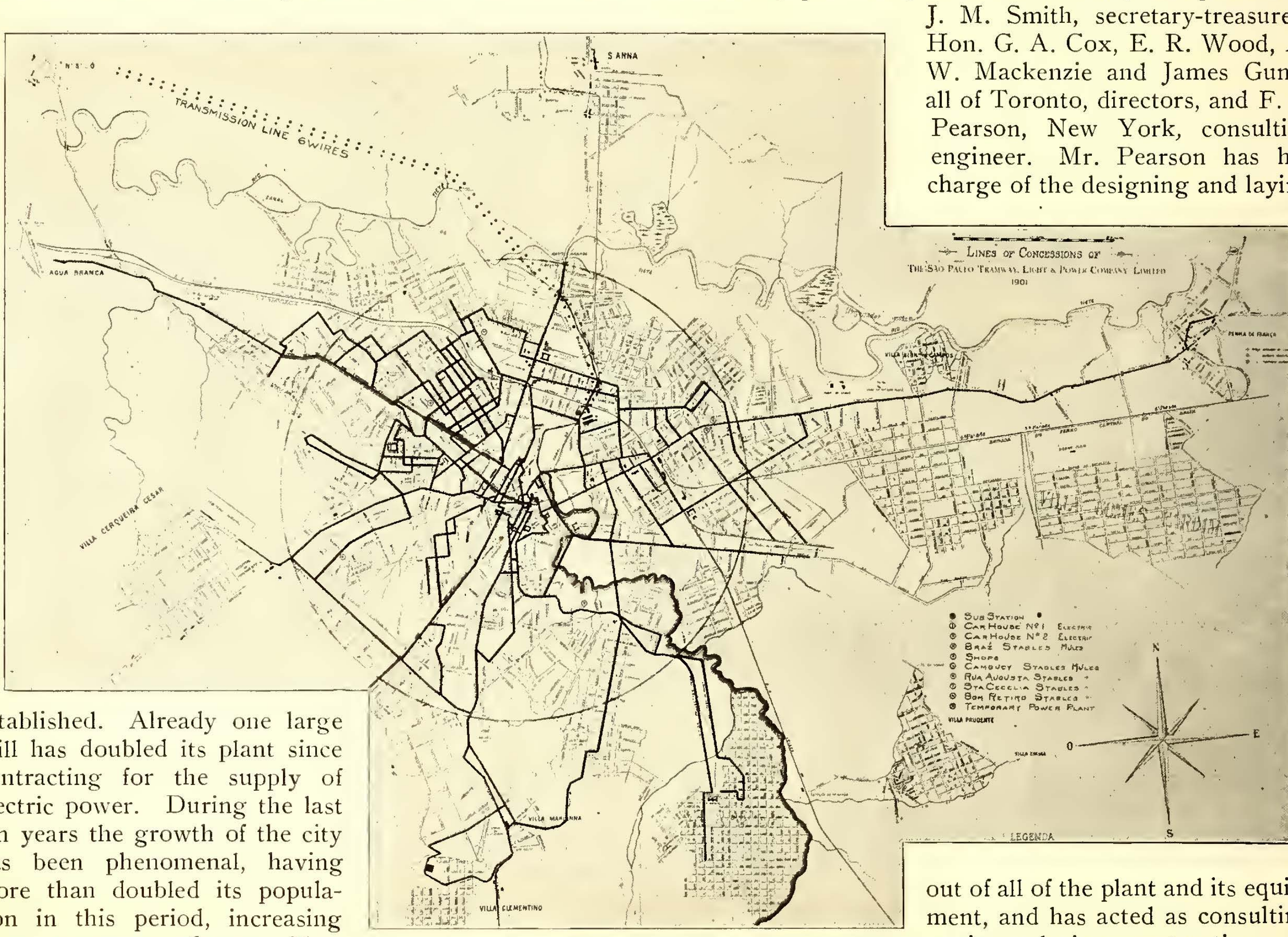
The State of Sao Paulo, which has always exercised a dominating influence upon the great historical events of that great country, is to the Union what New York State is to our own—the Empire State. It has already given two of the three Presidents who have held office since the constitution of the Republic, and the generally accepted candidate for the next term is the present Governor of Sao Paulo.

The city of Sao Paulo is the capital of the State of that name and is situated on a high plateau about 2500 ft. above the sea at a distance of about 34.5 miles from its seaport, Santos. It has a salubrious and equable climate and yellow fever and other contagious diseases are never epidemic and are indeed practically unknown. It is the center for the great railway systems of the State, all freight to and from the sea necessarily passing through the city. Although not so large as the national capital, Rio de Janeiro, it is recognized in many respects as more modern and progressive. Among its population there is a large percentage of Italians, Germans, Portuguese and English, and of late years a goodly number of Americans have taken up their abode there. The municipal government of the city is enlightened and progressive and compares very favorably with that of any northern city and much to the disadvantage of many. The leading business men do not hesitate to serve in the municipal offices and to give their fellow-citizens the benefit of their ripe experience by devoting their time and energies to the problems of municipal government. The Prefect, for instance, who occupies a place corresponding to that of a Mayor among us, is the head of a family which has made a powerful impress upon the commercial, political and social life of the State. Formerly a Minister of the Empire, he is now the President of one of the greatest railway systems in the State and of the most successful national bank in the country, and besides being one of the largest coffee producers in the State, is the head of one of its largest business firms. Private capital there has largely been taken up with the development of railways and agriculture, but there is much European capital employed in mining and other large enterprises. Paulistas recognizing the value of the investment of foreign capital, have adopted a liberal and enlightened policy in dealing with such investments and the laws of the country and their execution offer



POWER HOUSE AND FEEDERS FROM RESERVOIR—VIEW TAKEN JUNE 22, 1901 every reasonable guarantee for the security of investors.

Sao Paulo is fast becoming a manufacturing city, notwithstanding the great obstacle which expensive coal has placed in its way. Practically the whole State is dependent upon it for its supplies, therefore it is the business center and point of distribution of all imported and manufactured supplies for 5,000,000 people. Besides this, the export business of the State, chiefly coffee, all passes through Sao Paulo on its way from the fazendas of the interior to the port of shipment, Santos. Last year, the total shipment of coffee passing through Sao Paulo was 5,700,000 bags, being nearly 75 per cent of the total coffee crop of Brazil. With cheaper electric power now at their disposition manufacturers will increase their plants and new factories will be established. Already one large mill has doubled its plant since contracting for the supply of electric power. During the last ten years the growth of the city has been phenomenal, having more than doubled its population in this period, increasing from 90,000 to 262,000. Notwithstanding this fact, the development has been remarkably well directed and the public buildings, the public thoroughfares and all public works have been so constructed that the city in many respects is ahead of many Northern cities which have grown up in an equally short interval.



MAP OF SAO PAULO, SHOWING TRAMWAY LINES

Though Brazil is rich in natural resources of mines and soil, it has no coal mines yielding coal suitable for commercial use. Therefore the cost of power when produced by steam, and of light when produced from coal gas, is exceptionally high. Imported coal sells at an average of about $13 per ton. The gas rate is about $3 per 1000 cu. ft.

Some particulars were published about a year ago of the plans for electrical development in and about the city. These have since been rapidly completed, so that now a general review of the situation is rendered possible.

Sao Paulo some three years ago came to the notice of certain capitalists of the United States and Canada, who immediately realized that in this city there was an exceptional opportunity for the introduction of electricity for the supply of electric light and power, and for the operation of a street railway. Upon investigation it was found that at a distance of 20 miles from Sao Paulo, near the village of Parnahyba, there was a water power with a capacity of about 20,000 hp. Having acquired this water power and concessions for an electric street railway and for the supply of electric light and power through the whole city and its suburbs, a company was formed for the establishment of the plants necessary for the exploiting of these businesses. As this power is the only one worth developing within transmissible distance of the city, the company thus acquired a practical monopoly for all time of the business of supplying electric current to the city and vicinity.

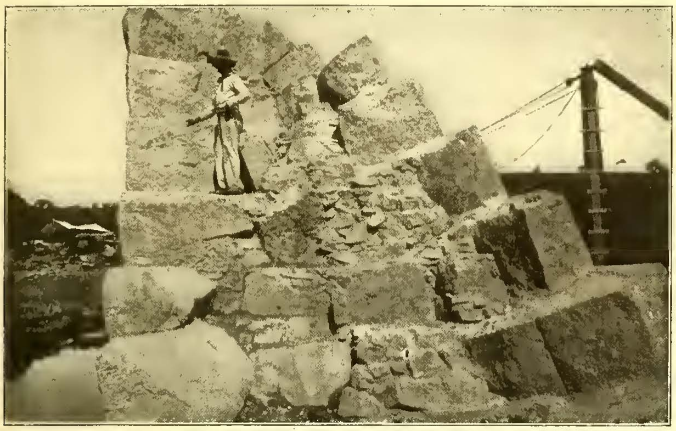
The officers of the company are the following: William Mackenzie, president; Frederic Nichols, vice-president; J. M. Smith, secretary-treasurer; Hon. G. A. Cox, E. R. Wood, A. W. Mackenzie and James Gunn, all of Toronto, directors, and F. S. Pearson, New York, consulting engineer. Mr. Pearson has had charge of the designing and laying out of all of the plant and its equipment, and has acted as consulting engineer during construction.

The street railway concession was granted for a period of forty years, with rights of renewal, but in the case of the light and power concessions there is no time limit.

When the company was formed there were in the city two other railway companies. They were, first, the Companhia Viacao Paulista, a mule road operating some 60 miles of track; second, the Companhia Carris de Ferro de Sao Paulo á Santo Amaro, a suburban steam line running from this city through a populous suburb to the city of Santo Amaro, some 12 miles distant. These have been acquired by the Sao Paulo Tramway, Light & Power Company, so that now it holds, by a recent unification of its concessions, an exclusive franchise for the operation of railway lines for forty years. The only other electric company operating in the city is the Companhia Agua e Luz, a lighting company which supplies about 5000 incandescent lamps, but as its plant is non-condensing from coal it could not supply power at a rate to compete with the mills supplying their own power. This company, though still operated as an independent company, is controlled by the Sao Paulo

Tramway, Light & Power Company, and these two now have a perpetual franchise for supplying light and power in the city.

The plan of development laid out by the company some two years ago was to install at the village of Parnahyba, 20 miles from the city of Sao Paulo, a power plant which



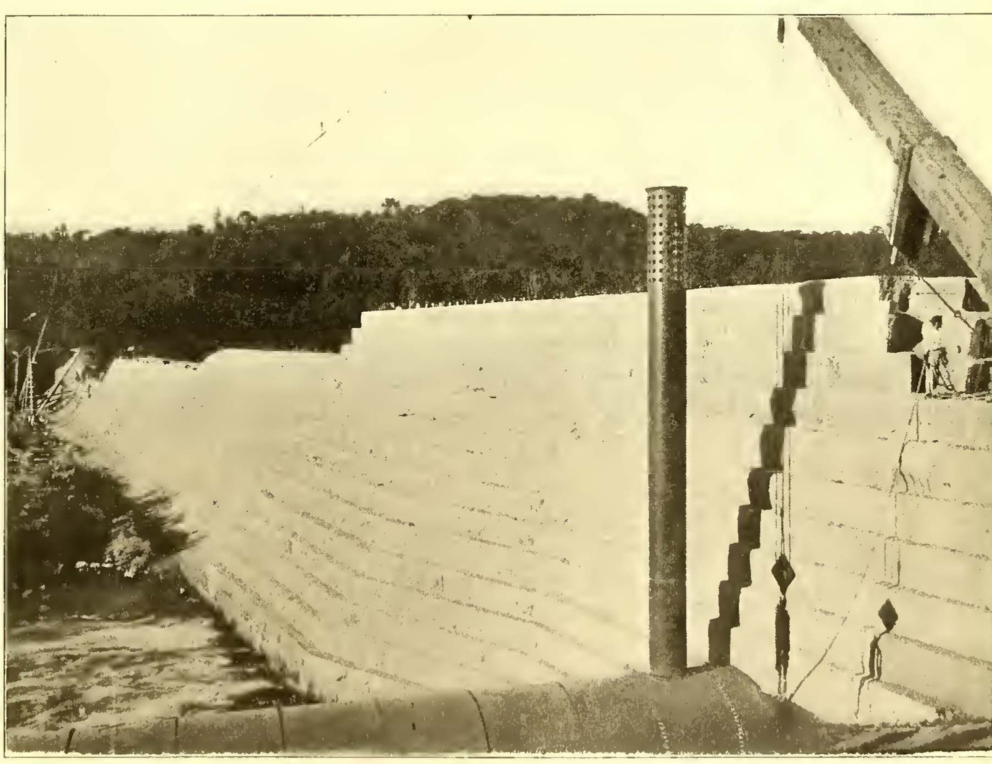
SECTION OF MAIN DAM

would give a maximum output of 16,000 hp; to build a double transmission line to Sao Paulo; to construct in Sao Paulo a sub-station, and distribute from this throughout the city and its suburbs electricity for an electric railway and for the use of general illumination, power and heating.

In the month of August the company proposed to put into operation its plant. In the beginning it was to operate fifty electric cars, supply electric current for 10,000 incandescent lamps and 400 arc lamps, and power for about 1000 hp of stationary motors. During the next twelve months, through extending its street railway system, the company will probably have in service 60 miles of track, with about eighty-five electric cars, 30,000 incandescent lamps, 500 or 600 arc lamps and 2000 hp of stationary motors.

WATER POWER PLANT

The company, after an extended investigation of all water powers available, finally acquired the somewhat famous Cachoeira do Inferno (Rapids of Hell) in the Tieté River, at Parnahyba. Why the early Portuguese settlers gave the rapids that name is not known, for they do not seem to deserve such a harsh description, as they have practically nothing more than a uniform dip of 38 ft. in the river channel, in length of about 2400 ft. The catchment basin above the rapids has been well surveyed by the Geological Department of the Brazilian Government, and shows an area of approximately 2700 sq. miles. Records of the average rainfall over this basin for ten years indicate an average precipitation of 65 ins., varying from 2 ins. to 12 ins. per month. The total absence of periods of drouth and the dense uncultivated vegetation combine to produce an unusually heavy yield of water in the minimum periods. The lowest gages of the river obtained show a yield of 35 cu. ft. per minute per square mile. The company has assumed the yield to be at times as low as 25 cu. ft. per minute per square mile, or 67,000 cu. ft. per minute. The development of the power has required the building of a main dam across the river at the crest of the rapids. This dam is 800 ft. in length over all, has an average height above the foundations of 43 ft., and produces a total drop between the crest of the spillway and standing water in the tail race of 77 4/10 ft. The spillway is 462 ft. long with an abutment at each end built to a level of 7 5/10 ft. above the crest of the spillway. The face of the spillway is O. G. in form, is 36 ft. wide on the base and has an averagė width at the crest of 12 ft. The spillway is designed to discharge a flood of 1,700,000 cu. ft. per second, and the gages of the greatest floods in the past indicate a maximum flood discharge of 1,000,000 cu. ft. per minute. The entire structure is founded on granite ledge and is constructed throughout of granite. The quality of granite used is excellent, being free from seams, is coarse, and has a specific gravity of 2.83. The lines of the dam are brought up in ashlar, cut to 1-in. joints, the hearting being of heavy granite backing, well bedded and the interstices filled with Portland cement concrete. River-washed sand, three parts to one part English Portland cement, has constituted the mortar used except for pointing, which has been two to one. Concrete foundations throughout have been one part cement, three parts sand and five parts broken granite. The main dam has called for the construction of 23,000 cu. yards of masonry. The excavation and delivery of materials for this work have been accomplished by an aerial

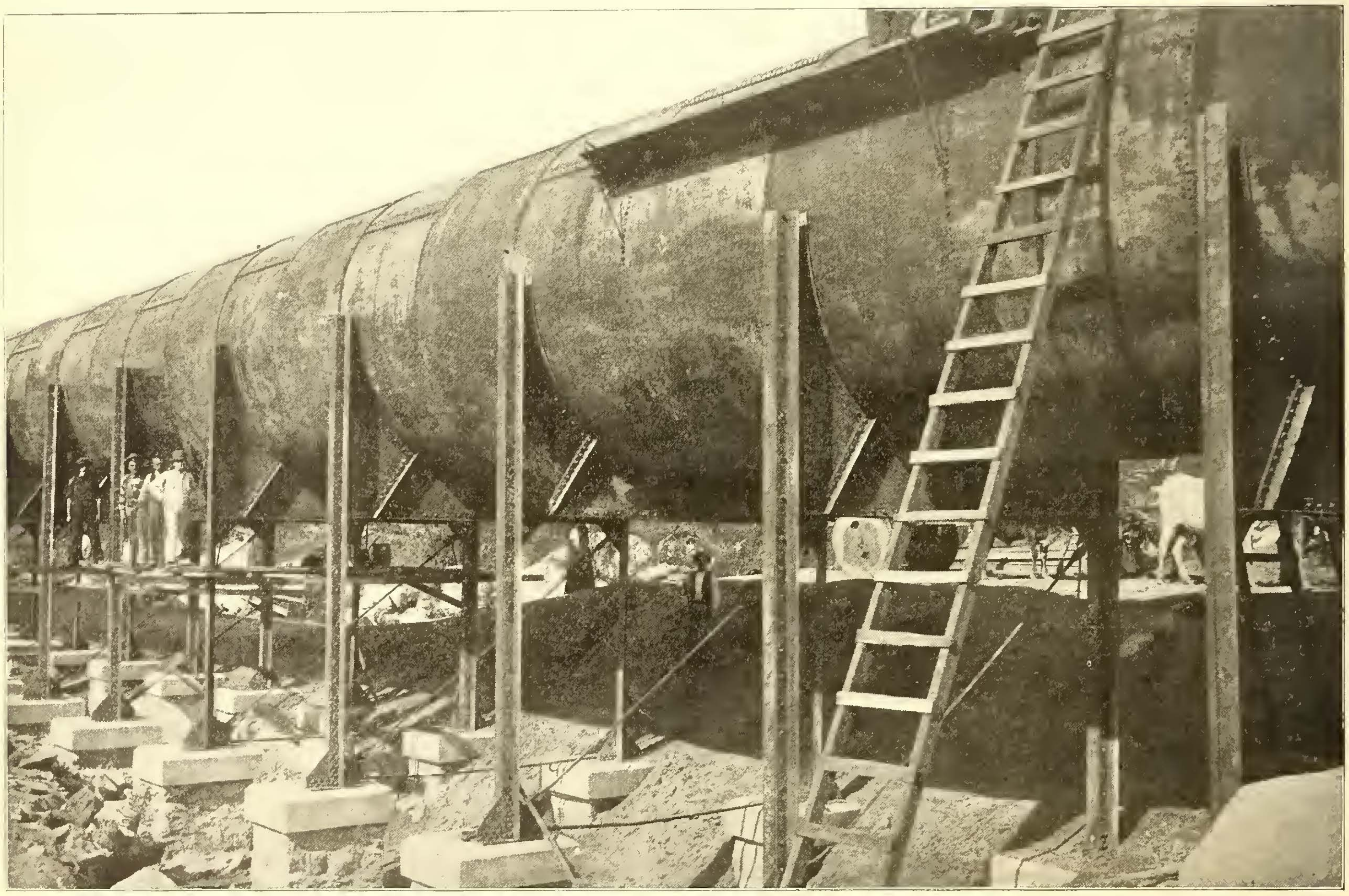


VIEW OF MAIN DAM, SHOWING PIPE LINE AND WATER PASSING THROUGH SLUICE GATES

cableway over the dam. The cableway has a span of 860 ft. and a carrying capacity of 10 tons at the rate of 600 ft. per minute. An interesting feature in the construction of this dam was the design of cofferdam used. The bed rock was always found overlaid with many boulders of varying size. The use of timber construction was not feasible owing to the irregularity of the bottom and the great expense of timber in Brazil. The dams were therefore made by first filling the crossing with stone averaging a cubic foot in size. A typical cross section for a dam to resist, say 18 ft. of pressure, was constructed with the top of the stone approximately 18 ft. wide, the stone taking the slope natural to its being dumped into the water. The up-stream side was then faced with a layer of fine brush and heavy grass to a depth of 2 ft. or 3 ft., over which was dumped from carts a good quantity of natural puddling clay. In all some 3000 lineal feet of such dams were built and found to be satisfactory.

The water from the main dam is conducted through a riveted steel pipe 12 ft. in diameter and 2300 ft. long to a reservoir near the power house. This pipe is built into the main dam at a point 23 ft. below its crest and is perfectly straight in alignment and level throughout its length, being supported every 12 ft. by steel saddles. The design of the saddles where the pipe crosses an old river channel is shown in the above cut, where the pipe is within 4 ft. of the surface of the ground; the saddles are not provided with steel-post supports as shown, but rest on masonry pedestals. The pipe is provided with three expansion joints and is designed to pass water at a speed of 11 ft. per second during peak-load periods. In order to provide for slow velocities on to the turbines the water is discharged into a reservoir formed by building a second dam across a ravine. This reservoir has a capacity of 500,000 cu. ft., and from it the water is led to the turbines through feeders 8 ft. in diameter and 245 ft. long. Each feeder leads directly into the water chamber of a pair of 48-in. horizontal cylinder gate wheels, direct coupled to the generators. They were manufactured by the Stilwell-Bierce & Smith-Vaile Company. Each pair of wheels is designed for an output of 2000 mechanical horse-power at full load and at 200 r. p. m. There are two exciters for the plant, each driven by a single cylinder gate 24-in. horizontal turbine direct coupled to the exciter shaft. Each wheel has a capacity of 200 mechanical horse-power at 550 r. p. m. Each 2000-hp turbine is provided with an independent type B. Lombard governor for regulation, and the exciter wheels with one type No. 2 Lombard governor.

Other engravings show the dam which forms the reservoir in the process of construction, the entrance of the 12-ft. main feeder, the exit of the 8-ft. feeders and the engineer's residence in the distance; also an end and side view of the power house and a bank of three 8-ft. feeders now installed. Nipples have been built into the dam for the future installation of five additional 8-ft. feeders to supply 2000 hp. The power house is built of brick and is plastered inside and out with cement. Trimmings are of cut granite. All frame work is of steel and the roof and floor of tile. The power house is equipped with a 10-ton traveling crane. The construction of the main dam at the head of the rapids creates a lake 8 miles long, having an average width of an eighth of a mile, thus affording sufficient storage for the production of 16,000 mechanical horse-power twelve hours per day during the time of low water. This plant when completed will be the largest water-power development in South America. The works have involved the construction of approximately 14 miles of construction roads, the hauling of 10,000 tons of construction material 7 miles from the nearest railway to the site of the works, the excavation of 120,000 cu. yards of rock and clay, and the building of 40,000 cu. yards of masonry.



MAIN PIPE LINE, 12 FT. IN DIAMETER

The electric plant was supplied by the General Electric Company, of New York. The most modern appliances for controlling and distributing alternating current are used.

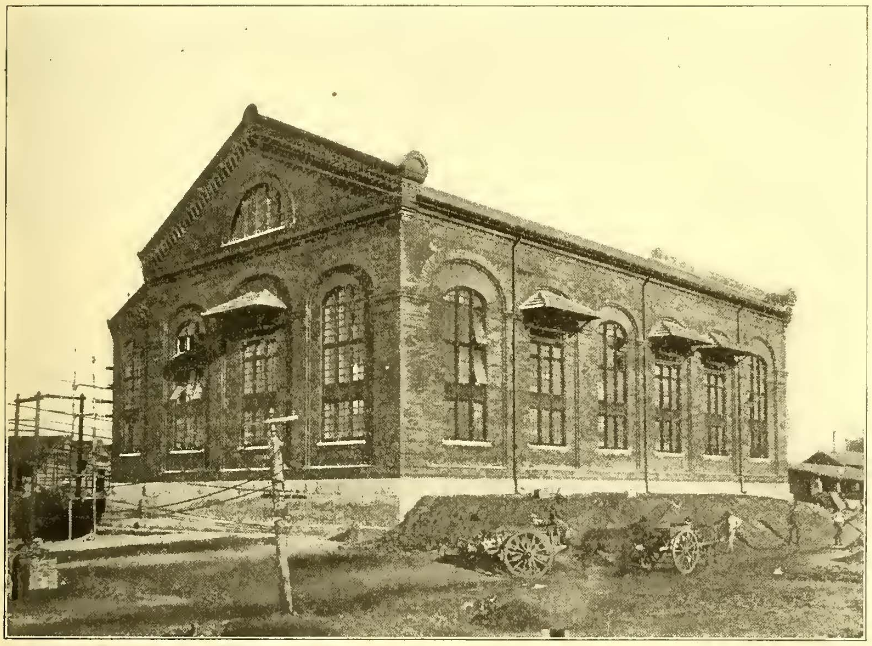
The current is generated at 2300 volts as a three-phase current, being raised to 24,000 volts by twelve air-cooled step-up transformers and is transmitted to Sao Paulo at this pressure. The connections in the generating plant are as shown in the diagram of wiring.

The electric apparatus in the station is as follows:

(1). Two 100-kw, 125-volt exciters. These are direct connected to turbines, and run at 600 r. p. m.

(2). Exciter switchboard. This consists of two panels for the exciters, and one feeder panel containing nine circuits, three for the blowers supplying air to the transformers and six for the station lights and additional exciting current for future installations.

(3). Three 1000-kw, 2300-volt, 60-cycle, three-phase alternators of the revolving field type, direct connected to the turbines running at 200 r. p. m. They are capable of giving 1400 kw for two hours without causing a rise in temperature of more than 40 degs. C. and will give 75 per cent of their rated output on any single phase operated by itself.



SUB-STATION AT SAO PAULO

(4). Low-tension switchboard, equipped throughout with two sets of bus-bars, so that the generators may be operated in two independent sets. The board contains three alternator panels, two station panels which record the output, and four three-phase transformer panels. Each of the transformer panels controls the low-tension side of a bank of three transformers.

(5). Twelve 333-kw transformers wound for 2300 secondary and 24,000 primary. They are of the air-blast type cooled by

(6). Three 70-in. Buffalo blowers. Each blower is driven by a 3-hp motor receiving current from the exciters. Two of the blower sets will generate sufficient air to cool the transformers.

(7). High-tension switchboard. This contains four transformer panels and two line panels and has two sets of bus wires. It has also two ground detector panels, one for each of the transmission lines.

(7). Six 24,000-volt lightning arresters.

TRANSMISSION LINE

The transmission line was laid out by a careful survey made from Parnahyba to Sao Paulo, in order to make its course as near as possible a straight line. After the survey was made, land was purchased, having through its whole extent a width of 100 ft. The total length from the power house to the sub-station is 20.7 miles. The line passes for a greater part of its distance through a very rough country, over a succession of hills and valleys. In the whole extent of the line there are only about 2 miles of level country. The construction therefore was made especially difficult through the physical conditions of the country. A road was built the whole length of the line and many miles of branch roads through the forests where poles were procured.

There are two independent pole lines 33 1/3 ft. apart, the poles being placed at an average of 110 ft. apart. On curves, angles and grades, distance between poles is less. The poles are set 28 ft. above the ground and are 8 ins. in diameter at the top. Those within the city limits are of Georgia pine, and the balance are of native woods. On marshy grounds and on angles the poles are braced for additional stability. Each line at present carries one three-phase circuit, each conductor being No. 0 copper wire. The insulators are multi-petticoat of porcelain. Tie-wires are No. 4 copper. The lines of conductors are spiraled according to the usual practice on long transmission lines. In the center of the line is located a lightning arrester house with lightning arresters for each conductor, they being of the same type as those used in the generating and sub-stations. This lightning-arrester house will probably be used as a point of distribution for the towns in the neighborhood of the center point of the line. The conductors are so arranged as to form almost an equilateral triangle, two conductors being on the top arm. The distance between wires is 30 ins. Cross-arms are braced with wooden braces. The energy lost at full load between the power house and the sub-stations is 7.9 per cent. The potential drop is 10 per cent.

The telephone line is carried on one line of poles, being placed 5 ft. below the transmission line.

SUB-STATION

The sub-station is located almost in the center of the city. Permission was granted by the government to erect the transmission line on the margins of a small river, which passes through the city, thus allowing a safe and exclusive right of way to the company for its transmission line. The sub-station is probably the most modern of its kind. It is substantially built, the foundations being of concrete upon a close pile foundation, the piles being driven through the river mud to sand bottom. The walls are made of hard-burned pressed brick, the framework is of steel and the roof and floor of tiles, the building thus being absolutely fireproof. The station is equipped with a 10-ton traveling crane.

The high-voltage current is reduced through twelve air-cooled step-down transformers to a pressure of 2200 volts, and at this pressure distribution is made to the three switchboards, from which the current is again distributed for the various purposes of street railway, light and power. For the street railway there have been installed two motor generator sets each of 500 kw capacity, and shortly another unit of 1000 kw will be installed. The electric apparatus for the sub-station is as follows:

(1). Six 24,000-volt lightning arresters.

(2). High-tension switchboard. This contains two line panels and four transformer panels. It is equipped with two sets of bus-wire.

(3). Twelve 333-kw transformers. These are wound for 20,000 volts primary and 2200 volts secondary. They are of the air-blast type, cooled by

(4). Three 50-in. Buffalo blowers, each driven by a 5-hp induction motor of 220 volts.

(5). Low-tension and induction-motor switchboard. This contains four transformer panels, each of which is for three-phase circuit and controls a bank of three transformers; a totalizing panel which records the output for railway service and for power service; two induction-motor panels for the motors of the two railway-motor generator sets, and a compensator panel which controls the starting compensator for these motors.

(6). Two railway-motor generator sets; each of these consists of a 700-hp induction motor driving a 500-kw generator at a speed of 400 r. p. m. The 500-kw generators are compound, wound for 525 volts, no load, to 575 volts at full load.

(7). Direct-current railway switchboard. This contains two generator panels and five feeder panels. The former are 1200 amps., Form K, and the latter 1200 amps., Form A.

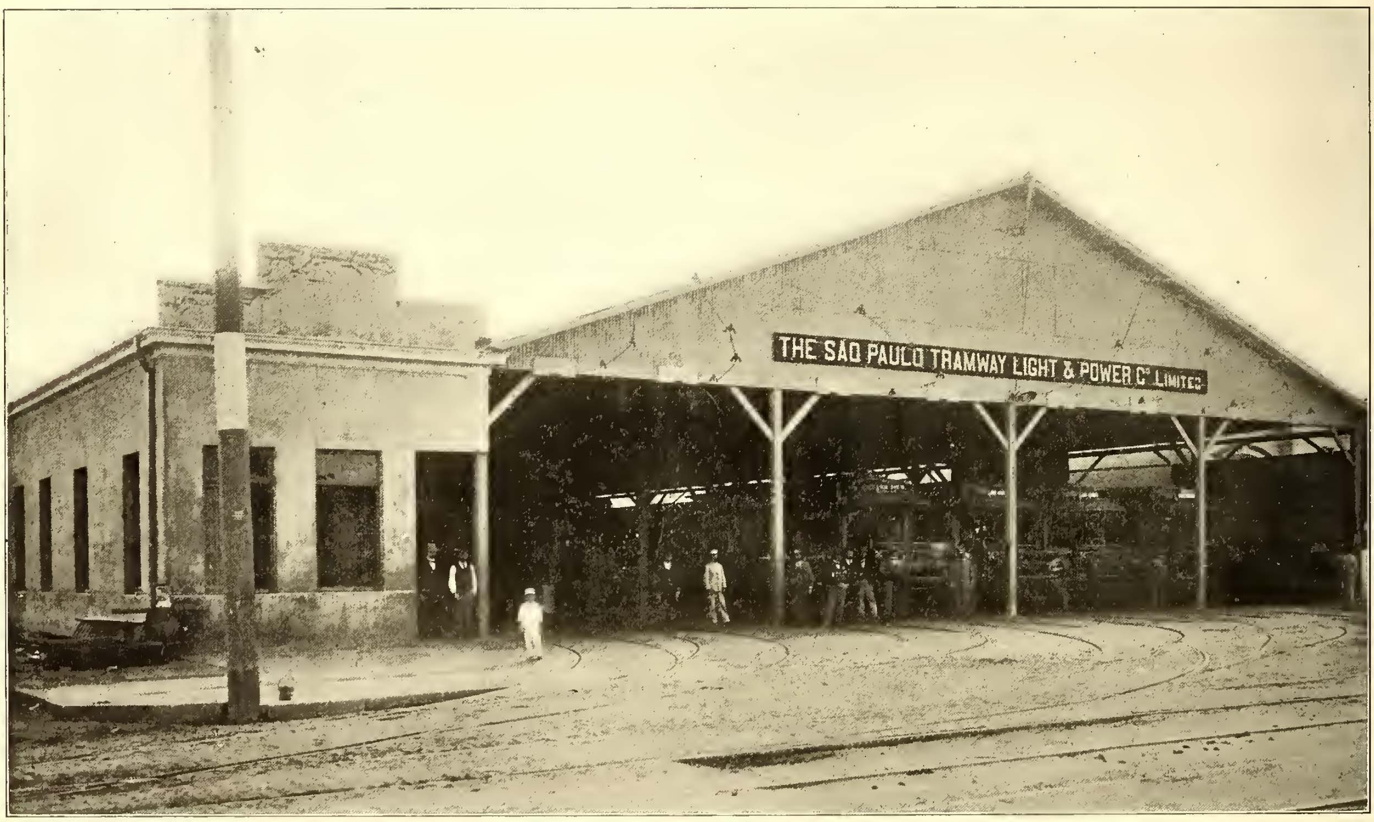
(8). Power-feeder switchboard, containing five 500-kw feeder panels for three-phase current at 2200 volts. These panels are provided with automatic overload circuit breakers.

(9). Lighting switchboard. This contains a totalizing panel which records the output for lighting service, and ten 200-kw feeder panels each provided with a hand regulator, and an automatic overload circuit breaker. The regulator allows a variation of 10 per cent above or below the normal voltage of 2200. The lighting feeders are single-phase, but each panel is provided with a three-way switch, allowing the feeder to be put on to any one of the phases.

RAILWAY SYSTEM

By reference to the map, it will be seen that the company has its lines in every direction of the city. They are either under the franchise for its electric lines, or under the franchise of the Companhia Viacao Paulista, the mule road which it lately purchased.

In its track work four types of construction have been employed, (1), 92-lb. girder rail, of the Metropolitan type, placed either on concrete with steel ties; or (2), 92-lb. Metropolitan girder rail on wooden ties in the usual manner; or (3), 62-lb. T-rail placed on concrete with steel ties; or (4), 62-lb. T-rail on wooden ties in the usual manner. All special work is of the best quality of guaranteed construction from the best makers of special work in the United States. Girder rails with concrete construction are used in the principal streets of the city where the traffic is the heaviest. Girder rails on wooden ties are employed where streets are paved and the foundation unstable. On some of the wider streets where the traffic is also heavy, T-rail is used with concrete, while for suburban traffic and streets of little traffic T-rail on wooden ties has been laid.



CAR HOUSE FOR ELECTRIC CARS ON AVENUE INTENDENCIA

For most of the railway lines the overhead construction is supported on steel poles, but on certain routes where a large number of light and power wires are also to be carried, wooden poles are used, they being preferable for the support of conductors of 2000 volts pressure.

The cars were manufactured by J. G. Brill, of Philadelphia, and some by the St. Louis Car Company. They are similar to the open cars used on Madison Avenue, New York, and are uniformly of nine benches, seating forty-five people, and are substantially built. They were shipped to Brazil, knocked down, and were assembled in the shops of the company. The electrical equipment is two G. E. 58 motors with K-10 controllers. The trucks are Brill manufacture, having 30-in. wheels and 8-ft. wheel bases. Consolidated fenders are used.

The company has at present two car houses for electric cars with a capacity of sixty-seven cars. All necessary repairs to the electric cars are made in these car houses, the pits being equipped with hydraulic lifting jacks and apparatus for the convenient changing of motors and wheels.

It was decided that inasmuch as the completion of the water-power plant would probably consume two years, it would be advisable to construct a temporary steam plant, and this was done. The first cars were put in operation from the temporary plant May 7, 1900. Since then the company has been able to give a satisfactory service for

GOVERNOR'S PALACE AND TREASURY BUILDING

twenty-six cars from its temporary plant. This will be abandoned after the water-power plant is put into operation, and will probably be entirely out of service when this article is published. The installation of the steam plant comprised the following: Two Robb-Armstrong engines of 300 hp each, direct connected to two 225-kw General Electric Company 500-volt railway generators, switchboard and feeder panels for the control and distribution of the current, 500 hp of Cahall boilers, and the necessary heaters, pumps, injectors, etc.

The division operated by animal traction is equipped with 137 mule cars, employing 2000 mules. The track mileage of this system is 60 miles. For its animal system the company has five car houses and stables.' The mule cars necessarily being small on many lines where the grades are severe, the company expects by the addition of fifty electric cars to its electrical system now in operation, to give an equally satisfactory service in capacity and headway to that given by the animal traction, with its 100 small cars.

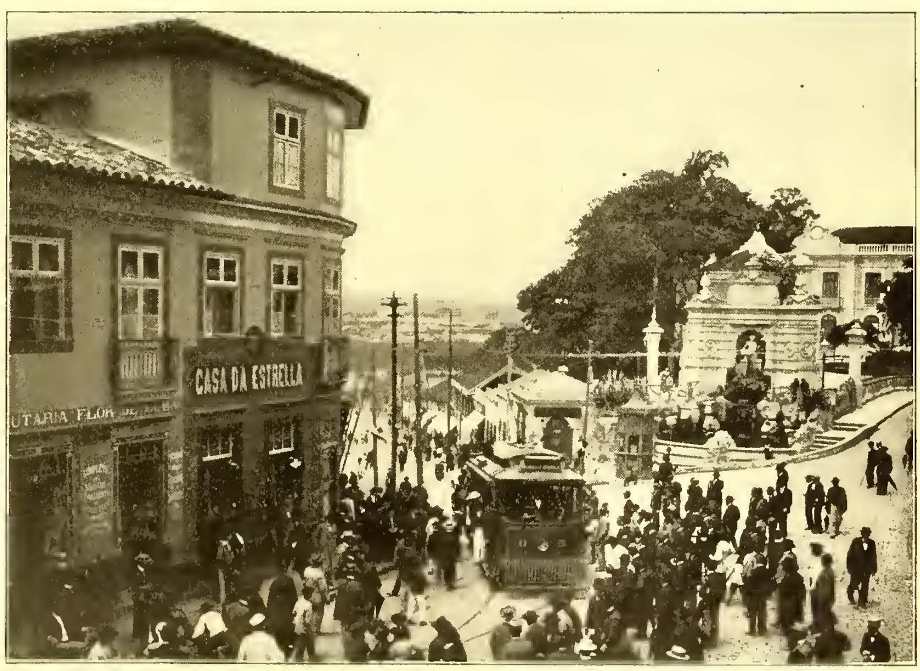
The steam line to Santo Amaro will be shortly equipped to the suburb of Villa Marianna with electricity. This will leave a branch of some 8 miles to be operated by steam with a service of one or two trains daily. The company has for the steam section of this road six locomotives, twelve passenger cars, twenty-four freight cars and six meat cars. The company has a contract with the municipality for the carrying of all meat from the municipal slaughter house, where it is killed, to the retail markets.

The wages paid to conductors and motormen is from 90 cents to $1 for a ten-hour day. The fares charged are on the zone system and are 200 reis Brazilian for all rides within a radius of 3 km from the center of the city; beyond that distance a second fare is charged; 200 reis at the present rate of exchange amounts to about 4 cents, American money.

LIGHTING SYSTEM

The lighting system is being constructed to extend over all the city, so that light will be available for every house after the general practice with gas companies. Inasmuch as gas in Sao Paulo costs over $3 per thousand cubic feet, the company feels satisfied that its electric light will be used by almost every house in the city, and therefore will form in a few years the largest part of the company's business. The plan of distribution has been laid out for giving the best regulation possible, and for such control that a twenty-four hours continuous service can be given. The distribution of light will be made in single-phase circuits, so arranged at the switchboard that any circuit can be thrown onto any phase, thus making it possible to perfectly balance the load on each phase.

In the central portion of the city, where the business houses are located, the distribution is by an underground, three-wire system, at 115 volts, there being for this service three distribution vaults, where transformers for transforming from 2080 volts to 115 volts are located. In these vaults are also located blowers for the proper ventilation of the underground system. The distribution to buildings is made through connections from the main underground feeders to an overhead system of sub-mains, which is run upon facades of buildings, connection being made between the underground feeders and sub-mains through switches placed in cast-iron junction boxes. The junction boxes are placed at suitable intervals on the walls of the buildings. In the remainder of the city, where the underground system is not necessary, the distribution is entirely overhead. The main feeders are at 2200 volts. Each feeder supplies electric current for a considerable area, this area being fed from transformers by three-wire secondaries of 115 volts, all in multiple, after the usual modern system of block distribution of secondaries. The secondary wiring, where the houses are close together, forming long blocks, is placed upon the facades of buildings, the insulators being supported on iron hooks fastened into the masonry.



TERMINUS OF LINE TO BRAZ AND PENHA

The Companhia Agua e Luz is at present operating 5000 incandescent and some 250 arc lamps. Its installation will be merged into the new system of the tramway company.

POWER SYSTEM

In the central part of the city, the power distribution is underground, similar to that for lighting, with three-phase secondary, of 460 volts. The transformers are located in the same vaults with the lighting transformers. For the rest of the city the distribution will be overhead on poles, the circuits being three-phase circuits at 2200 volts. For some of the large sized motors the primary voltage will be used, but for small motors the voltage will be reduced to meet the requirements of each particular case.

It is confidently expected that within a short time the company will have installed 3000 hp of electric motors. The largest installation contracted for at the present time is one for 600 hp, for the driving of a flour mill.

SHOPS AND STORES

In the purchase of the Companhia Viacao Paulista the company has acquired a repair shop and building for general stores. These buildings have been equipped with modern tools for the machine shop and blacksmith shop; a brass foundry has been added, and the carpenter shop improved. Also facilities have been arranged for the repair of the locomotives operated upon the steam lines, and for such repairs as are required for the cars operated by animal traction.

TELEPHONE SYSTEM

All office buildings, stations, etc., are connected by a private telephone system, the main switchboard being located in the head office of the company. All lines are double metallic circuits of hard drawn copper wire.

STAFF OF THE COMPANY

The staff of the company in Sao Paulo is made up largely of Americans and Canadians. The establishing of the company in accordance with Brazilian law and placing the company on a secure basis, so far as its concessions are concerned, has been in the hands of Alexander Mackenzie, of the firm of Blake, Lash & Cassels, barristers, etc., of Toronto, Ontario.

The general management of the company in Sao Paulo has been in charge of Robert C. Brown, who acts also as the formal representative of the company in Brazil; he also having general charge of the construction and operation of all of the work which has been done up to date by the company in Brazil. He has been assisted at Sao Paulo by Charles B. Graves, assistant manager; D. Mulqueen, assistant treasurer; Alipio C. de Borba, superintendent of railway department; H. Hartwell, engineer in charge of track building; L. L. Perry, electrical engineer; T. W. Bevan, superintendent of power stations; Norman Berry, superintendent of car repairs; J. H. Ryan, superintendent of transmission line construction; D. J. Kerns, superintendent of city line construction, and Oscar Krauss, storekeeper. Hugh L. Cooper, formerly connected with the Stilwell-Bierce & Smith-Vaile Company, of Dayton, Ohio, has been in charge of the construction of all of the hydraulic work at Parnahyba.

It has recently been said that the era of electric railway building in Massachusetts is on the wane, but a prominent engineer, one well qualified, says that such is not the case. He points out that there are now building in Massachusetts 300 miles of new line. The new construction work is not confined to one portion of the State; it is general throughout the entire State. Many new roads are being built, and many companies now in operation are extending their lines, seeking in adjacent towns a most promising field for new operations.

Visit of the Institution of Electrical Engineers to Germany

BY E. KILBURN SCOTT, A. M. INST. C. E., M. I. E. E.

The visit of the British Institution of Electrical Engineers to Hanover, Berlin, Dresden, Nuremburg and Frankfort during the fortnight ending July 5 was a great success. Nothing could exceed the kindness and hospitality of the principal hosts—the Allgemeine Electricitäts-Gesellschaft, Messrs. Siemens & Halske and the various other firms: Korting Brothers, Union Electricitäts-Gesellschaft, Niles Tool Works, Ludwig Loewe, the Schuckert Company, and Lahmeyer & Company, whose works were visited.

The various authorities of the electric light and power stations, traction systems, etc., were also equally anxious that the visitors should see as much as possible in the time at disposal, and a specially interesting feature was the recognition given by the Emperor and by various public bodies, starting with the Hanover municipality, who were the first publicly to entertain the institution. Hanoverians, indeed, claimed a particular interest in the visitors, for had they not supplied England with kings and queens!

One result of the trip was that the visitors were brought to see the underlying truth of the old saying, "Scratch an Englishman, and you will find a German." In fact, it was surprising to see how many members had relatives in Germany. Mr. (or as the Germans called him) Captain Alexander Siemens acted as chairman, and he filled the post excellently, his German parentage and his command of both the English and German languages being very useful. At the dinner given by the two great Berlin companies on Wednesday, June 26, in the Berlin Zoological Gardens, the toast of the institution was proposed by Herr Wilhelm von Siemens, representing Siemens & Halske, of Berlin, and responded to by his cousin, Alexander Siemens, of the firm of Siemens Brothers & Company, of London.

This dinner was the chief function of the visit, and in proposing the health of the Emperor, Herr Moeller, Minister of Commerce, emphasized the fact that William II., of Germany, had given much greater attention to science than any monarch before him, and it was a matter of much satisfaction to those present that this interest was particularly directed to electrical science. Readers of the STREET RAILWAY JOURNAL should note that these are not mere complimentary words; the longer one stays in Germany the more one sees the great advantage which accrues in having the head of the State closely interesting himself in scientific, and particularly electrical, progress. As Herr von Siemens said, a great deal of the success attained to by Germany was directly traceable to the suitable political conditions. As an example, it may be interesting to mention that when the matter of heavy electric traction on long distance railways came to the front and the experimental line had enabled the necessary data to be collected, the Emperor asked Herr G. Rathenau (the head of the great A. E. G. Company) to give a lecture on the subject. The Emperor immediately grasped the overwhelming importance of the matter, and has placed the military railway between Berlin and Zossen at the disposal of the electrical engineers, and has also commanded that all State officials should give every assistance in their power. Can one wonder that a country which is run by such an enterprising head of State should make the pace. German financial and military methods may have their disadvantages, but at any rate there is no "marking time" in that country. It should be remembered that the whole of their present vast industrial system has been built up since 1870, and no less than

70,000 persons are engaged in the manufacture of electrical apparatus alone, the largest concern—the A. E. G. Company—controlling over 17,000 hands. There is nothing very much wrong with a country that can show such a record.

Before concluding this note mention should be made of the happy way in which the English ladies were entertained. In Berlin especially they had a most delightful time.

Regarding the design and quality of the work turned out, there can be no doubt that the Germans are in the front rank. To those who took part in the visit the expression "made in Germany" will, in electrical machinery, at any rate, convey the meaning that the design, workmanship and finish is of the best. The thorough way in which everything is inspected and tested before being sent out made a great impression.

THE ELECTRIC RAILWAYS OF BERLIN

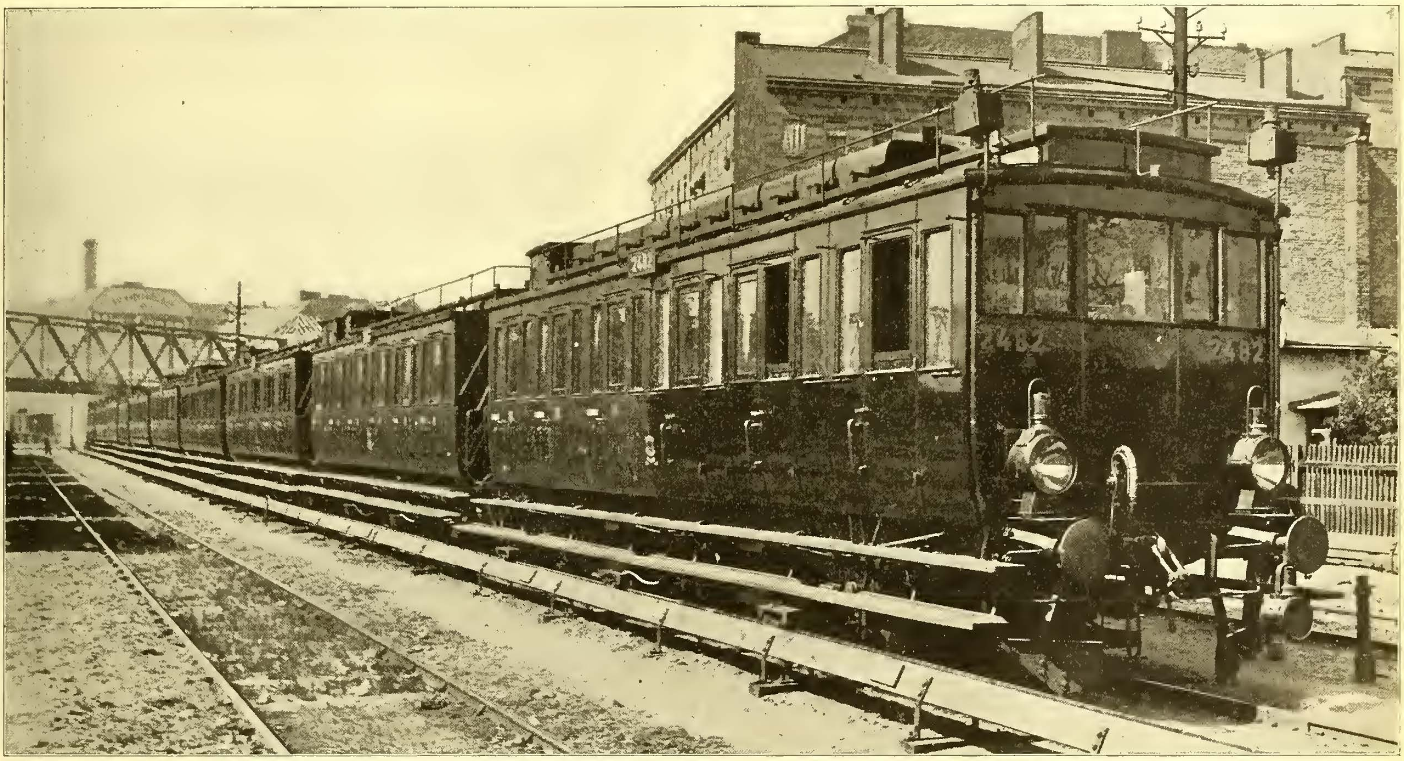
During their stay in Berlin the members of the institution were shown three electric railways—the railway from Berlin to Wannsee, the experimental three-phase railway, 10,000 volts, at Gross-Litcherfelde, and the new elevated and underground railway in Berlin. The two first were in operation, and the last is nearing completion.

The first train on the Wannsee railway commenced running in August, 1900, the method of traction employed being continuous current at 750 volts, to allow of the use of storage batteries. The trains are composed of ten ordinary suburban train cars of the Prussian State railways, the first and last being fitted with motors. The weight of the train when empty is 193 tons. Each of the six axles of the two-motor cars is coupled to a motor, and the weight of adhesion is, therefore, equal to the weight of the two-motor cars together, namely, 64 tons. The controlling of the two-motor cars is effected from the head of the train, in such a way that by means of one controller and a single controlling line running right through the train, the six motors can be simultaneously cut in and out on a system patented by Messrs. Siemens & Halske. Westinghouse brakes are used, the compressed air being generated by two electrically worked compressors, one of which is installed in each motor car.

Current is collected from a third rail by the side of the track by means of a number of sliding shoes fixed to the axle boxes of the motor car axles. The return is by means of the track rails. The conductor rails are of ordinary Vignoles section, with the bottom flange resting on the porcelain insulator. The rubbing surface of the conductor rail is 320 mm above the track rail. Wooden guards are run along each side of the conductor rails.

Electric power is generated in the station of the Gross-Lichterfelde electric tramways, and is conducted to the conduct rails by means of overhead wires suspended from wooden masts.

The engine is of the compound condensing type, coupled to a Siemens & Halske dynamo, having an exterior armature. As the requirements vary right away from 0 amp. and 1200 amps., equalizing batteries are installed at either end of the line, that is at Zehlendorf and Berlin.



TEN-CAR TRAIN ON WANNSEE RAILWAY—FRONT AND REAR CARS ARE MOTOR CARS

The experimental road to work with three-phase current at 10,000 volts is at Gross-Lichterfelde, and was built by Siemens & Halske, in order to study the application of high-tension currents to traction purposes. The road was opened at the beginning of the year 1899, and has been in operation ever since.

Three-phase current of 10,000 volts, and 50 cycles per second, is generated in a sub-station by means of motor dynamos and transformer, and fed directly to the overhead line wires.

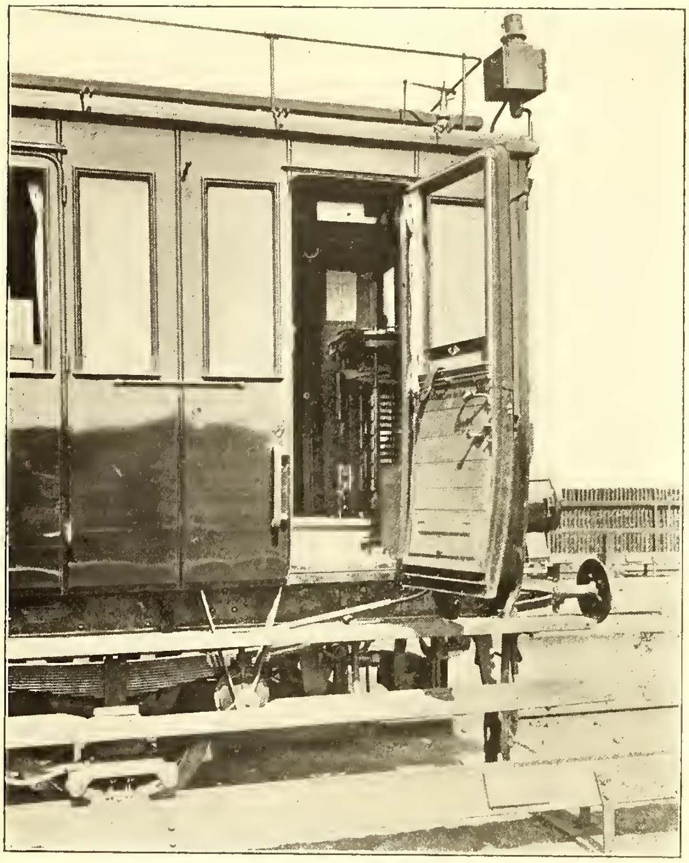
The electrical equipment of the line consists of three wires, mounted at the side of the track on poles, one above the other, and a meter apart. Bow-shaped brackets are festened to the poles, having a chain between their ends, to which the wires are flexibly suspended; the lowest wire is 5½ m above the track, and underneath the wires there is a guard net.

The locomotive has the following dimensions:

Gage	1.435	meters
Length of frame	4	"
Width of frame	2.2	"
Distance of axles	2.8	"
Diameter of wheels	1	"
Weight	16	tons

The locomotive is built up of steel in the usual way, the under frame being of the same kind as for an ordinary freight car. It is provided with a hand brake, as well as with an air brake, the air pressure being produced by an electric motor compressor.

On the roof of the cab there are three vertical spindles, each carrying a current collector having a vertical aluminum bow, which is pressed against the line wires by means of springs. Aluminum is used so as to lessen their mass, and so assist the springs to keep a good contact. The bows are operated by the driver through gearing and a jaw clutch. On the roof there are also mounted three Siemens horn-shaped lightning arresters.



FRONT OF CAR, SHOWING CONTROLLER, WANNSEE RAILWAY

The motors are operated at 750 volts, and in order to lower the pressure down from 10,000 volts, two transformers are provided. The high-tension switches are of Siemens & Halske special tube form, and are arranged in the roof of the car, the opening at the two breaking points, when switched off, being about a foot. As the switch carries 10,000 volts, the actual operation of switching on and off is arranged pneumatically. If the condition of the track and its length would allow of it, the locomotive could easily attain a speed of 120 km per hour, and under such conditions 2000 volts would be required at the motor terminals, when the winding is connected, "star" for starting, and 1150 volts when connected in "mesh" for normal running.

The locomotive is equipped with two asynchronous three-phase motors, each capable of giving 30 hp normal load, and 120 hp maximum. The ratio of gearing being 1:3.15, the locomotive has a speed of 60 km per hour.

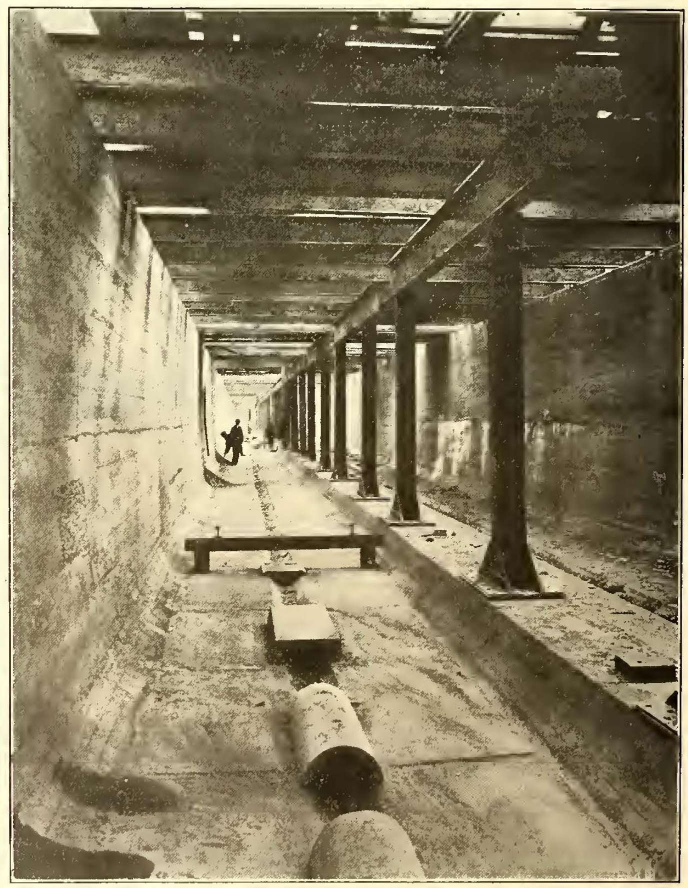
For regulation of the speed the controller in the cab can give the following connections: Standard, star connection; maximum pull, mesh connection; half speed, one secondary phase open.

The controller contacts are provided with magnetic blowout, and two chain wheels with chains to operate the rheostat switches in the second transformer chamber. The rheostats for the motors are of sheet iron, and are fixed underneath the flooring of the locomotive.

To insure perfect safety against electric shocks all parts of the locomotive are most carefully grounded.

The elevated and underground railway is about 11 km long, and runs approximately east and west right through the central portion of Berlin. The work is nearing completion, and it is expected that the line will be running early next year. The underground tunnels are excavated along the main streets, and then covered in, the transverse concrete arches being 22 cm thick at the crown, and the surface of the road being about 60 cm higher. The arches are of cement concrete, built on wooden centerings, the distance between the transverse girders being about 1½ m. The rise of the arch is 20 cm. As there is a shifting sand foundation, an enormous amount of piling has been necessary. The gage of the rails is 4 ft. 8½ ins., and the width of the subway 6¼ m.

The elevated portion of the railway is built on uprights, which are free to swing, being set in globular foundation shoes. Some of the overhead construction is very clever engineering, especially when passing the Potsdamer Bahnhof, where the elevated structure has had to be carried over the railway lines, two streets and a canal. One of the spans is 100 m long. In only two places does the railway cut through the houses.



AN UNDERGROUND SECTION OF THE BERLIN ELEVATED AND UNDERGROUND RAILWAY

Each train will consist of two motor cars and one ordinary car. One of the motor cars was shown near the generating station. It runs on two bogies, and each of the four axles is driven by a single-reduction motor, wound for 750 volts, and a current of 1000 amps. to 1400 amps. The wheels are 850 mm in diameter, and it is intended to run at 30 km an hour, normal speed. The stations average about 600 m apart.

The power house is practically completed. It contains three vertical 1200-hp engines, by Boesig, each coupled to a Siemens & Halske 800-kw vertical-pole dynamo, having ten poles, the armature being fitted with separate commutators. The boiler house is above the engine house, and supplies steam at a pressure of 10 atmospheres, and with 200 degs. Centigrade superheat.

THE WORKMEN AND STAFF OF GERMAN FACTORIES

The consideration shown by employers for their workmen was apparent in every factory visited. It took the form of dining-rooms, lockers for the men's belongings, provisions in the shops for washing, and in some cases elaborately fitted baths. These are all things which are omitted in the average British factory.

The foreign workman has not so high a wage, and has to work slightly longer hours, but there is no doubt that he is much better off in the conditions in which he has to work. Take a German workman out of one of the new A. E. G. shops, where there is room to waltz round every machine, and the floor is so clean that one could eat his dinner off it, and put that same man into the average dark, dirty and crowded English shop (or marine store, as many of them deserve to be called) at double the wage, and it is more than likely he will prefer Berlin.

The Continental workman is supposed to work much longer hours, but as a matter of fact, he works ten hours a day, and very seldom makes overtime.

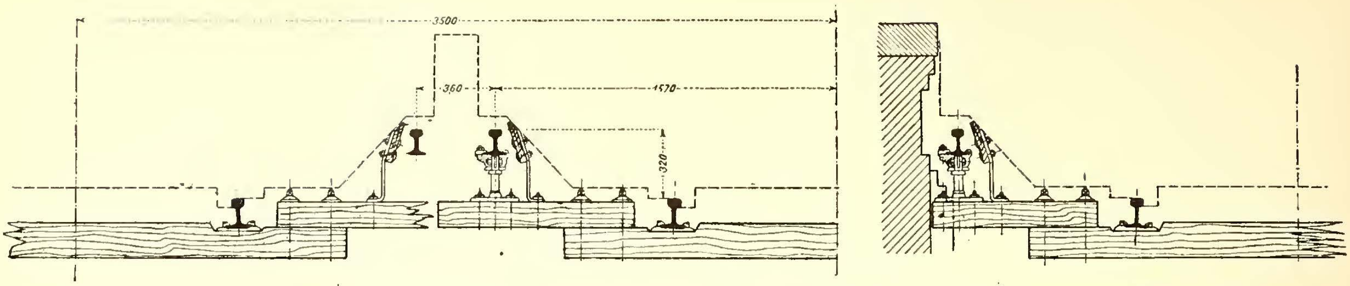
Piece work is the rule in most German works, and the prices appear to be arranged on an easy basis, as the hands do not seem to hurry themselves unduly. There is no doubt that an equitable piece work system without any sweating is good for both employer and employee, as it reduces the number of non-producers in a shop to a minimum point. The nagging and chivying which one sees in some British shops does no good in the end.

An excellent feature is the encouragement given the sons of employees. In many cases these young men are offered special facilities for passing through the shops and offices, so that they may, in due time, take leading positions on the staff. Many engineers remarked on the absence of the boy labor which is so common in England. Men and young women do all the work; the boys are either at school or going through their military drill. Those who know what it is to run an English shop full of boys will appreciate the German system.

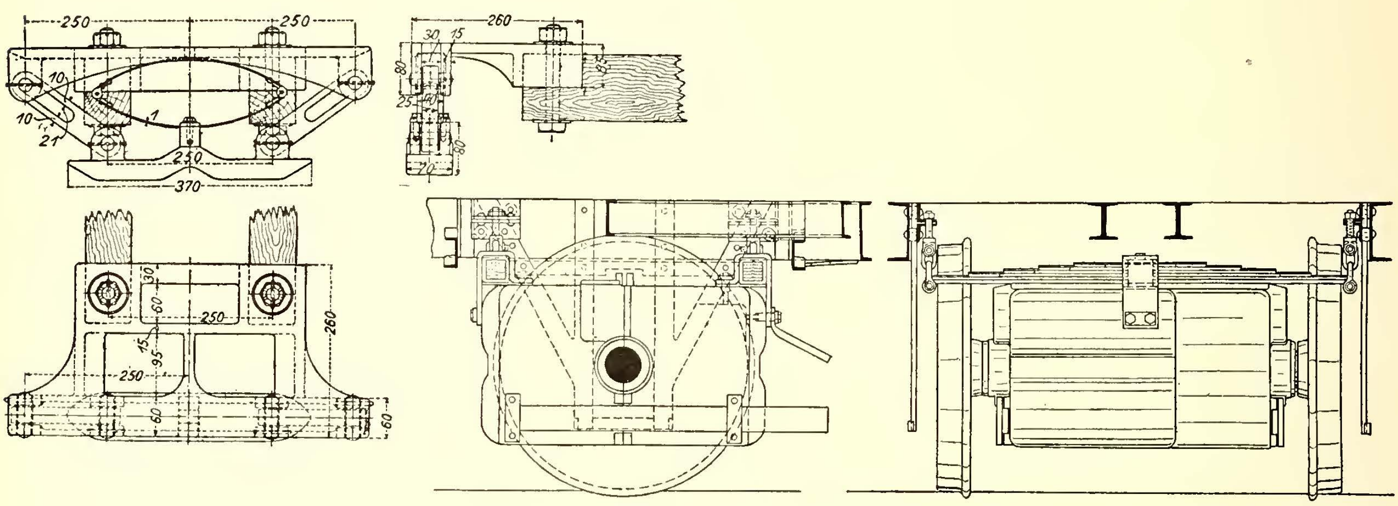
VIEW OF AN ELEVATED SECTION OF THE BERLIN ELEVATED AND UNDERGROUND RAILWAY

A feature of the German works is the orderliness to be found everywhere and the ease with which the various departments work together without any overlapping, no doubt due to the sense of discipline, which is second nature to a German.

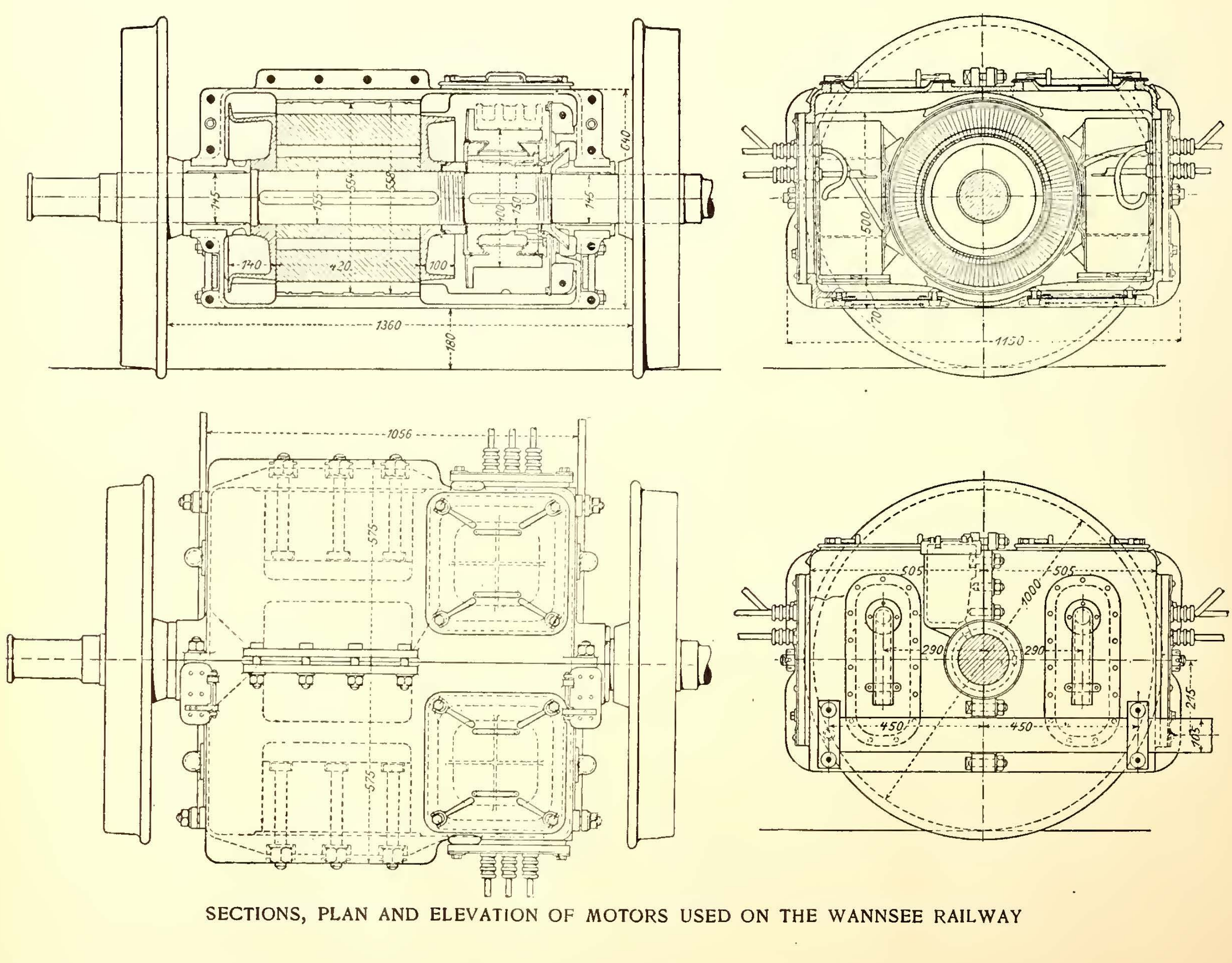
The German military system may have some drawbacks, yet the most prejudiced observer can not fail to see that the various manufacturers benefit largely from the fact that every able-bodied man in the works is, to all intents and purposes, a soldier. Many members of the staff are also officers of the reserve; in fact, the electrical firms like to have as many officers on their staff as possible, as it gives the firm prestige.



SECTIONS OF THIRD RAIL AND GUARD, WANNSEE RAILWAY

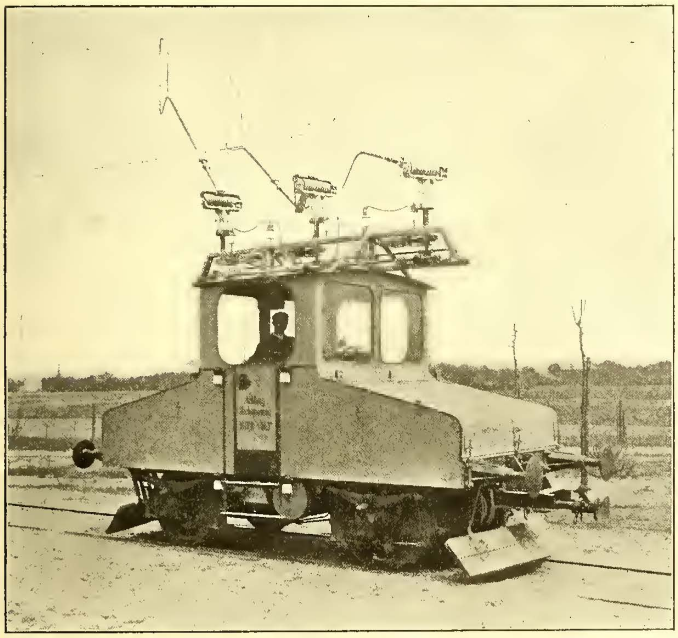


SHOE AND METHOD OF MOTOR SUPPORT, WANNSEE RAILWAY



SECTIONS, PLAN AND ELEVATION OF MOTORS USED ON THE WANNSEE RAILWAY

On the Continent a workman can easily travel or tramp from country to country, and he thus broadens his mind, and by going from works to works sees that engineering science or ability is not a thing which any nation or collection of individuals can claim to themselves. Great Britain benefits to some extent from her insular position, and yet she loses considerably in that there is not that rapid interchange of thought and ideas which is met with on the Continent. It may be worth mentioning that many of the leading electrical firms have factories in various countries, and on this account have a big pull, not only because they are better able to judge of the local requirements, but also



THREE-PHASE ELECTRIC LOCOMOTIVE AT GR. LICHTERFELDE

because when there is a labor trouble in one country, all they have to do is to transfer the manufacture temporarily to one of the branch works.

England is essentially the home of small concerns, and there is this to be said for the small shops, that it tends to greater individualism of character and thought. Birmingham and Leeds, for example, may be cited as districts where individualism is a strongly marked characteristic. At Frankfort the writer had an interesting conversation with a German gentleman who had spent ten years in the north of England, and where he had employed hundreds of workmen in erecting corn milling machinery. He thought most highly of the English workmen on account of their character and individuality, and was of opinion that on an outside job or in a tight corner there is no one to equal the North of England or the Scotch mechanic.

THE FINANCIAL SITUATION

One must, of course, be careful what one says or repeats in connection with the commercial or financial condition of an industry, but there is no doubt that the German electrical industry is passing through an acute crisis at the present time.

The position of affairs would appear to be very similar to that which occurred in the United States in 1893, and the wonder to those in the know is, why the present crisis did not come at an earlier date. The German boom commenced about 1893, and those with experience in the States gave it three years, instead of which it has lasted eight years.

At the reception of the Verband Deutscher Electrotechnische, Herr Buschkiel mentioned the unfortunate closing of the Leipzig and Dresden industrial banks, which had been indirectly the means of the failure of Messrs. Kummer & Company, and the Saxon Accumulator Works, two of the works which the institution was to have visited. The writer purposely made inquiries to see whether this happening, coincident as it was, with the meeting at Dresden, would act as a damper to the meeting, but such did not appear to be the case.

The Hooley collapse in London had practically no effect on the trade of Leeds, Manchester, Birmingham, Newcastle or Glasgow, and so in the same way, while the failure of the Leipziger bank is bad enough in its way, yet it seems to have had little or no effect on the general trade of Germany.

The Leipziger bank smash was due to speculation in the Cassel Träber Trocknung (Grain Drying) Company, in which company's accounts there is a deficit of £725,000. This company was founded for the purpose of making cattle food from the refuse of breweries, and the idea seems to have been a very good one. Unfortunately it got into the hands of men who deliberately set to work to swindle the public. German law is very strict with those who misuse public funds, and the manager of the Leipziger Bank and his colleagues are to be prosecuted by the State.

To understand why the electrical business in Germany is so stagnant at the moment, it will be well to explain briefly the German method of setting about the electric lighting or the supply of tramways to a town. A concession having first of all been obtained from the municipality, estimates are then prepared, which show that the capital value of the completed undertaking as a running concern is much higher than the actual cost of the plant supplied. An industrial bank is then approached to supply the money for the undertaking, and in return take the paper (shares) of the subsidiary lighting or traction company. Naturally the face value of the shares is much higher than the manufacturers' prices, and this paper profit goes to the bank, who, as occasion offers, is supposed to unload the shares on to the public. This brings us to the hitch in the business, inasmuch as quite a number of manufacturing companies have been at work doing this concession work, and the banks are, therefore, full up with shares which the public will not buy. Naturally the banks which were before so ready with their money will not now touch concession work.

As the work, while it lasted, went through at a very rapid rate, the manufacturers had to build very large works, and these they now find a difficulty to keep going. Hence the remarkably low bids which they are making for English and colonial contracts.

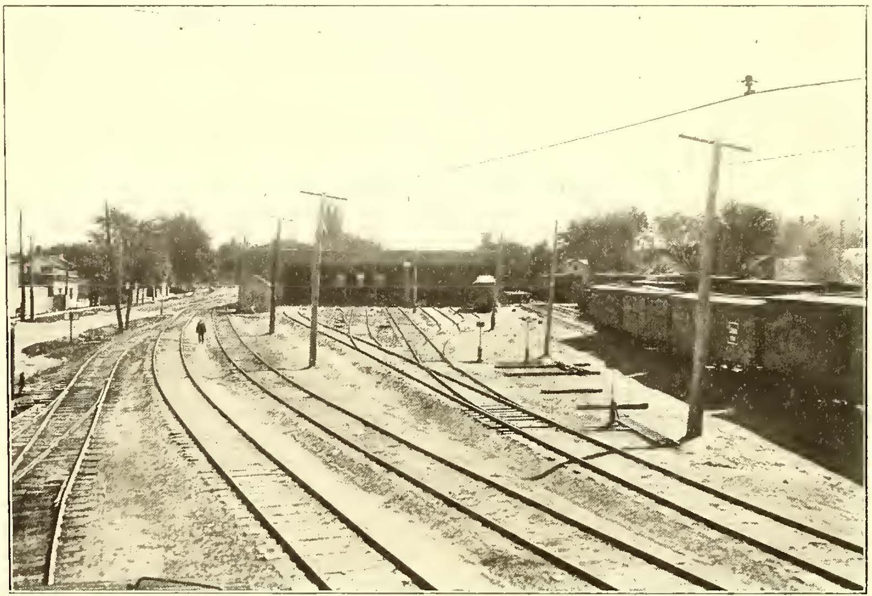
Körting Brothers, of Hanover, was the only firm visited which was not a limited company, and as this is somewhat unusual, it may be of interest to mention that the firm was started as a brass foundry by the two brothers Körting and one man in 1870. Now there are 2200 employees, inclusive of the 200 members of staff, engaged in the manufacture of such specialties as ejector condensers, radiators for steam heating and such like apparatus. The range of work done by the firm is very wide, and embraces double-acting gas engines up to 1000 hp, and an electrical department. The history of this firm is very similar to many others in Germany, for it must be remembered that as a cohesive country, with established industries, Germany can only date back to 1870.

The tramway employees in three Italian cities, Rome, Naples and Milan, went on strike last month. It is said that 1200 employees were on strike in Rome, and the authorities were called upon to protect the operators of the cars that were being run by the company. No acts of violence were reported.

The Niagara, St. Catharines & Toronto Railway

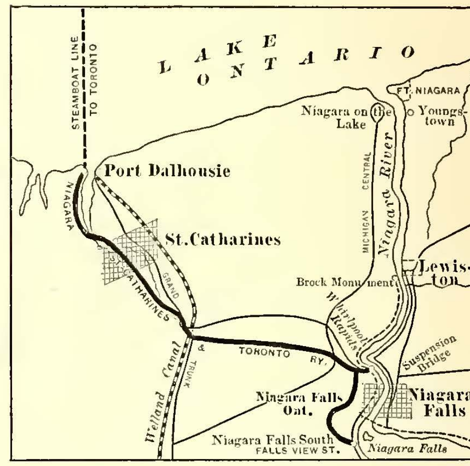
BY E. F. SEIXAS

While electricity has not yet "conquered the trunk lines," there are a number of examples of short railroads which were formerly operated by steam, but which have abandoned that power in favor of electricity. A striking example of this kind of conversion is to be found in the rehabilitation of the old Niagara Central Road, a former steam road connecting Niagara Falls, Ont., and St. Catharines, Ont. As a steam road, the less said about it the better. J. A. Powers, A. B. Colvin and J. W. Herbert, three typical representatives of the old Empire State, conceived the idea of connecting Buffalo and Toronto by an electric road. They bought up the link between Niagara Falls on the Canadian side and St. Catharines, and entered into running arrangements with the International Traction Company, which operates all the lines in Buffalo and Niagara Falls, and then proceeded to electrify the old steam road to St. Catharines. An extension of 6 miles was built from St. Catharines to Port Dalhousie, on Lake Ontario, and a boat service was instituted between Port Dalhousie and Toronto. Franchises have been given between Hamilton and St. Catharines, and the road between these points, half of which is in operation at the present writing and the rest under construction, leaves only the line between Toronto and Hamilton yet to be built, thus enabling a passenger to get on a trolley car in any part of Buffalo and run through by electric car to Toronto, the "Queen City of the West."

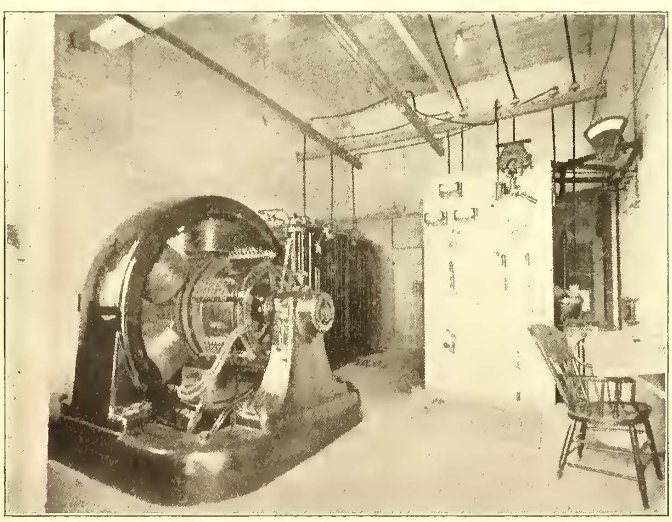


FREIGHT YARDS AND CAR HOUSE OF COMPANY

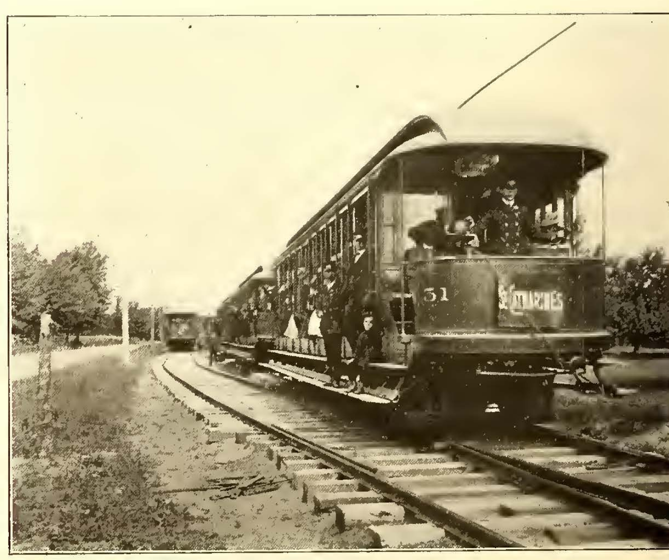
The roadbed is of the standard of steam lines in construction, almost entirely over private right of way, which is sufficiently wide to allow of double track. The overhead construction consists of 35-ft. poles and iron-pipe brackets, on which is suspended two No. 000 Fig. 8 trolley wires placed 1 ft. apart. These wires are cross connected every ten poles, and one acts as a feeder to the other. The winter cars on this line are veritable palace cars. They are 50 ft. long, are operated by four 55-hp motors, equipped throughout with Westinghouse air brakes and contain smoking and baggage compartments.



MAP SHOWING ROUTE OF NIAGARA, ST. CATHARINES & TORONTO RAILWAY



ROTARY SUB-STATION



TROLLEY EXCURSION CARS

The open, or summer, cars are the fifteen-bench type, seating ninety people, and both types of cars are so arranged as to operate at maximum speed of 50 miles an hour. Acetylene headlights are used entirely, the company having had special burners arranged for its cars.

The company also owns and operates two fast lake boats, one of which is illustrated, which run between Port Dalhousie and Toronto. Each boat will carry about 1000 people and from 50 tons to 75 tons of freight. The cars run within 50 ft. of the gangplank, making a very comfortable connection. The company is also laying out a park at the boat landing.

The Niagara, St. Catharines & Toronto Railway Company operates a through freight service in connection with the various steam roads; has freight sidings into as many as fifty manufacturing plants; has its own private telegraph and telephone lines, and is operated exactly on the basis of a steam road. There are five telegraph stations along the line; an operator at each station, who also sells tickets and looks after the freight, and at each turnout there is a telephone, so that the usual delays encountered on a

TEAMS FOR LOADING AND UNLOADING FREIGHT

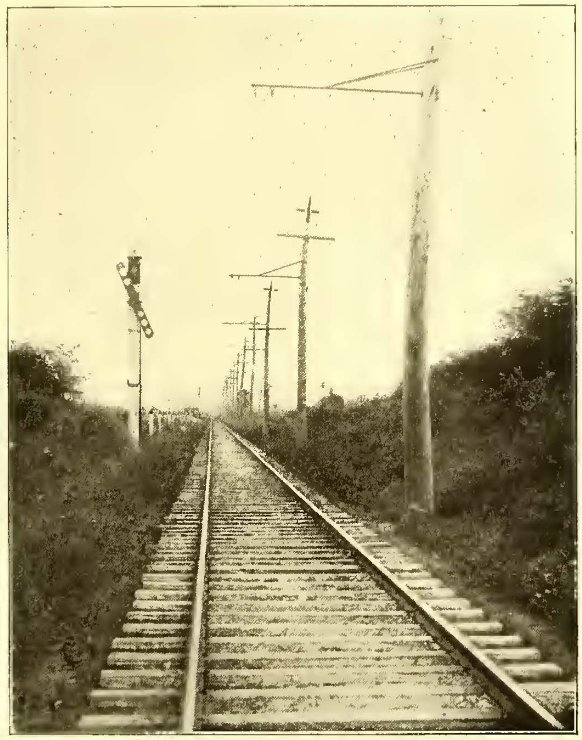
single-track road at the sidings is practically done away with. It is the rule in Canada for railroads to collect and deliver freight, and for this purpose the company owns five teams and drays, which can be seen in one of the accompanying views, loaded with Packard Electric Company transformers, this being part of one shipment to Ottawa from this progressive company. The rule regarding passenger baggage is similar to that on steam roads. Ordinary passengers are allowed 150 lbs., and commercial travelers double this amount.

For hauling freight the company has a 40-ton steam and a 35-ton electric locomotive. The latter is equipped with four 110-hp Westinghouse motors. In addition the company uses during summer months as a locomotive and repair car a large McGuire electric snow plow, with the nose and wings removed. Type K-14 controllers are used with the four motor equipments.

The country through which the road passes between Niagara Falls and Port Dalhousie is a veritable garden spot—first a peach orchard covering acres, then an apple orchard, then a vineyard; in fact, almost any fruit that is known to grow in a northern climate is to be found in this section.

The old Welland Canal, having been superseded as a waterway by a larger and better canal, has been turned to practical uses, and is used entirely for power; therefore, factories are springing up all along its banks.

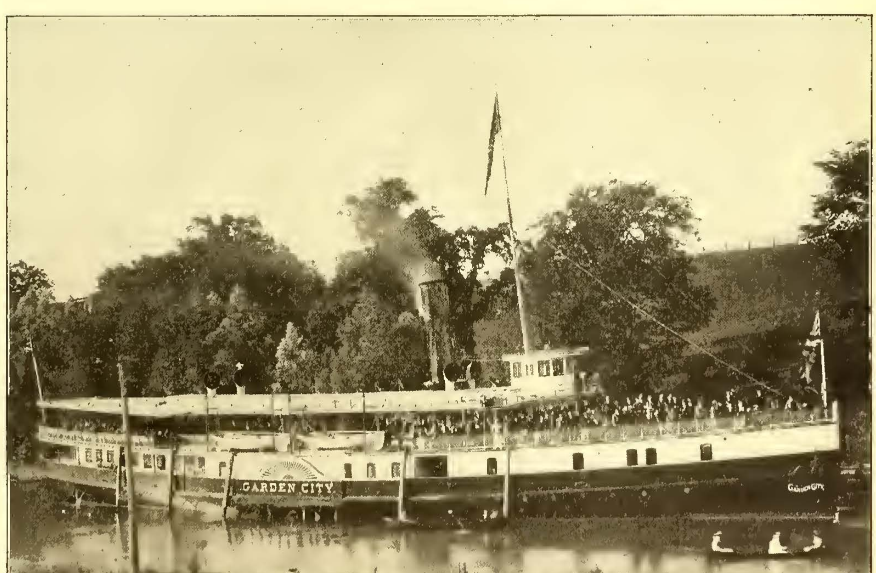
The freight yard and car houses cover about 6 acres. The car house is a square brick building 300 ft. long x 300 ft. wide, and is divided into four stalls. The first is used for the repair shop, in which the equipment is thoroughly complete in its appointments. In the back end is the storeroom. In the second stall is the washstand; the third stall



SECTION OF STRAIGHT TRACK AND BLOCK SIGNAL

is for storage, and in the rear end of the fourth stall are the carpenter and paint shops. The building is entirely fireproof and is equipped with the Kinnear steel doors. There are no openings between the stalls. The small building adjoining is the blacksmith shop.

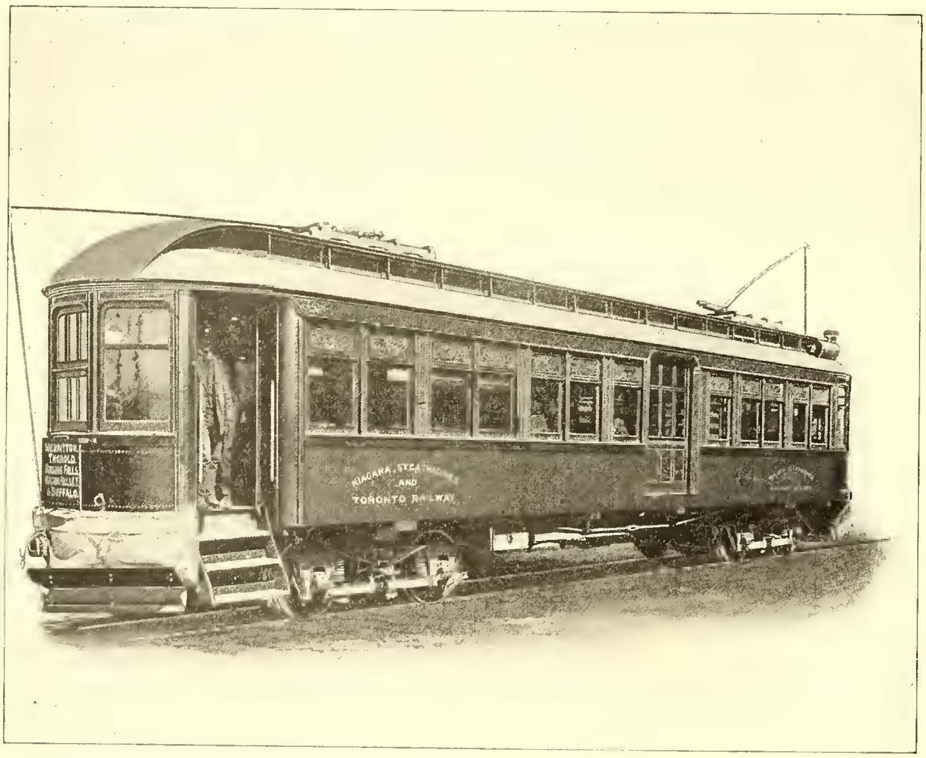
At the upper end of the yard is the freight shed, 260 ft.



STEAMER OWNED BY COMPANY USED IN TORONTO SERVICE

long and 40 ft. wide. Here are to be found the train despatcher's office and the general freight agent; also on the second floor, a lounging-room for the employees. An innovation in the handling of fruit has been adopted by this road. Small fruit platforms have been erected along the line almost at the door of the grower; trucks have been placed thereon, and fruit is immediately loaded on the trucks. The trucks are then run onto the freight cars and are taken through to their destination without having to be handled several times, as under the old system.

To give an idea of the amount of business that is done over the main line, one week in July alone 25,756 passengers were carried and 2296 tons of freight. The earnings have been beyond the expectations of the stockholders, and it is very evident that good service and proper equipment will bring good returns.



STANDARD COMBINATION DOUBLE-TRUCK CAR

The company has recently purchased a local line running through several small towns about St. Catharines, together with a water-power, and is now putting in apparatus to develop 600 hp. The power will be of the same character as that generated at the great Niagara power plant at Niagara Falls, so that either original powers may be used in case of necessity.

The power is at present derived from two rotary substations, one at St. Catharines and one at Niagara Falls, Ont., the original source of energy being the great Niagara power plant at Niagara Falls, N. Y. The current is received at the Niagara sub-station at 2200 volts, three-phase, 25 cycles. Here it is stepped up by three transformers, delta connected, to 11,000 volts, to feed the step-down transformers at Niagara and St. Catharines. These step-down transformers reduce the voltage to 375, and are controlled by oil switches placed 6 ft. behind the switchboard and operated from the board by a system of levers, so that no high voltage is on the switchboard at all. All transformers are oil cooled. The step-down transformers feed the rotary converters. These are of 300-kw capacity, and, as the frequency is so low, they run at the satisfactory speed of 500 r. p. m. All rotary converters operate quietly, and it would be almost impossible to tell when they are running if the observer is a few feet away, were it not for the beautiful end play given by the new C. G. E. end-play device. As the power supplied by the big falls company is very steady and of good wave form, no trouble has been experienced by hunting or getting out of step. No bridges are used by the rotary fields.

The switchboard consists of two blue Vermont marble panels, one for the alternating current and one for the direct current. On the alternating-current panel are mounted the standard instruments, the lever controlling the 11,000-volt switches and the lever operating compensator switch. On the direct-current panel are mounted the standard railway appliances and besides a starting switch.

As will be seen, it is possible to start the rotaries either from the alternating current or direct-connected current. The alternating current is preferred in these plants, owing to the varying voltage of the trolley circuit. In starting alternating current it is necessary to split the field of the rotary, and then, using the compensator, bring the armature current to current voltage and phase relations on the alternating-current side, with current voltage and polarity on the direct-connected side.

In starting from the trolley circuit the field is first excited, and, after armature current has been gradually introduced by the starting switch, the machine is synchronized by varying the field strength.

The 10,000-volt circuits are protected by fuse circuit breakers and by lightning arresters at each end.

The step-up transformers were supplied by the Westinghouse Electric & Manufacturing Company. The step-down transformers, rotaries, switchboards, etc., were supplied by the Canadian General Electric Company, of Toronto.

Opening of the Lisbon Line

On July 26 the officers of the Companhia Carros de Ferro de Lisbon were treated to their first ride on the electric cars in Lisbon. An open car left Santo Amaro at 12 o'clock midnight of that day, and made the journey to Algés in twelve minutes. The machinery worked very smoothly, everybody admiring the brilliant illumination produced by the electric lights, which so strongly contrasted with the old oil lamps used in the mule cars. The run from Santo Amaro to the Rua do Arsenal was made in thirteen minutes. On returning to Santo Amaro, all were treated to an ample quantity of champagne, and drank to the future prosperity of the company.

Opening of the New Conduit Lines in New York

On Aug. 25 the new extensions of the Sixth Avenue and Eighth Avenue lines to the foot of Cortlandt Street, New York, were successfully put in operation by the Metropolitan Street Railway Company. This terminus is one long needed, and is the first west side electric river terminus of the company south of Twenty-Third Street. The other most extensive track work of the company which the company is carrying on is the equipment of the Seventh Avenue line with the conduit. When this is finished all the longitudinal lines of the company will be in operation by electric power, with the exception of the Belt Line and that on First Avenue.

New Railway in London

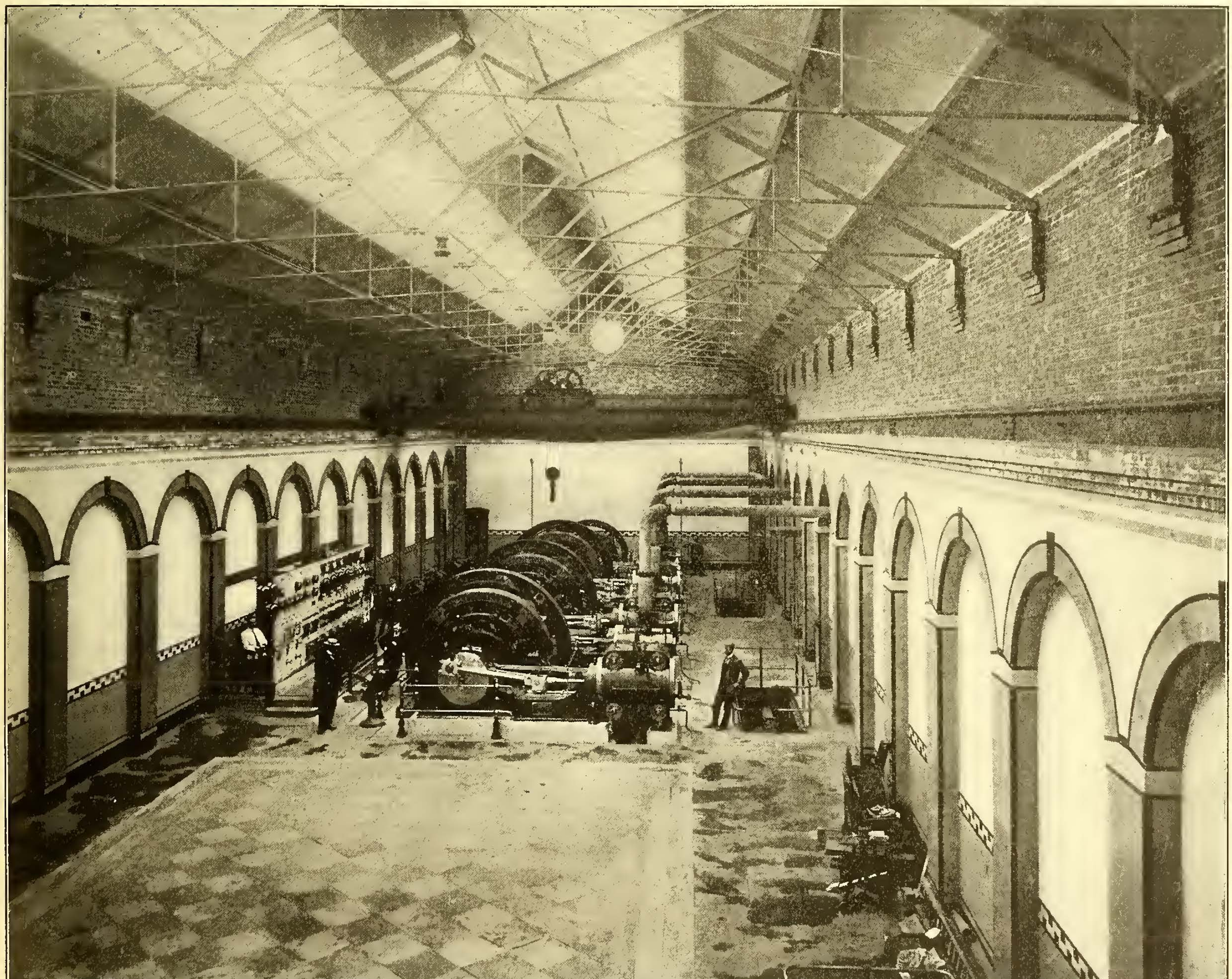
Greater London, like Greater New York, occupies a very extensive territory comprising many communities, which, some ten years ago, were under separate municipalities. The incorporation of each district, however, into the metropolis was not as complete as that in New York City, and many of the districts retained a certain autonomy and powers to carry on municipal enterprises. Acting under these powers, the district of East Ham, which has a population of about 160,000 inhabitants, and lies north of the River Thames in the eastern end of the city, has put in operation an electric trolley system, the first municipal electric tramway in the Metropolitan District of London.

Parliamentary sanction for the installation of the electric lines was obtained by the District Council at East Ham in 1898, and at the same time the Council procured powers for an electric lighting system. Tramway privileges were extended in 1900, so as to cover a total of 2¼ miles of double track and 6⅞ miles of single track, of which 4½ miles have been completed. The system is interesting, not only from the fact of its being the first municipal electric line in London, but also because it combines a lighting and tramway service. The contracts were awarded in September, 1899, and Dick, Kerr & Company were the successful bidders for the complete installation.

The power station is practically in the center of the distribution system on a plot of land 5 acres in extent, which is occupied by municipal buildings. The tramway buildings include the power station, car house, and practically all of the structures required in the operation of the cars. The engine room measures 177 ft. x 42 ft. It has a clear height of 26 ft., and is served by a 20-ton traveling crane. The walls are lined with glazed tiling up to the level of the girders on which the crane runs. The station contains three 225-kw generators, each direct coupled to a 350-hp engine, and one 100-kw generator coupled to a 150-hp engine.

The engines were built by Musgrave & Sons, of Bolton, and are of the horizontal cross-compound type, having an ordinary piston valve controlled by an automatic crankshaft governor on the high-pressure side, while the low-pressure side is fitted with Corliss valve gear. The 150-hp engine has cylinders of 9 ins. and 18 ins. diameter with 24-in. stroke, running at a speed of 150 r. p. m. The 350-hp engines have cylinders measuring 13½ and 27½ ins. with 27-in. stroke, and run at 135 r. p. m.

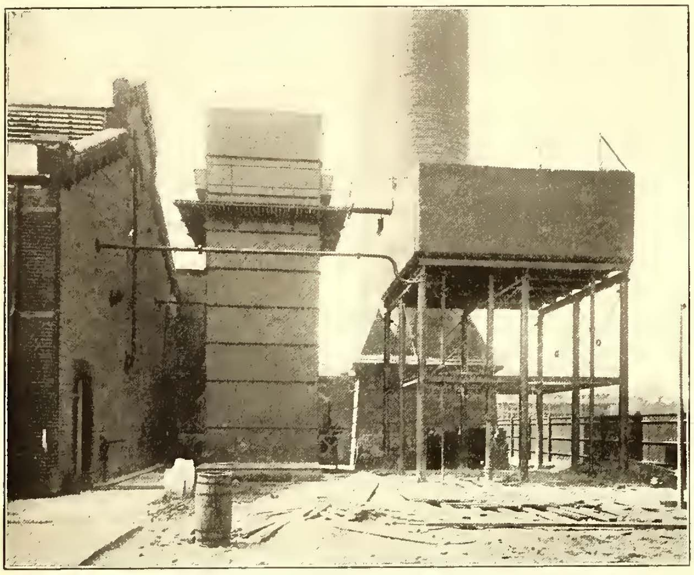
The generators, which are direct driven, were manufactured by the English Electric Manufacturing Company, of Preston, and each can be used for either lighting or traction work. When used for traction purposes they work with a compound winding, and have a variation of from 500 volts to 550 volts. When employed for lighting they are run as shunt-wound generators, having a full load capacity with a maximum of 580 volts at full speed, and are capable of giving the full load current of 480 volts at the same speed, a rheostat being provided of sufficient range to enable the voltage to be varied between the limits of 480 volts and 580 volts. The armatures are of the slotted type, drum wound with interchangeable coils, and special ventilating ducts are provided to insure a low temperature rise.



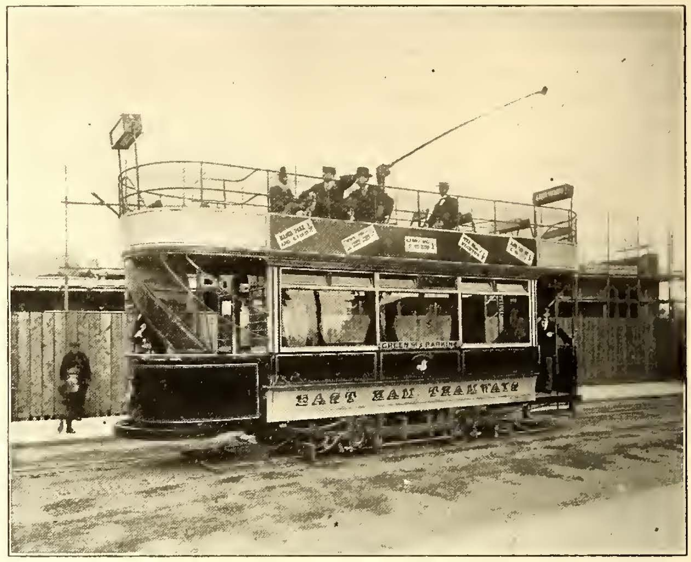
INTERIOR OF EAST HAM ELECTRIC STATION

The main switchboard consists of thirteen panels of white marble mounted on a raised platform, and was made by the English Electric Manufacturing Company, Ltd. It is composed of four generator panels, two balancers, two lightning feeders, two traction feeders, one station lighting, one booster and one Board of Trade panel, with all the usual switches, instruments, etc.

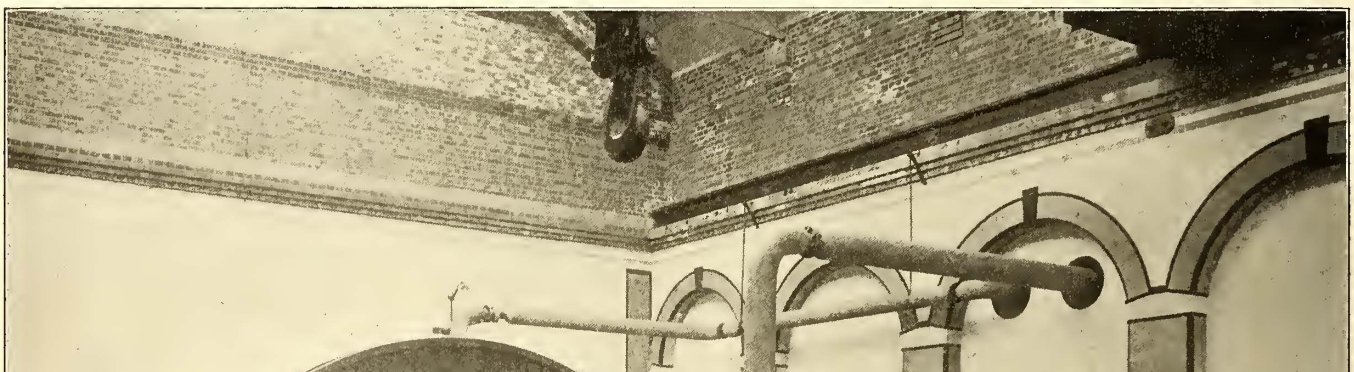
The boiler-house equipment consists of four Babcock & Wilcox single-deck boilers, each having a heating surface of 3580 sq. ft., and capable of evaporating 10,000 lbs. of water per hour at 150-lb. pressure. Babcock & Wilcox superheaters are supplied on each boiler. A "Boby" patent heater detartarizer is also supplied, capable of heating and purifying 3000 gals. of water per hour. The boiler feed pumps are of the Blake simplex admiralty type, so arranged to work as two entirely separate pumps, or as one compound if required. A Barnard Wheeler cooling tower is also provided, capable of dealing with the circulating water when condensing.



COOLING CONDENSING TOWER



STANDARD CAR



225-KW GENERATOR, EAST HAM STATION

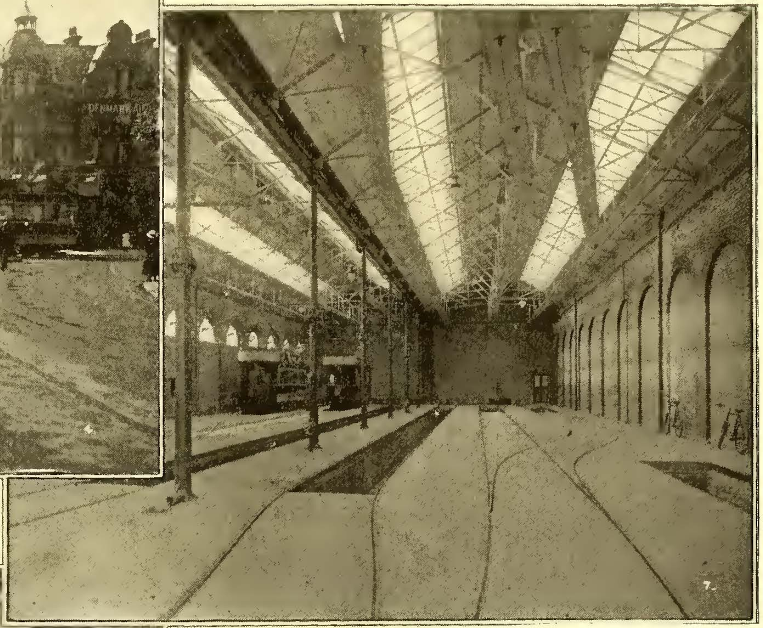
For the engine room Babcock & Wilcox have also supplied two Wheeler condensers, with combined air and circulating pumps, so arranged as to be available for any one or two of the sets which may be running.

The track, which is mostly level, is laid with 87-lb. rails, double-bonded throughout, with 0000 S. W. G. Neptune bonds. Askham Brothers & Wilson's cast-steel special work used throughout. The double track is laid upon a continuous bed of cement concrete, 6 ins. thick, and paved throughout to a distance of 18 ins. outside of the rails with granite blocks, while in the single track the rails are laid on a continuous bed of concrete 18 ins. wide by 9 ins. thick.

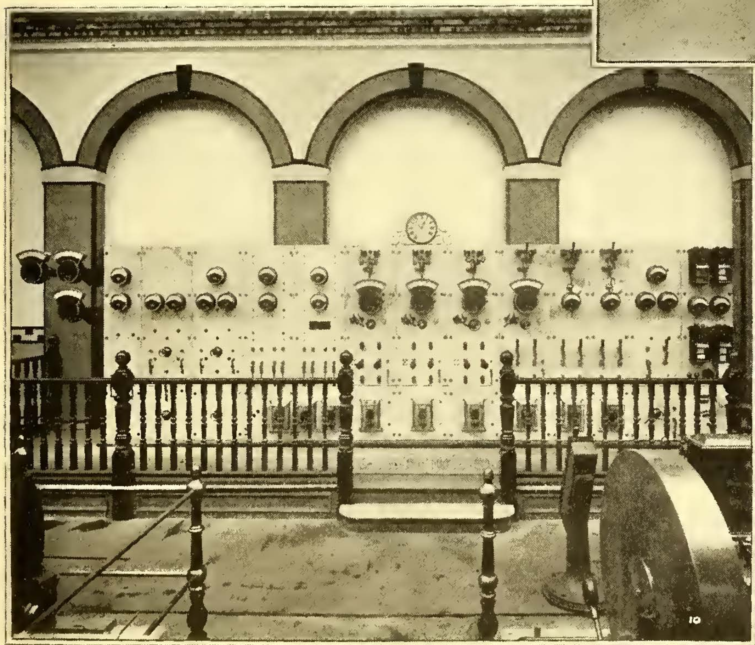
The overhead line consists entirely of side-pole and bracket construction, the maximum length of any bracket being 18 ft. The poles, which are of the telescope joint type, are known as the No. 3 and No. 4 pole, the No. 3 having a length of 31 ft., weighing, without the base, 990 lbs., No. 4 being the same length with a weight of 1321 lbs. The trolley wires are No. O. B. and S. gage tested to an actual breaking stress equal to 27.3 tons per sq. in. The design of the pole bases are of the type adopted by Dick, Kerr & Company, who are the contractors for this work.

All of the cables used in the district are of Messrs. Callender's make. The feeders, both for lighting and traction, are lead covered, and insulated with fine spun jute fibre put on in several layers, each layer being thoroughly impregnated with fine prepared bitumen. The lead sheathing is covered with two servings of bitumen tape laid in reversed directions and well compounded. The largest lighting feeders are 0.42 sq. in. in area, and the traction feeders 0.3 sq. in. The total length of feeders laid at present is 7.5 miles. The lighting distributor cables are laid throughout on the Callender's solid system in wooden troughing filled with bitumen, and consist of three single cables with a pressure of 480 volts between the outers. A total length of 13 miles of distributors has been laid in the district. Three core pilot and telephone cables are also laid to the extreme ends of the district for both lighting and traction purposes.

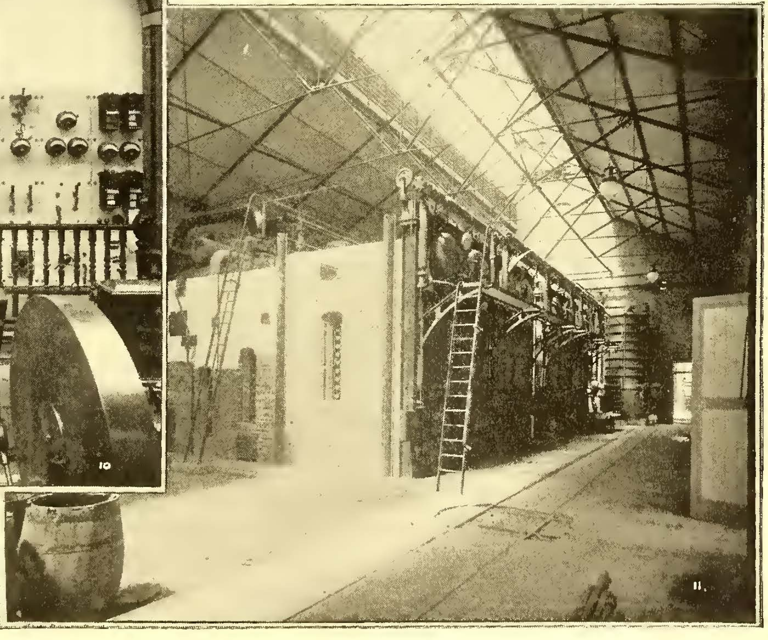
SIDE POLE CONSTRUCTION



INTERIOR OF CAR HOUSE



SWITCHBOARD



BOILER ROOM

The rolling stock at present provided consists of fifteen top seat cars, known as the Liverpool type, having the "Bellamy" reversed stairway. These cars were supplied by Dick, Kerr & Company, from the Electric Tramway & Carriage Works at Preston. Each car is mounted on a Brill 21-E truck, and has a seating capacity of fifty-six passengers, twenty-two inside and thirty-four outside. Each car has two motors of the 25-A type, designed to give a tractive effort of not less than 1000 lbs. when running at 10 miles per hour. The cars have illuminated destination boards at each end above the top of the upper deck. The interior finish is in quartered oak throughout, and the woodwork, while not over elaborated in detail, is of handsome and ornamental design.

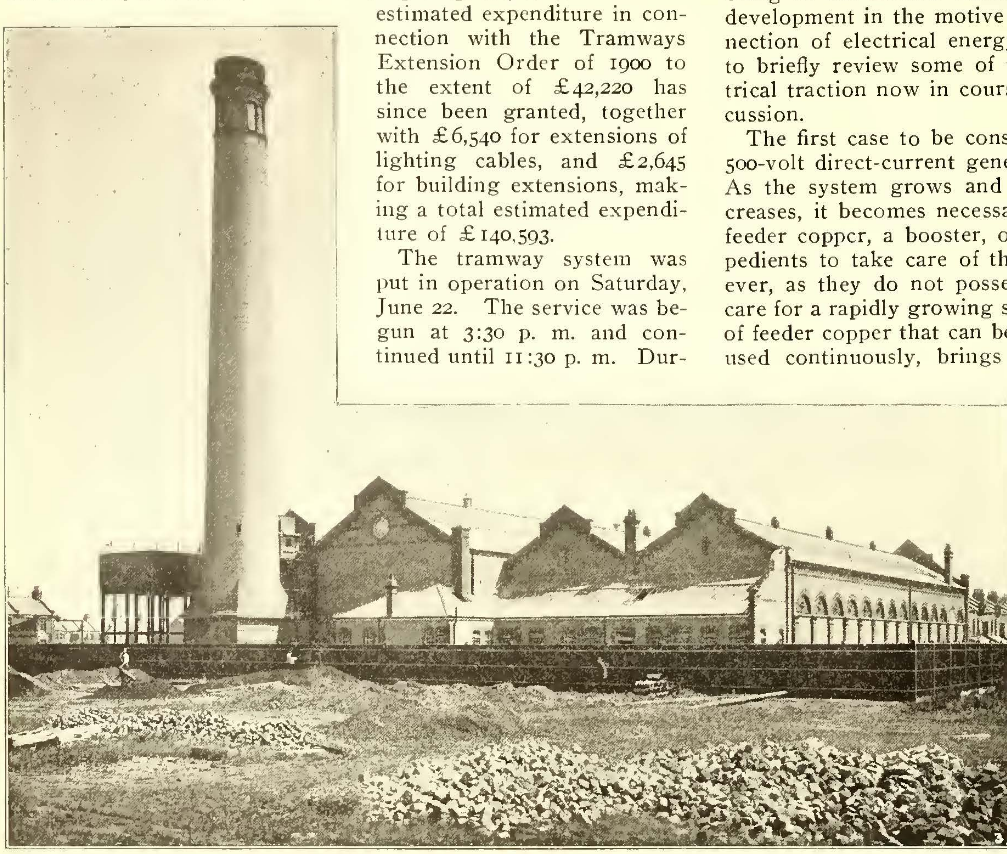
The controllers, like the motors, are of the well-known "Short" design, and are of the D. B. I. solenoid blow-out type, with rheostatic brake, capable of controlling the car in any emergency.

Nothing has as yet been said in regard to the exterior appearance of the buildings. Occupying, as they do, a conspicuous position in the city, care has been taken to make them, in appearance, as attractive as possible, and as the exterior view of the station, published on the next page, shows. A feature of this structure is the large chimney, which is circular, 135 ft. high, and with an internal diameter of 9 ft. 6 ins.

Water will be obtained from an artesian well, 13½ ins. in diameter, which is being bored in the boiler room. It has reached a depth of 500 ft., and when completed is expected to yield 12,000 gals. of water per hour.

Some particulars might now be given of the cost of construction and the results secured in operation. The estimated expenditure for the first section of the combined schemes was, for the tramways, £47,760, and for the lighting, £41,428. A further estimated expenditure in connection with the Tramways Extension Order of 1900 to the extent of £42,220 has since been granted, together with £6,540 for extensions of lighting cables, and £2,645 for building extensions, making a total estimated expenditure of £140,593.

The tramway system was put in operation on Saturday, June 22. The service was begun at 3:30 p. m. and continued until 11:30 p. m. During this time only eight cars were used; but 13,660 passengers were carried during the evening. The average results per day for the first complete week's working, as given in the *Tramway and Railway World*, were as follows:



POWER STATION, EAST HAM CORPORATION

Number of cars	11
Car miles	905
Units (kw-hour) supplied	718
Units per car miles	.79
Receipts	£67 13s. 6d.
Receipts per car mile	17.94d.
Passengers carried	20,149
Total number of passengers carried	141,140
Total mileage for the week	6,336

A Complete Technolexicon

The Society of German Engineers (Verein Deutscher Ingenieure) has undertaken to compile and publish a complete technical dictionary in German, English and French. Such a work will be of great, and eventually of indispensable, value to all technical trades and professions throughout the world.

The Verein Deutscher Ingenieure invites the collaboration of technical societies, associations, colleges, industrial establishments and trades everywhere. Those desiring to assist in this undertaking should address Dr. Hubert Jansen, editor-in-chief of the Technolexicon, Berlin (N. W. 7), Dorotheenstr, 49.

Niagara Falls Power

An attractive booklet with this title has recently been published by the Cataract Power & Conduit Company, of Buffalo. The pamphlet describes in a very clear and readable way the applications and uses made of Niagara Falls power in Buffalo and vicinity. It is profusely illustrated with views of some of the most important installations, and is attractively printed.

Notes on Modern Electric Railway Practice*

BY ALBERT H. ARMSTRONG

During the past few years electric traction work has been passing through a transition period, outgrowing the restricted limits of city surface traffic and encroaching upon a class of work hitherto accomplished with the steam locomotive. The broadening of the electric traction field has necessitated considerable development in the motive power, and the transmission and connection of electrical energy, and it is the purpose of this paper to briefly review some of the more important problems in electrical traction now in course of installation or under serious discussion.

The first case to be considered is the small city railway where 500-volt direct-current generation and distribution amply suffices. As the system grows and the demand for suburban service increases, it becomes necessary to install either a large amount of feeder copper, a booster, or a storage battery. All of these expedients to take care of the suburban load are temporary, however, as they do not possess inherent qualifications sufficient to care for a rapidly growing system. There is a limit to the amount of feeder copper that can be economically installed; the booster, if used continuously, brings the coal consumption up to a prohibitive figure; and the storage battery is not adapted for an expanding system, and, furthermore, can not successfully take care of long-sustained overloads at the end of a suburban line fed from a city system.

Transmitting energy by alternating current affords a means of feeding a large territory from a single generating station, but in the case of a small city road the amount of alternating current required is a small proportion of the total generating station capacity, the bulk of which calls for 500-volt direct current. The best method of meeting this demand for suburban service is, therefore, to install in the direct-current generating station a standard rotary converter operated from the direct-current bus-bars as an inverted machine, and feeding a similar machine at the objective point by means of step-up and step-down transformers. The advantage of this method of generation is that both machines may be used as converters later on when the suburban load has increased sufficiently to warrant the installation of alternating-current generators, replacing the direct-current machines in the city station. Double-current generators may be used, furnishing direct current for local consumption and alternating current for distribution purposes, but the installation of such machines presupposes that the ultimate load will be approximately evenly divided between the direct-current and alternating-current output. It is probable, however, that the alternating-current output will increase in a much faster ratio than the direct-current, with its restricted area of distribution, so that double-current machines do not afford the same convenience for taking care of future growth as do standard alternating-current generators furnishing alternating current only.

The direct-current system of generation, even for city distribution, becomes greatly handicapped with the continued growth of the city, owing to the large amount of power to be transmitted and the wide area which the city covers with its probable efficient street car service, thus relieving congestion in the center of the city. The alternating-current generating station, with sub-stations scattered throughout the city, appears to be the trend of the city distributing systems, even where suburban connections do not exist, and where such suburban extensions do exist, all arguments point still more to the alternating current as the proper method of generating and distributing railway power.

One great advantage of the alternating current lies in its affording a means of consolidating adjacent roads under one system of generation and distribution; indeed, the alternating current is a prime factor in such consolidations, as it effects a large saving in operating expenses by doing away with the many small direct-current stations required with the local 500-volt direct-current power house.

The above discussion considers primarily the city surface road

* Paper presented at the Annual Convention of the American Institute of Electrical Engineers, Buffalo, Aug. 24, 1901.

with suburban extensions running at moderate speed and operating cars of moderate weight, say, 15 tons to 18 tons. The growth of such a system in this country has been, first, the installation of direct-current operating apparatus, then the motor or engine-driven booster, followed by the inverted rotary converter with alternating transmission, and finally, as the system expands, a large generating station containing high-tension alternating apparatus, with several rotary converter sub-stations suitably located to take care of the various parts of the system.

There is another class of railroads which differs in many points from the ordinary city lines, and included in this list are the elevated and underground rapid transit roads. The problem presented here is the operation of trains of two to six cars, weighing from 50 tons to 150 tons, at schedule speeds ranging from 13 miles to 16 miles per hour, with stops averaging from three down to two per mile. These roads operate on private right of way, stopping at designated stopping points, and are not influenced in any way by the surface traffic of the city streets.

The motive power to operate these trains at high schedule speeds and with frequent stops must be so designated that it can give an enormous torque during acceleration, and the controlling apparatus must provide for the efficient handling of these motors during fractional speed running. The problem becomes one of carefully determining the proper motor characteristics for efficient acceleration, and a proper motor design so that unsafe temperatures will not be reached from repeated temporary overloading of the motors.

Direct current has been generally used for such work, while the system of transmitting the electrical energy is in a transition period, but gradually changing over in the older installations and being installed in the newer installations as alternating-current generation with rotary converter sub-stations operating at 600-volt direct current. The reasons are the same as those influencing the change of the generating stations operating surface lines—the inability of a single direct-current generating station to feed the large systems in operation with a reasonable amount of feeder copper, and the reduction in operating expenses resulting from replacing several direct-current stations with a single alternating-current station well located.

The direct-current series motor seems particularly well adapted for the propulsion of rapid transit trains running at variable speeds. Of the total input to the train, a properly designed motor equipment will give out over 70 per cent as useful work at the car wheels—that is, all the losses occurring in the motors and in the controlling apparatus are less than 30 per cent of the total energy input to the train. Where the runs are longer, and the train is permitted to run for some distance at full speed, the losses are, of course, considerably less; but even with the frequency of stops ruling in our elevated roads, the "efficiency of acceleration," so-called, is very high. This high efficiency of acceleration is due to the fact that direct-current series motors can accomplish a considerable part of the acceleration of a train on the motor curve with starting resistances entirely cut out and motors operating with full line potential. This part of the acceleration curve may be made at an efficiency of over 85 per cent, thus making up for the starting resistance losses while the motors are running at fractional voltage. In making the above efficiencies of acceleration it is understood that the series-parallel controller is used. A slightly better efficiency of acceleration is obtained by a series-parallel controller provided for starting with four motors in series, changing to two in series, then all in multiple; but the complication of this controller is not warranted by the 1 per cent or 2 per cent higher efficiency obtained with it.

Elevated and rapid transit roads within the cities are built along the following lines: A single alternating-current generating station, well located with respect to cheap fuel and water; a transmission line, consisting of underground triple lead-covered cables leading to sub-stations suitably located with regard to the load, and operating at 600-volts direct current; a direct-current distribution system, consisting of third rail and track return, with feeders of either copper or rail, if required, and finally, direct-current series motors mounted either upon a locomotive or motor car, and controlled by a single controller or distributed throughout the train and controlled from a system of train control.

There is a new class of railways which is becoming the center of great attention. These are high-speed interurban, or cross-country lines of considerable extent. These lines operate on private right of way, are carefully graded, have few sharp curves and operate cars weighing from 30 tons to 40 tons at schedule speeds as high as 40 miles per hour, including stops at every 3 miles or more. These roads are paralleling the steam roads, and make the same schedule speed as the steam roads provide, with the additional benefit of more frequent stops. Owing to the great tractive effort provided with motors connected to each axle, trains electrically driven can accelerate much faster, and hence maintain the same schedule with more frequent stops than it is possible to accomplish with steam locomotives.

These interurban lines operate their cars through the city streets at the termini, thus picking up and discharging passengers at the most objective points, and thereby making them still keener competitors of the steam railroad systems. Owing to the high speed of these heavy suburban cars and the necessity for fairly rapid acceleration, each car or train unit will demand considerable current when starting up. This current may reach 400 amps. to 600 amps. per car, falling to 150 amps. to 200 amps. per car when running at constant speed of 50 miles per hour, or more. Some interurban roads are being installed contemplating a maximum speed of nearly 70 miles per hour, so it is evident that the motors as well as the distributing system must be so designed that they can take care of enormous fluctuations in load. As these interurban systems are now being installed with 100 miles or more of track, the advantage of alternating-current distribution at high potential is evident, and this method of distribution is universally used. Sub-stations are located at intervals of 10 miles to 15 miles, and may or may not be equipped with storage-battery auxiliaries. The storage battery effects a more uniform load curve on each individual sub-station, but the effect of such storage-battery auxiliaries upon the generating station load curve may be quite small, due to the number of sub-stations fed from a single generating station. A single alternating-current generating station operating at 26,000 volts can feed the territory lying within 50 miles radius of the power house, and the load thus secured, although violently fluctuating at the individual sub-stations, is greatly smoothed out when the resultant load of the several sub-stations is read upon the generating station bus-bars.

In interurban work the direct-current series motor shows itself to be capable of taking care of the widely different demands placed upon the motive power. For instance, the cars must be able to run for long distances at full speed with infrequent stops, but must also be capable of operating over city streets at city schedules with the stops six to ten per mile customary in city work. The series-parallel control of motors is, of course, a considerable help, as it permits half-speed running with motors in series, but even this half-speed may be too high for city work, thus calling for considerable rheostatic control with motors in series.

Although great care is taken in laying out suburban roads to keep down the grades and eliminate the curves as far as possible, still the grades may be heavier than would be permissible with steam locomotive propulsion, owing to the greater traction provided with electrically-propelled cars. The characteristic of the series motor, which permits it to slow down on grades and speed up on levels, is, therefore, very valuable in this kind of service, as it reduces the fluctuation upon both the motive power and the distributing system.

The qualifications of the direct-current series motor for interurban work have been entered into at some length, as there is another method of electrical distribution coming into notice—alternating generation and transmission, and alternating induction motors upon the cars. The system consists, in brief, of a polyphase generating station feeding into transmission wires extending along the line of travel, feeding at frequent intervals into step-down transformers, which reduce the transmission potential to a still considerable pressure for the overhead trolleys. Induction motors receive their power directly from these trolleys, and are geared to the car axles by the standard method.

A principal advantage of the induction motor system lies in the reduction of the labor account due to the elimination of attendance at the sub-stations, the step-down transformers being self-cooled and requiring no more than casual inspection. Where the train service is infrequent and does not justify the expense of sub-station attendance every 12 miles or 15 miles, the induction motor system offers a substitute to the converter system worthy of very careful consideration. As the induction motor system introduces several features which are new, viewed from a direct-current standpoint, a few of its characteristics will be touched upon.

The induction motor, while not a synchronous piece of apparatus, is such, so far as its behavior in railway work is concerned. A car equipped with such motors will run at practically constant speed up grade and down, or on level, thus making the car speed nearly independent of the profile of the road. The speed of the induction motor, depending upon the frequency of the source of supply, is not affected by the voltage, provided the voltage is sufficiently high to provide the torque required. This constant speed quality of the induction motor at first sight appears to be a desirable feature, as it would seem to insure the maintenance of a constant schedule speed not influenced by grades. The greatest objection, however, is that the practically constant speed of the induction motor car up the severest grades calls for a very large motor output, and produces much more violent fluctuations upon the distributing and generating system than is the case with the direct-current series motor, which falls off considerably in speed on heavy grades. The system, being alternating throughout, provides no means of introducing storage batteries to smooth over these excessive fluctuations, and they are more liable to reach the generating station and produce an irregular load curve with its greater coal consumption than is the case with direct-current series motors and rotary converter sub-stations, even though this may be used without storage-battery auxiliaries. Where the system is so extensive that each individual car or train is a small increment of the total load, this objection of fluctuations upon the generating station will, of course, not hold true. The motive power, however, must provide for the running of the car or train up the steepest grade at practically the same speed at which the car operates upon a level, and the motors must, therefore, be designed to stand a greater output for the same service performed than the direct-current series motor.

The induction motor can give only a certain maximum torque with a given impressed line voltage, and, as this torque decreases with the square of the impressed voltage, it will be necessary to carefully determine the operating conditions of the motor and of the distributing system in order that the motor may be able to start its car or train upon the heaviest grade with the minimum line potential met with in operation. The direct-current series motor can give a torque much in excess of any service demand, without sacrificing its running qualities at light loads. Railway service calls for a large overload capacity of its motive power, and the induction motor can meet these infrequent demands only by a design which sacrifices some of its advantages for normal operation. For example, a motor car to be successful must be able to operate through snow storms, occasionally haul a trailer, or push in a disabled motor car over the irregular profile of the road. An induction motor car designed to provide just sufficient torque to operate itself alone would fail to give the commercial satisfaction which is given by the direct-current series motor car with its capability of standing enormous overloads for a short time. It is evident that the practically synchronous operation and limited torque of induction motors introduce a number of problems into high-speed interurban work not met with in direct-current distribution, and that the motive power, transformer sub-stations, distributing system and generating system must all be designed very liberally in order to take care of the violent and large fluctuations inherent in the operation of the railway induction motor.

The induction motor, like any piece of alternating apparatus, demands a magnetizing current, and this current is much larger than that met within stationary motors, due to the larger air-gaps demanded in traction work. Stationary motors can run at air-gaps of but three or four thousandths of an inch, but the railway man would decline to assume the responsibility of keeping up his bearings for any such air-gap. Increasing the air-gap will raise the magnetizing current, lower the power factor of the system, and hence increases the size and cost of the distributing and generating apparatus. The necessity of designing the railway induction motor to meet unusual demands occurring very unfrequently further increases this magnetizing current, due to the high density required in the iron circuit with a reasonable motor weight. Even with a liberal air-gap, viewed from an induction motor standpoint, such a motor demands a clearance between field and armature nearly 50 per cent less than is common practice with direct-current motors. The maintenance of linings with a small gap is a matter for consideration, particularly when it is remembered that when the armature of an induction motor strikes its field it may destroy two sets of windings, as the field is a duplication of the armature winding. We are, therefore, confronted with the maintenance of an air-gap of half the width and double the expense of repair with induction motor to offset the small commutator maintenance of the direct-current motor.

The installation of high-speed interurban roads in this country has been brought about by the financial success of the earlier roads of this character. Because a system is operative is no reason for its adoption, unless there is sufficient promise of its superiority over present methods. Our interurban and suburban roads possess a very strong advantage in being able to traverse city streets en route and at their termini. All the large cities in this country, and most of the smaller ones, have direct-current railway systems in operation, and the direct-current interurban and suburban system can, therefore, run its cars over existing city systems without in any way conflicting with the operation of such roads. The induction motor interurban system, on the other hand, would necessitate the changing of cars at the outskirts of the termini cities, running around the cities passed en route, or else the equipment of unused streets with double trolley and alternating current; or, as an alternative, changing over the generating and distributing system and motive power of all cities entered to alternating current. There are a number of engineering difficulties to overcome before such a change would be commercially practical.

A chief advantage of the induction motor system lies in the ability of running motors from trolley potentials far in excess of 600 volts universally used with direct-current series motors. Not having any commutator, the induction motor can use trolley potentials of several thousand volts, and proper line insulation and safety in operating are the only limits placed upon the trolley voltage. Owing to the large lagging currents demanded by induction motor roads, which operate at power factors ranging from 50 per cent to 75 per cent, it is desirable to use as high a potential as possible in order to eliminate the excessive feeder copper or frequent transformer sub-stations required with low voltage distribution. A trolley potential, therefore, of 2000 volts or 3000 volts offers advantages in interurban distribution well worth the extra expense and development needed to insulate trolley and car wiring at this comparative high potential. In order that the motive power will be reasonably cheap, and bearing in mind that such motive power must stand maximum demands considerably in excess of the direct-current motor, it is advisable to wind the motors directly for the trolley potential rather than introduce the expense and provide space for step-down transformers. We are, therefore, confronted with the difficulty of running a 3000-volt trolley through small cities along the route and into large cities at the termini, even assuming that the cost of changing over such systems to alternating current would be justified.

Step-down transformers installed upon the car, reducing from 3000 volts to 600 volts, open the possibility of running motors without step-down transformers on city streets, and with step-down transformers when the trolley potential is 3000 volts in the open country. The double trolley, however, complicates the city system and adds additional expense to the already expensive motor equipment. The induction motor, moreover, is not adapted to city street running, calling, as it does, for constant acceleration and efficient operation at fractional speeds. Instead of efficiencies of acceleration in the seventies, obtained with direct-current motors, the induction motor would give an efficiency of only 40 per cent to 45 per cent during acceleration with a corresponding increase in coal consumption, making it compare very unfavorably with the direct-current motor for city work. The adoption of the induction motor for interurban work seems limited, therefore, to those roads running on private right of way throughout, and having no connection with existing city systems at their termini or en route. Even in this class of roads, if the service is at all frequent and profile very irregular, the direct converter system, with its third-rail distribution, may prove cheaper to install and operate. The reduction in operating expenses which the induction motor effects by dispensing with rotary converter sub-station attendants may be more than offset by introducing apparatus whose volt-ampere capacity may be double the kilowatt capacity required, and which, furthermore, may operate with a very irregular and inefficient load curve, as compared with the load curve produced with direct-current series motors.

The writer has endeavored above to bring out a few of the obstacles in the way of the success of the induction motor for general interurban work. There are, of course, special instances where the roadbed is practically level, grades and curves being eliminated and the conditions ideal for the installation of induction railway motors. It is unfortunate, however, that all interurban roads can not pick out a level country, or have unlimited capital at the back of them in order to provide ideal conditions for the motive power. In fact, the motive power must accommodate itself to the physical limitations of the road, and it is just here that the direct-current series motor shows its superiority to the induction motor where the profile is irregular and where the service consists of mixed city, suburban and interurban high-speed work. As before stated, interurban high-speed roads are being rapidly extended in this country owing to their economic success, and in a large number of cases coming under the writer's observation, the induction motor could not compete in first cost of installation, nor in expense of operating with the direct-current motor, operated from rotary converter sub-stations and high-tension alternating transmission. The expense of the few men required to operate sub-stations is a very small item in the total operating expenses of the road, and as our interurban roads more nearly approach steam practice, they require attendants every 10 miles or 15 miles to serve as ticket agents, train despatchers, etc., so that, with a well-organized interurban system, the item of sub-station attendance can be largely charged to the general operation of the road and not to the cost of producing power.

The ideal conditions for the operation of induction railway motors seems to be a regular profile, either level or a uniform upgrade, private right of way with no city or suburban running, infrequent service and freedom from unexpected and fluctuating demands upon the motive power. Electric railway work up to the present has demanded considerable of the motive power in the way of meeting large momentary overloads, running at different speed, line voltage, etc., and the direct-current series motor has shown itself well equipped to meet these requirements. The induction motor is more adapted for operation under predetermined conditions, and its design does not lend itself to the same broad field of usefulness now covered by the direct-current series motor.

In a service calling for frequent stopping where the demand upon the motors is largely acceleration work, the induction motor must dissipate considerably more energy for the same service performed than the direct-current motor, and hence must be correspondingly heavier and more expensive. For constant speed running, the induction motor, however, must dissipate but little more energy than the direct-current motor, and from the nature of its design may dissipate that energy more rapidly.

This brings up a new class of railroad work just being considered, and that is mountain railroading, and long-distance cross-country roads for either high-speed passenger or freight work. The conditions governing both these classes of work are practically the same in that they demand a constant sustained output of the motive power, and it is in this class of work that the induction motor is being seriously considered.

Direct-current motors fed from a system of rotary converters connected to a high-potential transmission distribution system are open to the objection that a trolley or third-rail potential under 1000 volts must be used, necessitating the collection of very large currents and an undesirable frequency of converter stations, or prohibitive expense of third-rail and feeder construction. The power consumed by a freight train of 2000 tons or more may reach 3000 hp on the grades encountered in steam railroad mountain work, and the ability of the induction motor to collect this large amount of energy at a trolley potential of 3000 volts or more gives it a distinctive advantage in first cost of installation and expense of operation compared to direct-current distribution. High-potential alternating trolley systems present certain difficulties in the way of insulation, but after several years' experience with high-potential transmission lines, these difficulties should be easily surmounted. Such systems also employ locomotives and not individual motor cars, so that the high-potential apparatus is localized, and more space is provided to properly insulate all high-tension wiring.

The operation of heavy freight trains, or high-speed passenger trains on trunk lines is the work of the future, and will be undertaken as soon as it is evident that a saving will result in operating expenses by the substitution of electricity for the steam locomotive. Trunk lines having local passenger traffic could very well equip their tracks with both high-potential overhead trolley for the operation of heavy through trains and freight work, and also use a third-rail construction to operate direct-current 600-volt direct-current motors for the short-haul work. Both these systems could be fed from the same generator and transmission lines, operating 25-cycle rotary converters to feed the third-rail system at intervals, and step-down transformers to reduce the potential to the 3000 volts or more required for the overhead high-tension trolley line. This mixed system provides for the maintenance of a steady load on the generating station, while it permits the local and short-haul traffic to benefit from the advantages of the direct-current motor for this class of work.

The electrical equipping of trunk line steam roads is a very large engineering proposition, involving such radical changes in the operation of such roads that its commercial success must be undoubted before the work is undertaken. It is possible that such a movement will be brought about by the equipping of some of the new high-speed third-rail interurban systems with overhead trolley operating at 3000 volts alternating current. These systems are rapidly being extended and interconnected, and will soon be able to take care of long-distance work when the systems are sufficiently joined together. The management of such roads, owing to their experience with electric traction, may be reasonably supposed to be more open to the advantages of electric haulage, while the establishment of a line of generating stations, all operating at the standard frequency of 25 cycles, will offer the means of feeding such a system with a comparatively small cost for equipping. The various sub-stations, however, and the direct-current copper distribution are not adapted to the operation of large, heavy units, although the transmission lines and generating stations could well feed these trains with a reasonable outlay for high-tension overhead trolley construction.

It is along such lines that the writer looks for the introduction of the induction motor as a railway factor in this country, and there are several propositions in view where the introduction of the induction motor seems justified and preferable to the steam locomotive now in operation.

DISCUSSION

The discussion on the two papers on railway topics, that by Mr. Armstrong, given above, and that by Mr. Berg, was quite full. Upon the conclusion of the reading of the papers, Mr. Gifford described a method of starting converters as simple shunt motors, thus obviating the difficulties otherwise resulting from variations in the voltage of the starting current. Professor Gillon, of Louvain, Belgium, gave some details of the polyphase traction experiments at Berlin at high speeds and employing a potential of 10,000 volts. He expressed the opinion that under certain conditions with respect to starting, this system was applicable where the direct-current system would fail. With respect to the use of polyphase motors for urban traction, he said that the arguments made against this system were based upon high acceleration, but as high speeds are never used in urban service, any arguments against the polyphase motor based upon such speeds were unfair. Polyphase motors, he said, can be designed to give as large a starting torque as may be desired by momentarily increasing the voltage at the terminals. Professor Gillon expressed the opinion that the air resistance offered to a train consisted largely of frictional resistance against the lateral sides of the train. Mr. Janisch, of Berlin, also referred to the Berlin-Zossen experiments, which were carried out by the company of which works he is chief engineer. He said the tests were satisfactory as to the application of the polyphase system to high-speed traction. It was found, however, that the overhead trolley is not practicable for high speeds, and at Zossen side contacts were substituted. He intimated that the reason the work had not been followed up was due to the disfavor with which the German Government viewed prospective electric roads with respect to competition with State lines and cost of transforming the latter from steam to electricity.

Mr. Arnold, of Chicago, expressed regret that American engineers were antagonistic to the three-phase railway, and that we had to go abroad to find the defenders of this system. Personally, he was a friend of the direct-current rotary-converter system, and, therefore, in a position to consider impartially the merits of the polyphase system. He believed that, if left to themselves, our American engineers will solve the problem. One solution of this problem he considered to be the use of energy usually dissipated in starting a train. Electric elevator motors are started at less than normal current, and he believes that the same can be done with polyphase motors. He considered that Mr. Berg's example, which worked out against the polyphase system, was not fair, since it applied to a shorter road well adapted for direct-current traction; with a longer road his conclusions would be modified. He believed that the direct-current motor is best, in connection with sub-stations, for urban roads, and also best for interurban roads with light cars. For heavy railroading he was strongly in favor of the alternating-current system.

Mr. Mailloux, of New York, said that short runs precluded the use of the alternating-current motor. The greater the speed the greater the difficulty for the alternating-current motor, due to acceleration. The problem is a function of the speed and the length of run. Integral acceleration curves, he considered, give the best indication as to the relative merits of direct and alternating-current motors for railway traction, and referred to Mr. Berg's diagrams as showing that the direct-current motor is better than the alternating-current motor for accelerating. The starting torque of an alternating-current motor is only two and one-half to three times that of the running torque, while that of the direct-current motor is four or five times greater. In conclusion, he said that the question of alternating-current motors in electric traction was one for the future and not for the present.

Professor E. P. Roberts, of Cleveland, expressed disappointment at the statements made concerning alternating-current traction, particularly in view of present conditions in Ohio, which seem to call for the use of the alternating-current system. Owing to recent consolidations of railroads in Ohio the connected lines are very long, and he had hoped that this would produce conditions that will permit the substitution of alternating-current traction.

Mr. Stillwell, of New York, said that in the electric railway field we had been apt to go along old lines and have not given sufficient attention to alternating currents. He believed that the question should not be considered generally, but with respect to specific cases. An objection to the present sub-station system is that it is dependent upon three or four points of supply, each point demanding the exercise of skill. On the other hand, with the alternating-current system, all the skill could be concentrated at one point. With a direct-current system and a number of sub-stations the reserve and corresponding investment is out of all proportion with the generating plant. For example, in the Manhattan Elevated Railway system there is one reserve generator and seven reserve rotaries. On a large direct-current sub-station system the acceleration is limited by fluctuations in the sub-stations, for though the fluctuations may be moderate at the power house they may be extreme in the sub-stations. Before adopting the alternating-current system, however, it must be worked out for specific cases. As to the claims of greater transmission efficiency of the alternating-current system, he said that on New York elevated roads this saving would only apply to 18 per cent on the total cost, so that by raising the efficiency from 80 per cent or 90 per cent by the use of alternating currents, the increase would be but 2 per cent, not considering the labor element or a large saving in investment. In conclusion he said that to-day the sub-station system is the best for large cities.

Mr. Arnold coincided with Mr. Stillwell in this latter conclusion, saying that the sub-station system was the best to-day for urban and low-speed interurban roads. For heavy railroading, however, the alternating current is alone applicable, and he quoted a railroad president who has operated both steam and electric roads for five years to the effect that he can carry freight cheaper with electricity than with steam. As to the factor of acceleration in the railway problem, he had thoroughly considered it, and what he said in favor of the alternating-current system was said with a full knowledge of the importance of this factor. In conclusion, he said that he did not like to see American engineers take the attitude that the direct-current system is perfection and appear to be antagonistic to the alternating-current system.

Professor Roberts said that he found that sub-station charges were a great factor in transportation charges.

Mr. Steinmetz, of Schenectady, said that at one time he believed that the polyphase system had a higher transmission efficiency and less operating expense, but after thoroughly considering the question recently he has found that the transmission efficiency is less, owing to the efficiency of the induction motor. With the induction motor the fluctuations are very great, and transformer sub-stations would be required, and this latter is the electrical apparatus which will stand less overloading, with the consequence that the expense for transformer plant would be very great. Rotary converters require extremely little attention and not much expense.

Mr. Potts, of London, said that, in the face of such very diverse opinions as to the relative merits of the direct and alternating-current railway systems, he thought it best to say nothing in view of the smaller experience of Great Britain in electric traction. He referred to the very much lower bid offered in London in connection with the Ganz system, and said that he would regret it if American manufacturers did not obtain the work.

Mr. Scott, of Pittsburgh, said that the papers which had been read confirmed calculations that had been made by Westinghouse engineers. He gave some figures which confirmed those arrived at by Mr. Berg, and said that the conclusions of the Westinghouse engineers coincided with those of the General Electric engineers to the effect that the saving with the polyphase system would be negative. As to the saving from braking with the latter system, since braking can not be done under half speed, the saving would be slight, and the increased weight of apparatus would more than take this up. He said it was better to coast and to give up braking. He said that the opinion of the company engineers was also confirmed by Mr. Stillwell in connection with the New York elevated system. The constant speed of alternating-current motors was, in fact, a disadvantage. The same size of direct-current motor would give higher speed on the level or low grades and thus make up for the lesser speed on high grades.

Mr. Scott referred to a remark made by one of the foreign guests, who said he did not understand the position of the American company's engineers in their antagonism to polyphase railways, but ascribed it as a commercial policy of their employers. Mr. Scott repelled this insinuation, and said that the commercial departments of the companies were, on the other hand, constantly urging the engineers toward the alternating-current system. He said the question was really not one of alternating current vs. direct current, but that of series vs. shunt motors. If direct-current shunt motors are not good for railway service the induction motor is not good. The invention of a speed-changing device might change the situation. In conclusion, he said that he coincided with the authors of the papers in that the induction motor is not applicable for electric railway service.

Mr. Potts asked to be allowed to make a personal explanation concerning a remark he had made as to the influence of manufacturing companies with respect to the position taken by their engineers on the polyphase railway question, which he did not wish to be applied in any personal sense. One could, however, generally take it for granted that manufacturers are in favor of the apparatus they can supply with the most profit to themselves. Mr. Steinmetz said that this latter point was true, but it was a serious matter for companies to be left behind, and that, in fact, they are always seeking to make advances. He said that his company had done a great deal of work on the problem under discussion, but there were no results thus far, except in the supply of six induction motor cars, and these for a railway of Italy.

Mr. Stillwell said that direct-current systems, although used on the New York and Chicago railways, were not in themselves ideal. With reference to the greater efficiency of the direct current over the induction motor, he pointed out that in the case of the former there may be 35 per cent difference between the energy delivered to a car and that used. He expressed the strong hope that our manufacturing companies would not accept the direct-current system as perfect and bury the alternating-current system, and said that if the latter system were adopted and found successful in London, it would be a blow to American electrical engineering prestige.

Mr. Steinmetz said that the advantage of the return of energy to the line by braking was not borne out. The solution of the traction problem was to accelerate as fast as possible, then coast, and then in stopping let the energy be dissipated by rolling friction. Mr. Stearns expressed the opinion that the alternating-current system is best for long runs on interurban roads. Mr. Spalding described a speed-changing device, which he thought might be applicable to electric railway motors. This consisted of a pair of discs, each with a beveled face, one disc being adjustable. A beveled belt runs between the two discs, which may be adjusted to give different transmission diameters. Mr. Holmes said that he had seen a car driven by this device, and expressed the opinion that the alternating current would prove an economical substitute for steam between New York and Albany.

Mr. Mailloux said that an important favor in the problem of high-speed railways was that of air resistance. At high speed the rolling friction is negligible in comparison with the air friction, and he hoped that some data would soon be forthcoming relating to the latter. The problem is rendered indeterminate at high speed, and the supply of data calls for the joint effort of all interested. Mr. Armstrong said that the General Electric engineers had been disappointed at the inapplicability of the induction motor in railway work. As to its application to suburban roads, he said these were governed by the same conditions as city roads, the higher speed schedule counteracting the effect of stops at longer intervals.

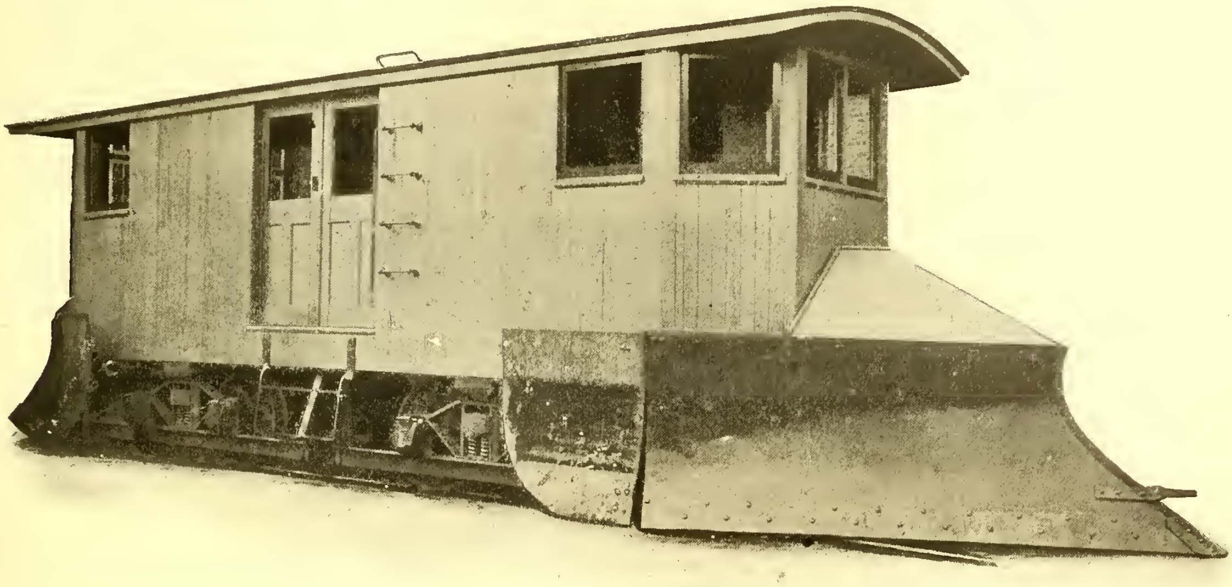
Fare Registration

A subscriber writes as follows: "A few days ago I received a check for $27 from an Ohio interurban railway company, which was signed by its treasurer, countersigned by its secretary and approved by its president. The three signatures to a check of this nature would be no unusual occurrence if the company was a large one and its officers actively engaged in its operation. In this case, however, the railway is merely a side deal to the various large interests owned and controlled by each of the parties referred to, and for that reason the writer was forcibly struck by the great contrast between the apparent caution exercised over the outgo and the very crude and loose system prevailing in connection with the income. This road collects possibly five or six, or more, different kinds of fares. Its conductors are supposed to ring them all up on one register, give receipts for certain classes of fares, and from the register settle with the company. Unfortunately for the railway company, its officers are inexperienced railway men, and, while apparently protecting themselves from one another, and the company's interests from treasurer to president, they seem to forget to put out any guard that will protect the company from the wholesale retention of fares paid by the riding public to absent-minded conductors.'

"A company operating electric cars is absolutely at the mercy of its conductors, and is obliged to depend solely upon their honesty unless some system of protection is provided whereby all fares received will find entrance into its treasury. The latter also, in justice to themselves, should be provided with some system, if possible, which is absolute and accurate and upon which both they and the company can implicitly rely."

New Types of Snow Plows

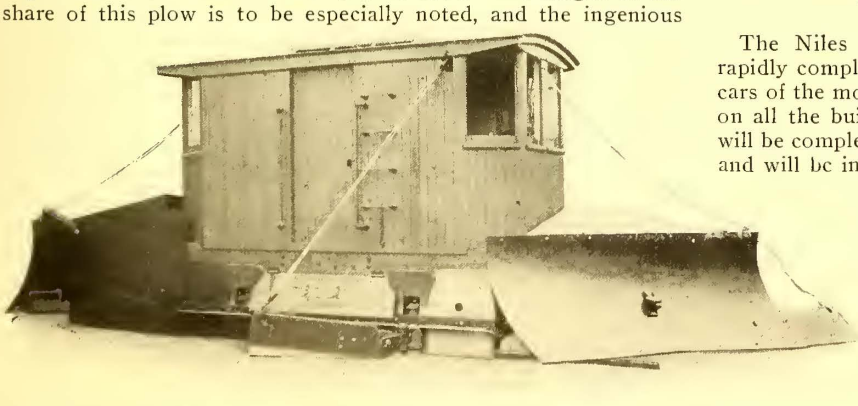
The accompanying engravings show two new types of snow plows which are being put on the market this season by the Taunton Locomotive Manufacturing Company, of whom Wendell & MacDuffie, of New York, are the Eastern representatives. The present extensive use of the Taunton plows makes these designs particularly interesting.



EIGHT-WHEEL PLOW BUILT FOR HEAVY SERVICE

The one which, for its novel features, will attract the most attention is the eight-wheel plow, intended for the heaviest class of work. This plow is mounted on Taunton trucks, which are M. C. B. standard throughout. Simplicity and strength have controlled the design of these trucks. The bolster bearings are 18 ins. in diameter, and no particular dependence is placed on the king-pin. The nose frame is of heavy white oak, strengthened by wrought-iron braces and guide bars. The main frame of the plow is of hard pine and the cab of North Carolina sheathing. The nose can be lifted 10 ins. clear of the rail, and is operated by hand power exerted through the worm-gear mechanism. An 8-in. lifting cylinder is provided, however, for each nose, and compressed air may be employed for lifting the noses and operating the gear. The wing operating mechanism is novel in design, of exceeding simplicity, of great strength and almost wholly of wrought iron. The same remarks apply to the digger mechanism, which has received the most careful attention.

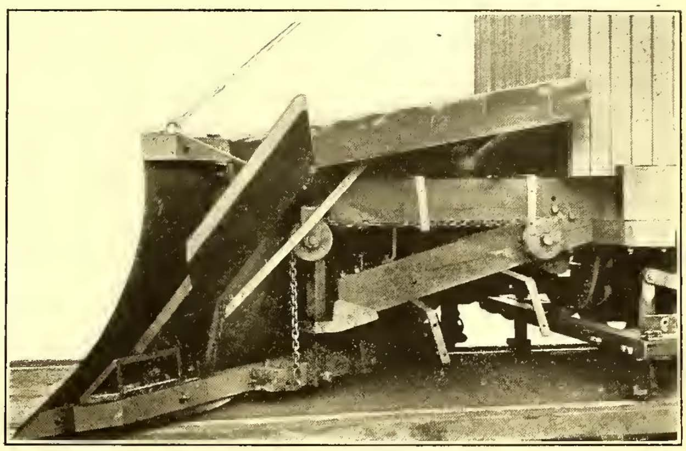
The other plow illustrated is the company's standard share plow. The house and body of this share plow are, as far as possible, exactly like the corresponding parts of the standard nose plow, the end of the body frame being changed to meet the requirements of a share rather than a nose. The height of the share of this plow is to be especially noted, and the ingenious



STANDARD SHARE PLOW

arrangement which allows the share extension to be both raised and lowered by one rope from the cab will please every practical railroad man. The snow-protecting casing back of the share is fastened in part to the main frame and in part to the share itself, and these two parts lap over and slide by each other. This casing gives ample protection to the running gear.

The eight-wheel plow is something entirely new, and will appeal to railroad men generally. The Taunton snow plow is known all over the country. The company has extraordinary facilities for



DETAIL OF LIFTING DEVICE

turning out these plows, and is now ready to accept orders for the coming season.

New Car Works at Niles, Ohio

The Niles Car Manufacturing Company, of Niles, Ohio, is rapidly completing its new plant, and will shortly be able to build cars of the most approved type. The work has progressed rapidly on all the buildings, so that it is expected by Sept. 15 that they will be completed. The machinery for the plant is being delivered, and will be installed as soon as possible, and unless some unforeseen circumstance occurs, the factory will be in operation by Sept. 15, 1901. The company will start work under the most auspicious circumstances, orders having already been taken for twenty-four 18-ft. cars, complete with motors and trucks, and for the rebuilding of sixteen cars. It will be necessary, therefore, when the works open, to employ some 300 car builders. The general superintendent of the company, Mr. Jacobs, has been in the East, and secured the very best men for the positions at the heads of the various departments. George E. Pratt has been appointed assistant general manager and contract agent, and will enter upon his duties on Oct. 1. He will represent the company at the American Street Railway Association convention in New York, and is already in a position to receive orders for fall deliveries.

Large High-Speed Cars

The accompanying engravings show the exterior and interior

LONG CAR FOR GALESBURG

of some large cars recently built by the J. G. Brill Company for the Michigan Traction Company, of Galesburg, Mich. These cars

INTERIOR OF GALESBURG CAR

are somewhat of a departure from ordinary practice, inasmuch as they combine many of the distinctive features of both steam cars and street cars. The bodies are 34 ft. over the end panels, 8 ft. 5¼ ins. wide over the posts, and have straight steam-car sides. They also have a steam-car roof, combined with a vestibule which, in most of its characteristics, belongs strictly to the electric railway pattern. The framing of the sides is of the steam-car type and the covering narrow vertical sheathing. There are two truss rods taking a bearing upon saddles resting against the usual needle beams. The platform is dropped, and the platform timbers are faced and strengthened with angle irons. The buffer beam is of the Brill angle-iron type. There is one Wagenhals electric arc headlight for each car, transferable from end to end, according to the direction in which the car is operated. The floor is provided with trap doors for reaching the motors.

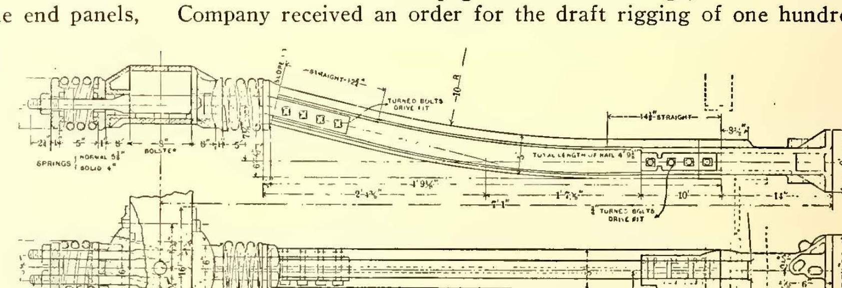
The interior of the car is shown in the second engraving. The seats, which are of the "walk-over" type, have hand holes at the corners of the backs, giving a firm hold to those standing or walking through the aisles. The car is heated by a standard Baker hot-water heater in one corner. The sash are in two pieces, the lower one of which drops into a pocket, but the opening is so arranged with a cover as to be closed either by the sash or the cover. Inside the sash there are the usual curtains. The seating capacity is forty-four.

These cars are mounted on No. 27-G trucks, arranged to operate on 10-deg. curves—practically 574-ft. radius. The trim is of solid bronze. The drop of the platform is sufficient to make it possible to reach it with a single step. Wood grab-handles are placed on the corner posts at the entrances, and the whole car is fitted up with a view to making the passengers comfortable on long rides at high speeds. The motive power is furnished by a G. E. 1000 double-motor equipment.

A New Type of Van Dorn Coupler

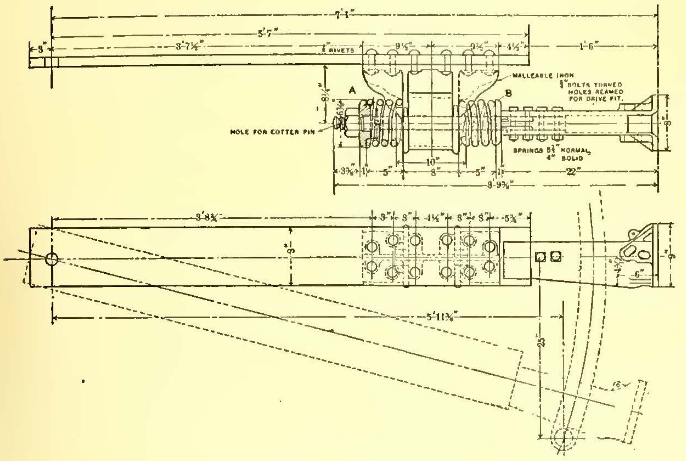
The accompanying illustrations show the new types of coupler which have been perfected by the W. T. Van Dorn Company, of Chicago, for use on the elevated railroads of New York. A service of this kind requires a most efficient form of coupler, and the selection of those of the Van Dorn make for both the New York and Boston systems is a guaranty of their merits. The managements of the elevated railroads in both of these cities made extremely careful tests before adopting any of the apparatus to be installed on their roads, and they made exhaustive investigations before deciding upon the type of coupler to be installed.

As recorded in these pages a few weeks ago, the Van Dorn Company received an order for the draft rigging of one hundred



DRAW BAR FOR TRAILERS AND FOR THE END OF MOTOR CAR NOT EQUIPPED WITH MOTORS

cars to be supplied to the car builders, as well as a lump order of 1000 car equipments for cars already in service or to be built. For this contract the company will build entirely new automatic heads with extra heavy links, in order to meet the extremely heavy service required on the elevated lines. After the installation of these equipments all the new cars of the Manhattan Elevated, of New

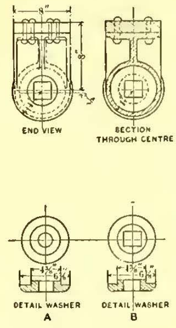


DRAW BAR FOR MOTOR END OF MOTOR CAR

York, as well as those of the Boston Elevated, will be fitted with Van Dorn couplers.

The Van Dorn Company has had its couplers in use for eight years on both city and interurban roads, and there are now over 50,000 in use for such service. They have also been employed on the elevated roads of Chicago for seven years. Had anything, however, been wanting to demonstrate the superior merit possessed by these couplers, the awarding of the above-named contracts would have supplied it. One of the features which makes the coupler a favorite with railway companies is the complete draft riggings, which are furnished in connection therewith. The so-called D. L. Barnes patent swivel on the body bolster in connection with the Van Dorn automatic head assures smooth running of trains with a minimum of jerking motion, and it is claimed that during the lifetime of the car there will be no appreciable slack in the rigging.

As will be seen from the drawings reproduced herewith, two types of draw-bars are to be used. That having the long, flat arm with the helical springs placed near the coupler-head will be used on the motor end of motor cars, and is especially designed to have the draw-bar clear the motors and yet always give a direct pull. This is called No. 16. The other type is for trailers, and the plain end of motor cars—it will be remembered that the Manhattan two-motor equipments are to be placed at one end of the car to increase the tractive effect—and will be known as No. 15.



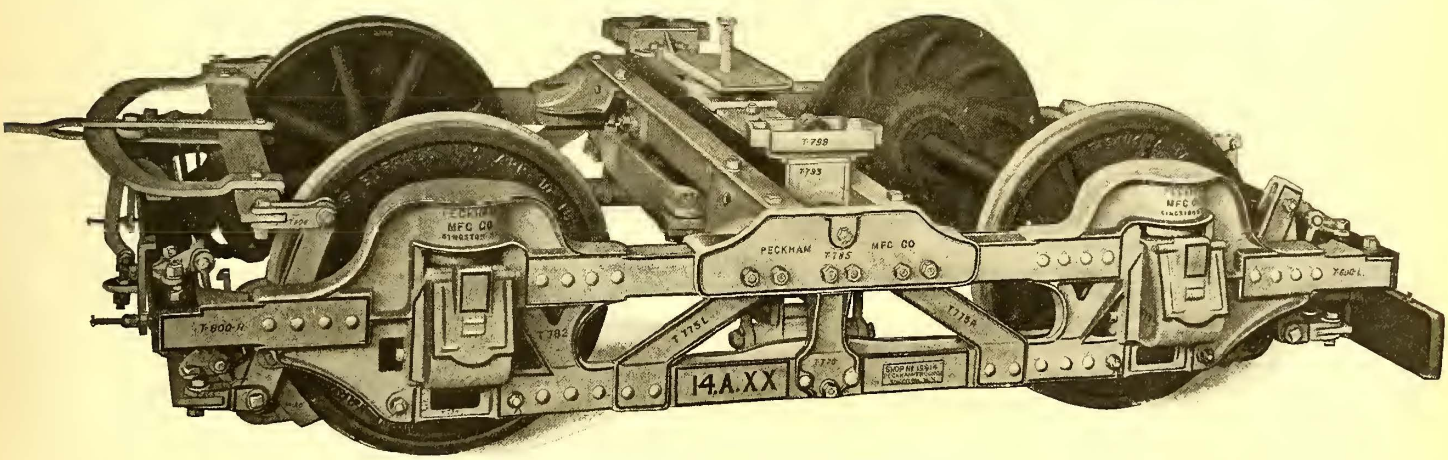
Including the latest types put on the market, the Van Dorn Company is now prepared to furnish, therefore, sixteen sizes of couplers, and thus supply any class of service from that requiring the smallest size, as mining cars, etc., to the heaviest traffic. The automatic head makes the coupler one of the most efficient devices for connecting cars, and will give a tight coupling on the best mechanical principles.

The Peckham Extra Strong Truck No. 14AXX

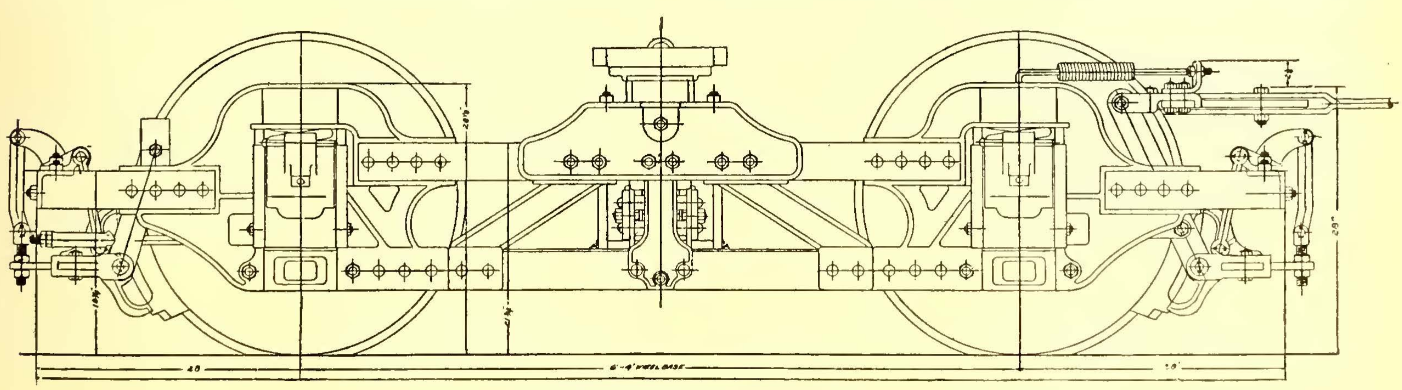
This truck, which is illustrated herewith, is another addition to the large line of high-speed double trucks which the Peckham Manufacturing Company has developed during the past summer for high-speed interurban service. It is constructed along the same general lines as the company's 14Ax and the Chicago special elevated trucks, but with several modifications to adapt it to high-speed interurban work.

The side frames are of steel, bridge trussed. They consist of two upper and one lower soft steel bars firmly riveted hot by hydraulic pressure to semi-steel yokes or pedestals provided with recesses for receiving the steel bars. The rivets used to connect the bars to the pedestals are relieved from all shearing strains. Between the upper and lower members of the side frame is inserted a "bridge truss," secured by rivets to the lower member and abutting against the foot of the pedestal. This construction distributes the weight of the load evenly over the entire truck frame. By actual test one of these side frames will sustain, without breaking, over 50 tons, 100 tons to the truck, or 200 tons to the pair.

The end sections are of angle-bar shape, machine fitted to the end extensions of the side frames and secured in place by machine-

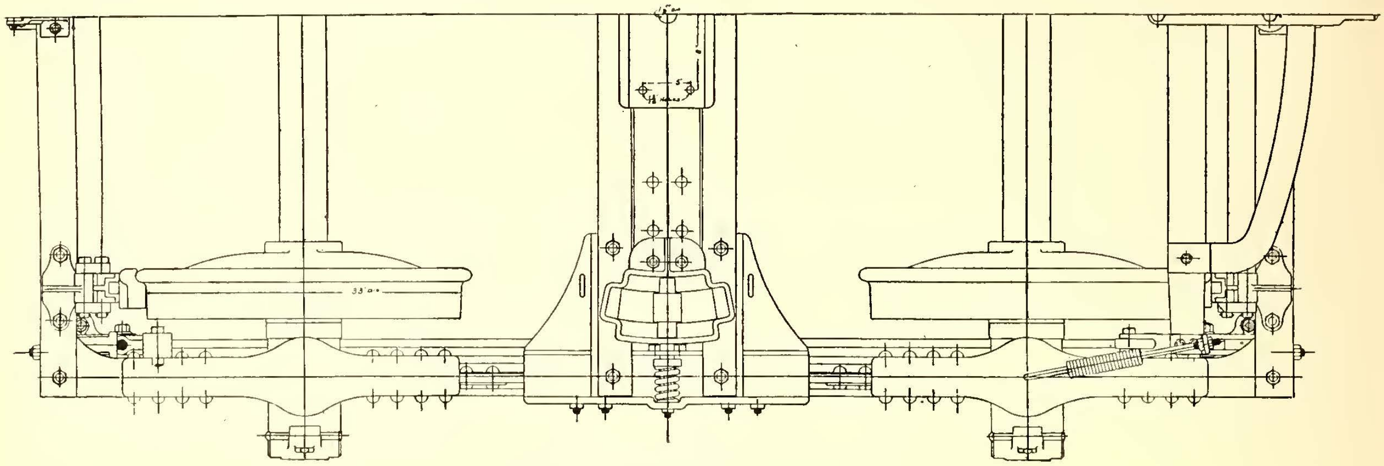


THE NO. 14AXX TRUCK FOR HIGH SPEED ROADS



SIDE ELEVATION OF TRUCK

turned bolts. This construction, besides being very strong, keeps the truck square. The bolster is constructed of steel channel bars, firmly secured to center cross sections, so as to make the bolster practically one solid piece. It is supported upon a combination of half elliptic and spiral springs—the elliptic spring being located in the center and the spiral springs (two) at each end of the bolster.



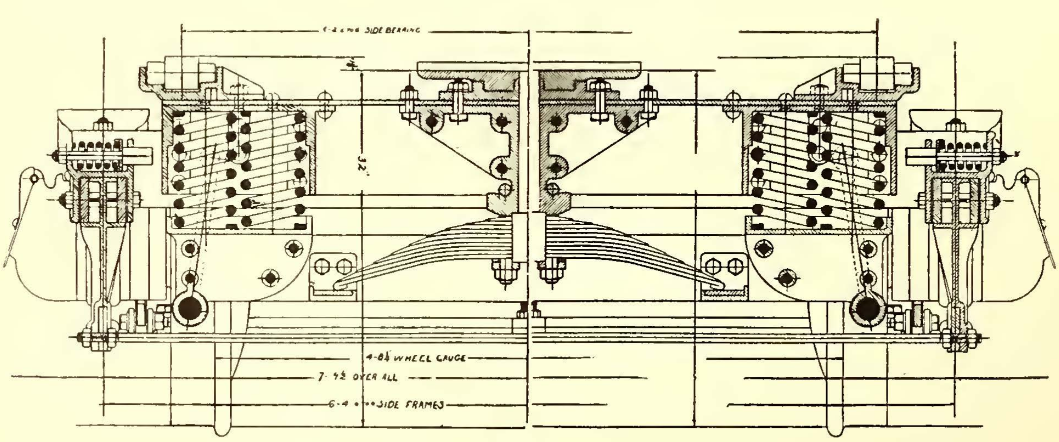
HALF PLAN OF NO. 14AXX TRUCK

Their strength is so adjusted that the spiral springs prevent the rocking of the bolster and reinforce the half elliptic springs as the load of the car body is increased. The spring plank supporting the springs is suspended from the transom bars by links which are outwardly inclined so as to smoothly check the swing of the car. Buffer springs are inserted in the transom bars and receive the end thrust of the bolster when it is inclined to swing too far.

The swivel plates are of male and female shape and carefully machine fitted. This construction prevents the oil from oozing away. The transom bars are made angle shape, so as to give great strength and prevent buckling. The transom-bar holders are of the best quality of malleable iron and carefully machine fitted to the upper members of the side frames. They are provided with pockets into which the angle-shape transom bars are accurately fitted. To keep the truck square, the transoms are made V-shape, project inwardly beyond the side frames, and are secured to the angle-shape transom bars forming a brace on each side.

The journal boxes are of the standard M. C. B. type with journals 4½ ins. x 8 ins. and larger if desired, and machine fitted to correspond with pedestals. The axles are 5 ins. to 6½ ins. The pedestals are machine fitted and provided with wearing strips, which can be renewed when worn out. All bearings are machine fitted.

The brakes are so constructed that the pressure is applied equally to all wheels at the same time. The leverage is at a ratio of 20 to



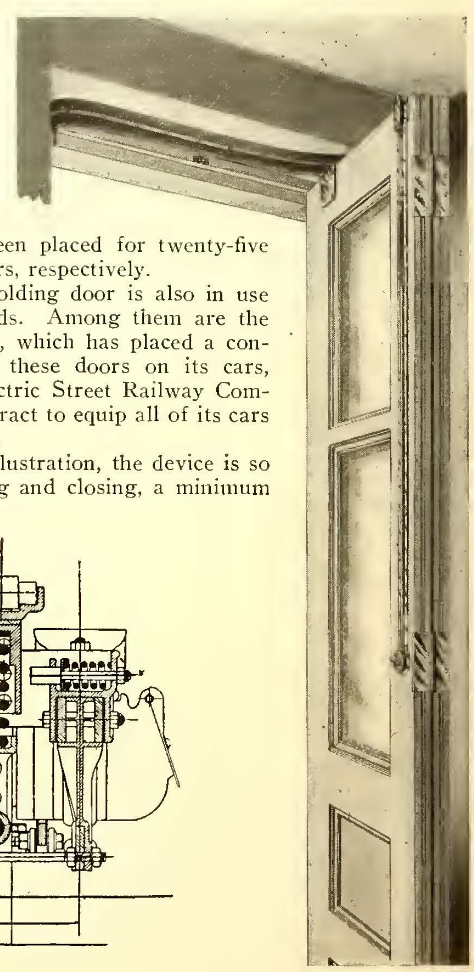
CROSS SECTION THROUGH CENTER OF BOLSTER

1. The journal boxes are packed with wool waste and oil after the Pennsylvania Central Railway's formula, and guaranteed to run cool.

Among the companies using these trucks is the Detroit Construction Company, the assistant general manager of which says that the trucks frequently run from 55 miles to 60 miles per hour, and that they are giving excellent satisfaction under the cars on his road.

A New Folding Door for Street Cars

A decided novelty in the way of space saving on street-car platforms is shown in the accompanying engraving. J. C. Duner, a foreman at the Pullman shops, has invented and patented a folding door (illustrated herewith) which has received much attention from car builders. The most ingenious part of the device is the slot which automatically controls the movement of the door in opening and closing. Mr. Duner makes four claims in his letters patent, all of which have been granted. The Northwestern Elevated, of Chicago, first used two doors for one year, demonstrating beyond question the merits of the invention, and two subsequent orders have been placed for twenty-five cars and forty-five cars, respectively.



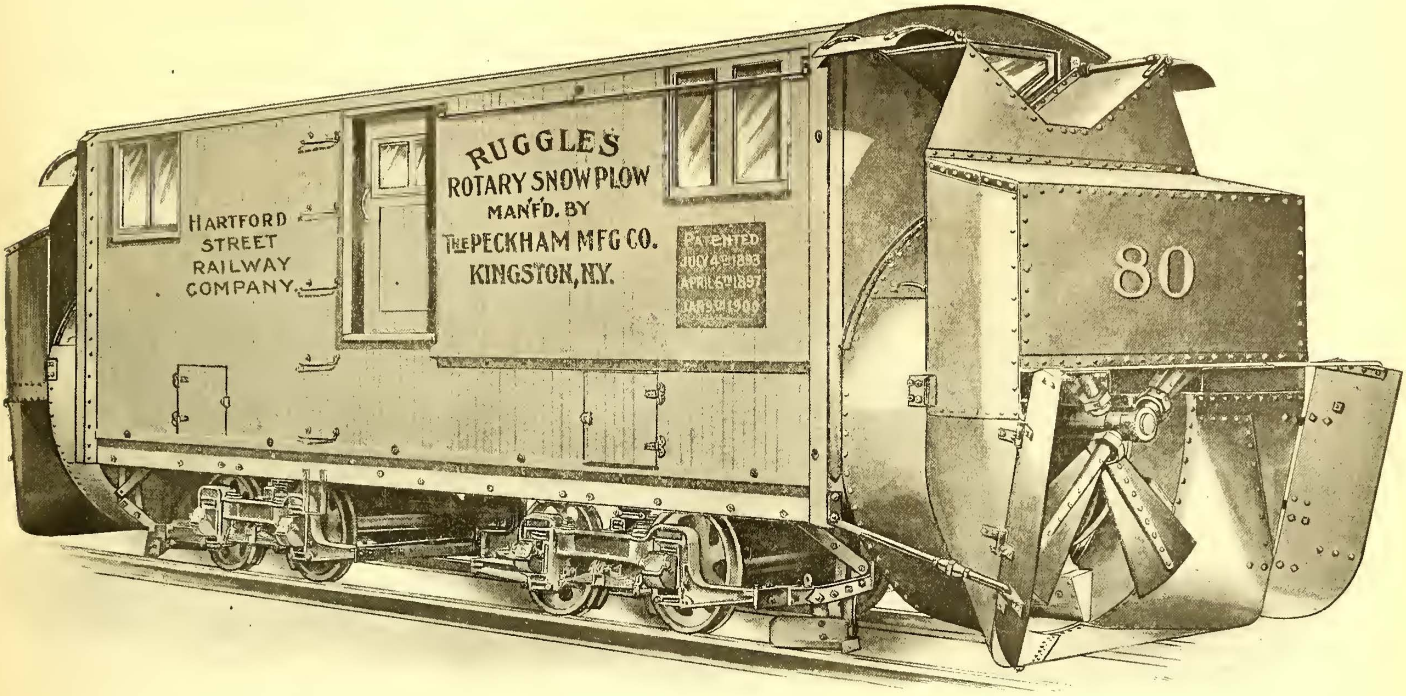
FOLDING DOOR

The new type of folding door is also in use on several other roads. Among them are the Lake Street Elevated, which has placed a considerable number of these doors on its cars, and the Calumet Electric Street Railway Company has made a contract to equip all of its cars with the Duner door.

As shown by the illustration, the device is so made that, in opening and closing, a minimum of platform room is required. There are very few, if any, roads in this country which do not find it impossible to keep their platforms clear of passengers at all times. The feature which attracts the railway man most in the construction of the Duner door is, therefore, the ease with which it can be opened and closed on crowded platforms, but the handsome appearance, excellent workmanship, practical design and durability have proved important factors toward its success.

Double-Truck Rotary Snow Plow

Last month a view was published of the Ruggles double-fan, rotary snow plow, built by the Peckham Manufacturing Company. The accompanying illustration shows another type of rotary plow, of which a few were manufactured last year, and for which the Peckham Company has received a number of orders this year. It is mounted on double trucks, and is intended for interurban railways. The use of double trucks gives a very much heavier plow than where single trucks are used. This allows the plow to handle heavier drifts, and to run at higher speeds than if it was a lighter plow. In the construction of the plow the center of gravity is kept very low, and this increases the efficiency of the plow and decreases the possibility of derailment.



DOUBLE-TRUCK ROTARY SNOW PLOW

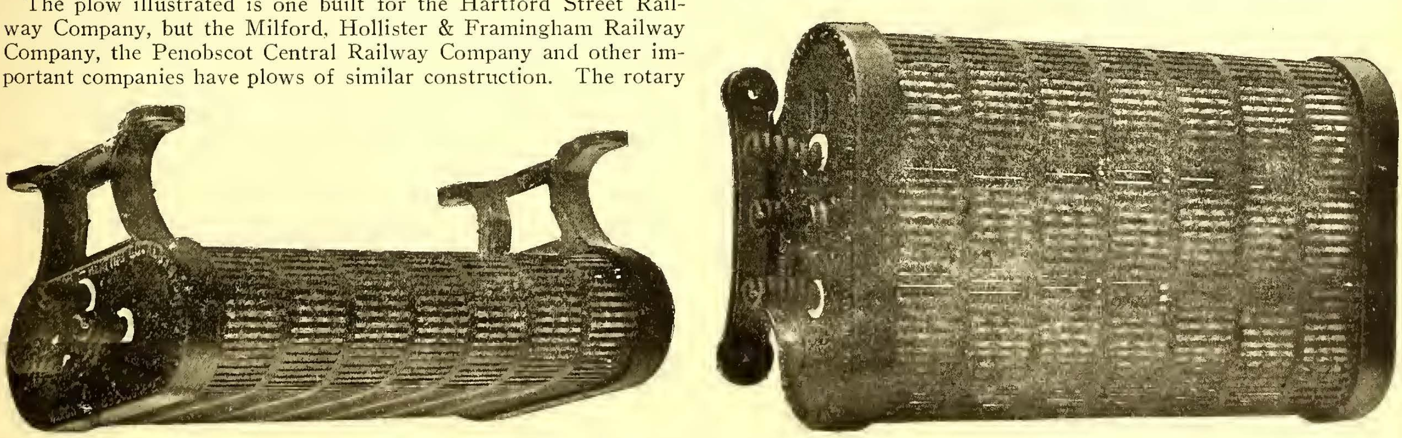
The plow illustrated is one built for the Hartford Street Railway Company, but the Milford, Hollister & Framingham Railway Company, the Penobscot Central Railway Company and other important companies have plows of similar construction. The rotary plow has demonstrated its usefulness on electric railways, as well as on steam roads, and the Peckham rotary plows have been adopted on many lines, including roads in Rochester, Niagara Falls, Buffalo, Wilkesbarre, Mt. Mansfield, Wilmington and elsewhere.

Canadian Discovery for Preserving Wood

United States Commercial Agent Johnson, of Stanbridge, reports a new Canadian discovery for the preservation of wood. If necessary, the impregnating plant can be used at the felling ground. The cost of impregnating is said to be about 2 cents per cu. ft.; cost of plant, about $1,000.

The Manhattan Railway Car Heaters

As mentioned a few weeks ago in these columns, the contract for the electric heaters to be installed on the Manhattan Railway Company's elevated lines in New York City was given to the Consolidated Car Heating Company, of Albany. The accompanying illustrations show two views of the new type of heater which is to be furnished for the 1200 car equipments called for. While this heater is constructed on the same principle employed in all the Consolidated Car Heating Company's apparatus, it is, in part, especially designed to meet the requirements of the Manhattan Railway's engineers. The chief difference in construction between this heater and the ordinary type furnished by the contracting company lies in the fact that three entirely independent coils are used in each of these heaters, while in previous cases only two coils have been used. These coils, however, are of the same well-known spiral coil construction which has been developed by this company, and so successfully introduced on many electric roads. The second illustration distinctly shows the triple coil feature of the Manhattan heaters. There are to be eighteeen heaters for each car, and they are to be suspended beneath the seats, about half-way between the seat and the floor. The heat will be still further distributed by means of deflectors arranged above the heaters, which are not shown in the cut. It is an interesting fact in connection with this Manhattan contract that for the 21,600 heaters necessary to supply the 1200 cars, 1350 miles of wire will be required in the construction.

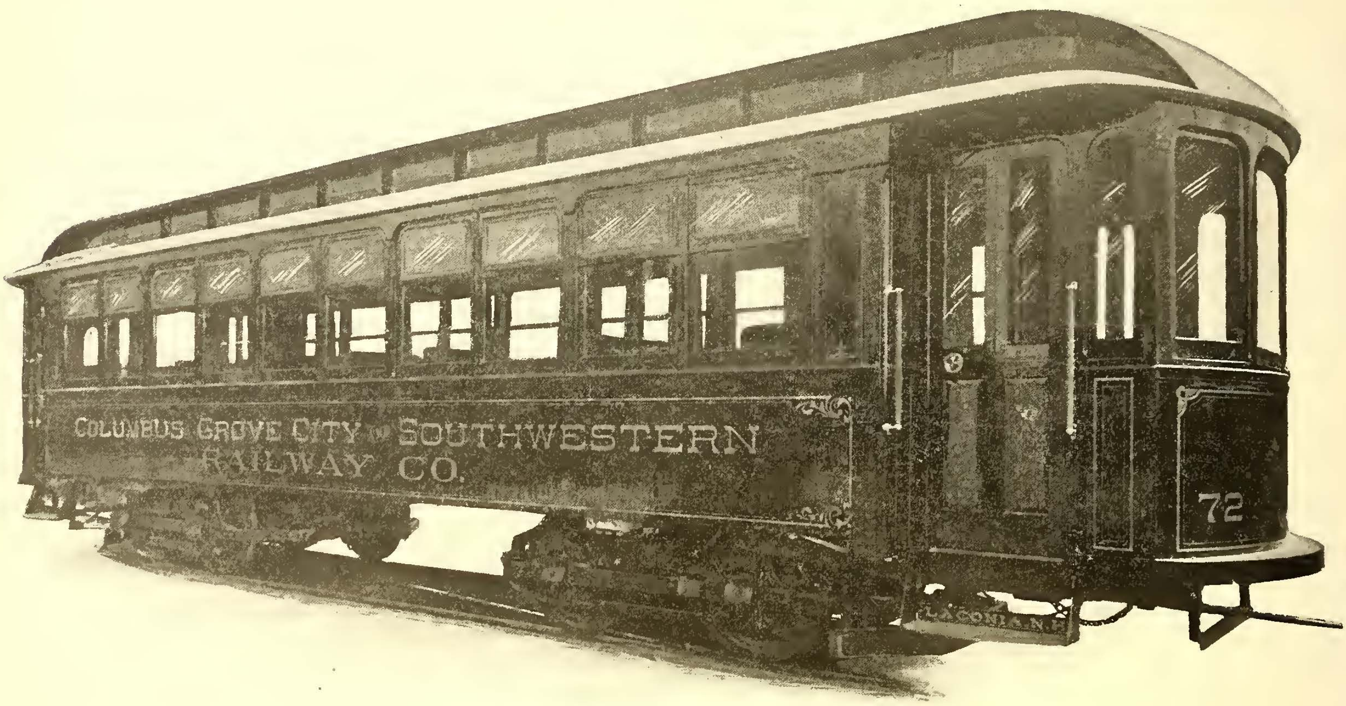


HEATERS FOR THE MANHATTAN ELEVATED RAILWAY CO.

Long Double-Truck Cars for Columbus

On this page appears a cut of one of the cars recently built for the Columbus, Grove City & Southwestern Street Railway, by the Laconia Car Company Works, of Laconia, N. H. No expense has been spared in these cars to make them the finest which can be bought, and the Laconia Car Company Works consider them among the finest electric cars ever turned out at their plant.

The cars are of the semi-convertible type, having double sash windows, and both arranged to drop flush with the window-sill, making a very comfortable car for summer use when the windows were dropped. The car body is 29 ft. 8 ins. long, and 39 ft. 9 ins. over bumpers; 8 ft. 5 ins. wide, and 9 ft. 2¼ ins. high from bottom of bolster to top of trolley board. The inside finish is in highly figured Tabasco mahogany in panel work, with carved caps and moldings of special design, and the ceilings are highly decorated.



LONG DOUBLE-TRUCK CAR FOR COLUMBUS

The seats are of the Heywood Brothers & Wakefield Company's walk-over pattern, 35 ins. long, and upholstered in figured plush. Pantasote Gold Star pattern curtains are used for the side windows, and also for the end doors and windows in the vestibules, to prevent reflection of light on the vestibule glass.

The cars are wired for electric push-buttons at each post, and are lighted by ten 16-cp incandescent lamps, placed in clusters, and also by ten 8-cp lamps placed between the windows. One end of the car is divided off by a partition, with a swinging door in the center, and a glass top, making a smoking compartment, with seating capacity for ten people. The trucks are of the Laconia No. 9-B high-speed type, with patented, perfectly cushioned swing bolster, which prevents the car from receiving any shock while rounding curves at a high rate of speed. They are fitted with 4-in. steel axles, 33-in. double-plate wheels, with 3-in. tread and 1-in. flange.

Consolidation of Central New York Roads

On Aug. 14 the consolidation of the railways composing the Powers-Colvin system in Central New York was formally accomplished, when a joint agreement of consolidation was filed in the office of the Secretary of State at Albany. The following corporations were parties in the consolidation: Glens Falls, Sandy Hill & Fort Edward Street Railroad Company, Warren County Railway, Stillwater & Mechanicsville Street Railway Company, Greenwich & Schuylerville Electric Railroad, Saratoga Traction Company and Saratoga Northern Railway. The new corporation bears the name of the Hudson Valley Railway Company.

The capital stock of these consolidating companies is $2,600,000. The directors named in the articles of consolidation are the following: Edwin Langdon, president of the Central National Bank & Merchants' Trust Company, New York City; Joseph A. Powers, Troy; Hon. Addison B. Colvin, president Glens Falls Trust Company, Glens Falls; Hon. Erastus C. Knight, Comptroller of New York State, Buffalo; William W. Worden, Saratoga Springs; J. Ledlie Hees, president Fonda, Johnstown & Gloversville Railroad and Mohawk River National Bank, Fonda; G. Tracy Rogers, president Binghamton Street Railroad; Thomas O'Connor, lawyer, Waterford; Hon. George E. Green, State Senator, Binghamton; Charles E. Brisbin, president National Bank of Schuylerville, Schuylerville, N. Y.; Hon. Lewis W. Emerson, member of Congress, banker and manufacturer, Warrensburgh, N. Y.; Watson N. Sprague, manufacturer, Greenwich; Thomas S. Coolidge, superintendent transportation department International Paper Company, New York City; Peter McCarthy, capitalist, Troy; John W. McNamara, general manager of United Traction Company, Albany.

The officers are: President, Addison B. Colvin; vice-president, George E. Green; secretary, Thomas O'Connor; treasurer, Frank L. Cowles; executive committee, Joseph A. Powers, Peter McCarthy, Edwin Langdon, Addison B. Colvin and Thomas O'Connor.

The entire list of appointments for the various departments of the road has not yet been filled, but it is understood the following appointments have been made: Supervisor of freight department, Charles T. Ames, formerly east-bound freight agent of the Boston & Maine Railroad; master mechanic, Frank W. Thomas, formerly in the Roanoke shops of the Norfolk & Western Railroad; superintendent of lines, H. G. Sherer, of Stillwater, formerly superintendent of lines for the American Telegraph & Telephone Company; roadmaster, J. W. Harris, formerly roadmaster of a division of the Louisville & Nashville Railroad; chief engineer, J. H. Armstrong, formerly chief engineer for the McKenzie & Mann syndicate, of Canada, and later of the Niagara Falls, St. Catharines & Toronto Railroad. W. C. Colburn, Mr. Powers' private secretary, will continue in charge of the purchasing department.

The firm of Drake, Breed & Company was incorporated July 24, 1901. Messrs. Drake and Breed are both men of long experience in the electric railway field. F. S. Drake was for years the right-hand man of the late Albert L. Johnson, and at the time of the latter's death was at the head of the great electric railway system centering in Allentown, with the roads projected and building to connect New York and Philadelphia. Before this time he had been for a number of years vice-president and general manager of the Nassau system in Brooklyn, and in an important capacity in the street railway systems of St. Louis. George Breed is a graduate of the United States Naval Academy, and was, from 1890 until the time of the war with Spain, connected with the General Electric and Westinghouse Companies. He was retained by Mr. Johnson to design the power stations and supervise the electric equipments of his projected roads. The new company was formed with a view of completing this work, and to enable the members to push efficiently other large enterprises now in hand. The address is Real Estate Trust Building, Philadelphia.

High-Speed Car on the Berlin-Zossen Line

Particulars have already been published in this paper of the proposed high-speed electric railway experiments, under the auspices of the German Government, on the military road running between Berlin and Zossen. It will be remembered that an association has been organized, consisting of the principal German manufacturers, to conduct a series of experiments on this line with high-speed electric cars. This association is called the Studiengesellschaft für Elektrische Schnellbahnen, and two locomotives have been built, one by the Allgemeine Elektricitäts-Gesellschaft, and one by Siemens & Halske, to operate at a speed of 200 km (125 miles) per hour. The line itself is comparatively short, but it is hoped that the trials will determine the best system for long-distance lines. As for these long lines high potential would have to be used, a voltage of from 10,000 to 12,000 was selected for the line in question, although the manufacturers do not intend to limit themselves to this voltage on longer lines, should a higher potential be necessary. Through the courtesy of the Allgemeine Elektricitäts-Gesellschaft some views of the motor car recently completed by that corporation are published herewith. The transformers are mounted on the car, by which the voltage for the motors is reduced to 435 volts, but for long-distance work the manufacturers state that it may be preferable to use a transmission voltage of 50,000, reduced by stationary transformers in sub-stations along the track to 3000 volts, and to wind the motors for this voltage.

The car illustrated in Fig. 1 is designed to accommodate fifty persons, and has two six-wheel, double trucks. The motors are designed for a total normal output of 1100 hp, and 3000 hp maximum. A frequency of 50 cycles is used.

It was first proposed to construct at each end of the car a driver's cab, in which the necessary starting apparatus should be provided, so that the motorman could control the car directly from either end. Owing to the quantity and size of cable required, however, considering that 3000 hp had to be controlled, this was considered impracticable, and it was decided to have one controller in the middle of the car, operated from each end by mechanical means. In the center compartment are also the switches, brakes, etc. The transformers and resistances are carried under the center of the car, and are cooled by air shafts led from the roof in such a manner that the front shaft is used for fresh air, and the back shaft as an outlet for the heated air. The total weight of the equipment as finally decided upon is as follows:

WEIGHT OF CAR EQUIPMENT

Four motors	12,800 kg
Two transformers	6,500 "
Starting resistance with casing	4,750 "
Two controllers, with driving mechanism	4,750 "
Braking and lighting batteries	2,600 "
Motor with compressor	800 "
Oil pump	.... "
Oil tank	.... "
Total weight of cable	1,000 "
Collector bows	1,400 "
Summary	29,850 kg

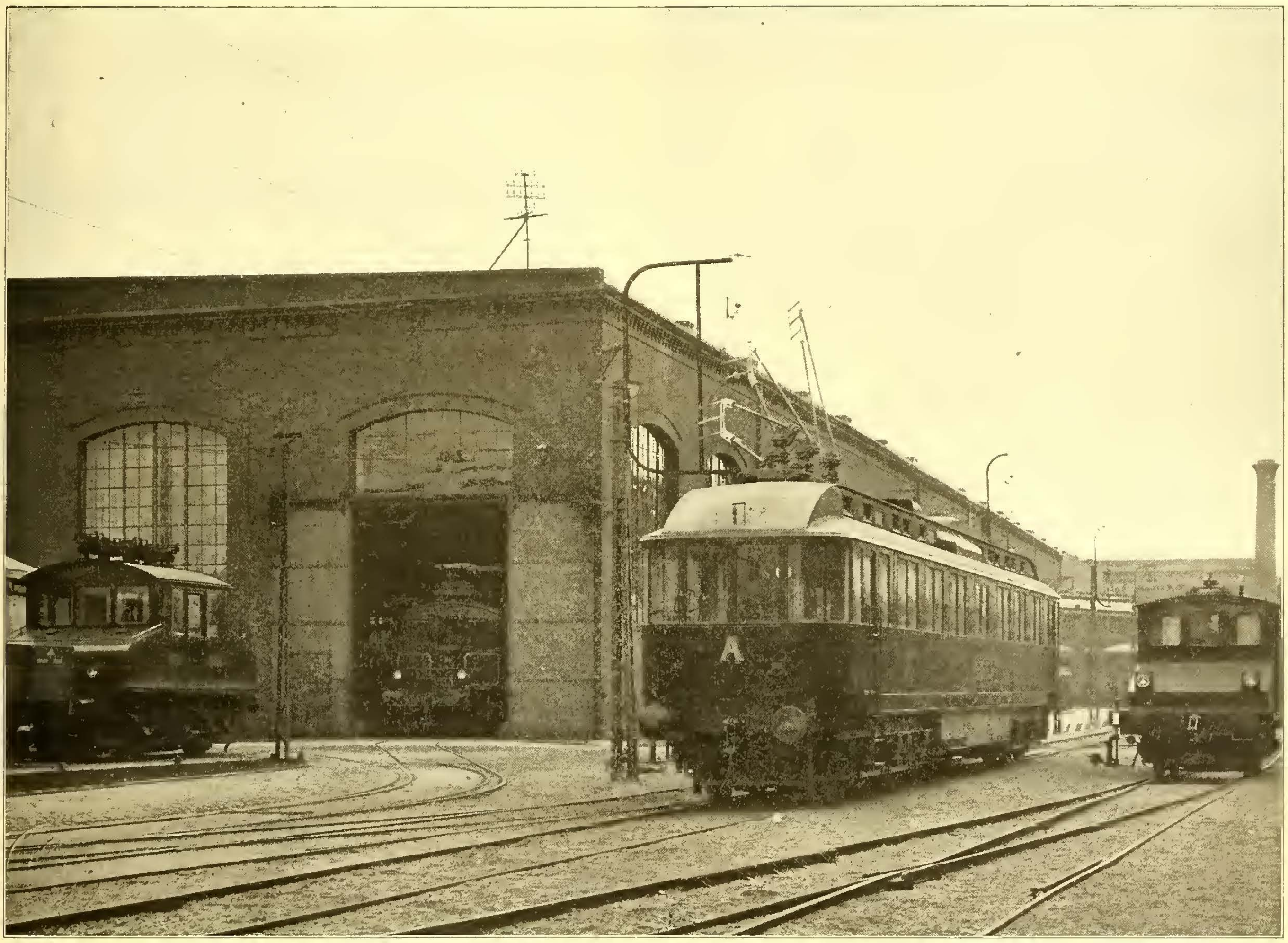


FIG. 1.—EXPERIMENTAL CAR BUILT TO OPERATE AT 125 MILES PER HOUR ON THE BERLIN-ZOSSEN LINE

The question of the support of the motors on the axle was a serious one, and owing to the fact that the radial air space between the stator and the rator amounts to only a few millimeters, it was finally decided to carry the motor on a hollow sleeve around the axle, and to convey the power to the wheels through a set of six leaf springs on each side, as shown in Figs. 3 and 4.

For starting and regulating, liquid starting devices of the usual type in which the electrodes are lowered into a tank were first tried, and the company experimented considerably upon the best type to employ for the purpose. Owing to the amount of current used, difficulty was encountered in the heating of the liquid, but it was finally obviated in a way which had proved successful in other work of the company. This was not to raise and lower the electrodes from and into a liquid, but by the use of a small pump to introduce or withdraw the liquid, which is a soda solution, from a tank in which the electrodes, *i. e.*, the terminal or end plates of the opened circuits are located. This gives the liquid a constant motion and insures success. By inserting an adjustable cut-off in the pipe leading from the centrifugal pump, the speed at which the liquid is delivered, and consequently the starting time, can be regulated at will.

The car is equipped with Westinghouse compressed air brakes, assisted in braking by the motor, first, by opening the armature circuit by means of the liquid rheostat already mentioned, then cutting out the field and switching it on to a storage battery, and, second, by reversing the direction of the current in the rotary field. After the switching has been effected in either way, the armature circuit is gradually closed again, *i. e.*, the inflowing liquid connects the phases through very great resistance, and according to the desired intensity of the braking action the level of the liquid is raised or lowered. It is assumed that the motor braking will be used at high speeds and the air brakes will be applied only at the end of the run.

Another serious question was that in regard to the selection of

FIG. 2.—INTERIOR OF CAB OF HIGH-SPEED CAR

current. This is supplied to the car from three wires and six bow-shaped collectors, as shown in Fig. 1. To insure a continuous contact, a side pressure was considered preferable to a vertical one. The trucks are 13.3 m apart, and the diameter of the wheels 1250 mm, with a wheel base of 2 mm x 1900 mm. Each of the four motors is adapted for a normal output of 250 hp, and a maximum of over 750 hp, and they are mounted on the outer axles of the trucks. The speed of the motors is 960 r. p. m.

The Equipment of the Leicester Tramways

After full discussion on the recommendations of the sub-committee on tramways of the Leicester Town Council in regard to the installation of an electric system in the city, the recommendations of the committee, which had been confirmed by E. Manville, consulting engineer, were adopted, with the exception of that dealing with the power station, which is to be discussed later. The making of the surveys, preparation of the working plans and carrying out the work has been intrusted to E. George Mawbey, M. I. C. E., borough engineer and surveyor, with E. Manville as consulting engineer. The length of road to be equipped is a little over 22 miles with about 38½ miles of track.

The corporation has yet to apply to Parliament for powers for the equipment by electricity.

The Boston Elevated Opens Atlantic Circuit

The Atlantic Avenue section of the Boston Elevated Railway Company's elevated lines was opened for traffic on Thursday, Aug. 22, 1901, thereby inaugurating train movements over the entire elevated trackage at present completed. The new line was operated without trouble from the start, and the occasion was marked by the absence of the enormous crowds that congested the subway route on June 10, the opening day of the first link of the rapid-transit system between Roxbury and Charleston.

Train movements on the circuit are at present confined to looping around the Subway and Atlantic sections on a six-minute interval, while about 75 per cent of the cars operate between Dudley Street and Sullivan Square via the Subway. As the main line interval is two minutes, every third train loops via Atlantic

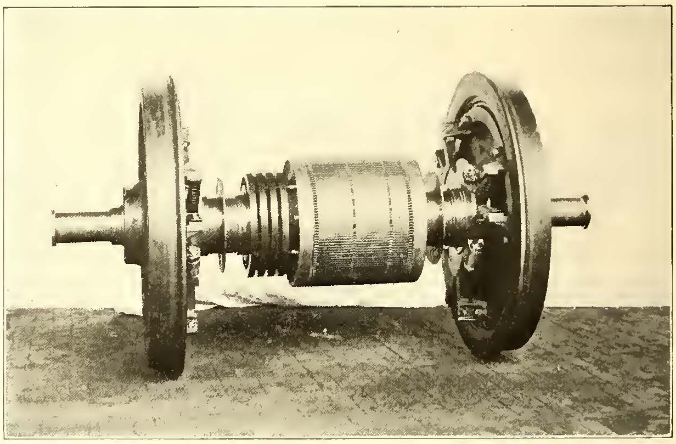


FIG. 3.—THREE-PHASE MOTOR

Avenue, giving direct fast service between the great North and South Union stations. The running time around the Atlantic circuit, including the Subway, is about twenty minutes per com-

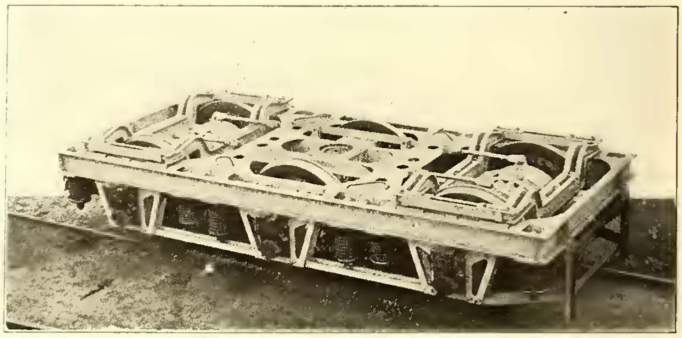


FIG. 4.—SIX-WHEEL TRUCK

plete cycle. From six to seven minutes are ordinarily required between the North and South stations. Surface cars rarely make the time here in less than fifteen or twenty minutes during busy hours, and if the streets are congested it is doubtful if a car can thread its tortuous way through the densely crowded narrow streets in less than twenty-five minutes, from terminal to terminal. Surface cars via Atlantic Avenue require perhaps fifteen minutes in the run.

The elevated schedule has been excellently maintained thus far the occasional delays being at the Causeway or Castle Street junctions, where the trains are spaced between those of the direct through service. These delays, however, rarely exceed one and one-half minutes in the aggregate. Owing to the distinct announcement of the destination of all trains, very little confusion has resulted from passengers getting on the wrong cars.

Stations are numerous on the circuit run, there being twelve stops on the northbound route via Subway, in a run of 4.098 miles, or 2.94 per mile. Adams Square station in the Subway carries northbound traffic only, reducing the southbound circuit stops to eleven in 4.108 miles, or 2.68 per mile. Outside the Subway Beach Street station is located at the corner of Harrison Avenue and Beach Street, practically as near the business center of the city as Boylston Street, and destined to become a large distributing point for passengers to and from Roxbury and Dorchester. Next comes the South station, whose commodious design, platforms and convenient direct covered connection with the South

Union station in Dewey Square, emphasizes its large importance as a traffic center. This is an excellent point on the elevated for the large business interests on Federal Street, lower Summer Street, and possibly Devonshire Street southeast, and it promises to deflect a large amount of travel from the already overburdened subway. Proceeding north, Rowes' Wharf station is an important point, located at the ferry station of the Boston, Revere Beach & Lynn Railroad and the Nantasket, Plymouth & Provincetown steamers' wharves. An enormous seashore traffic is expected here, and the station's accessibility to the business district east of Postoffice Square insures its steady growth of business in a through direction. State Street station is also in close touch with the steamboat lines, and is handy for the market district near Faneuil Hall. Battery Street station, the last of the Atlantic group, is located at the foot of Hanover Street, and its transfer facilities in connection with surface cars below and its nearness to the East Boston and Chelsea ferries, give it a commanding traffic position. The North Union station, located on Causeway Street, has at present no direct connection with the Elevated's North station, but some suitable bridge footwalk is projected.

The widest possible transfer freedom is extended to passengers at present. As soon as the fifty additional cars, which the Elevated has ordered, arrive it is probable that through service via Atlantic will be inaugurated. At present the arrangements for passengers' convenience are very flexible.

Passengers who enter the Subway from surface cars reaching Park Street loop from Brookline, Back Bay, Brighton and Cambridge change for Atlantic Avenue at Boylston Street to northbound trains looping south via North station.

Passengers from Atlantic Avenue who wish to reach Brookline, Back Bay, Cambridge or Brighton by surface cars from Park Street take Atlantic circuit trains running into the Subway via North station.

Passengers for intermediate stations can take circuit trains in either direction.

Passengers from Charlestown for Atlantic Avenue change at North station unless they wish to reach their destination by the circuit train via Subway and Castle Street.

Passengers from Roxbury find it most convenient to change at Pleasant Street.

While it is difficult to estimate the value of the Atlantic circuit from the transportation standpoint at this early date, it is highly probable that the comparatively level and unobstructed line, with its freedom from the distressing curves and grades of the Subway and easy accessibility to both business districts and wharves, will prove a most powerful agency for the despatch of heavy business, the partial relief of congestion uptown, and a through line between terminals of maximum speed value per minimum time input.

Report of the Central London Underground Railway

The annual meeting of the Central London Underground Railway was held late last month, and a 4 per cent dividend per annum was declared. This requires £57,000. The gross receipts from operation amounted to about £161,000. The chairman reported that the earnings per mile per week were £950, and that the opening of the Shepherd's Bush extension had increased considerably the traffic. The operating expenses were about 54 per cent of the receipts, as compared with 58 per cent during the first five months of operation. As regards vibration, the chairman said: "We have at this moment running a modified engine, which has given us great satisfaction, and bids fair to settle the question. A second experiment, which we shall complete in a month or so, is the division of power on the principle of the multiple motor—that is, dividing the whole weight of the engine over several carriages, with a view to lessening the force of the impact of the wheels upon the rails as the train progresses. I can not say whether the committee will be satisfied, because it has not been before them; but our engineer advises that the modifications will so lessen the effect of the running of our trains that we need have no further anxiety upon the subject."

A visit to Schenectady was made by the members of the American Institute of Electrical Engineers while en route from New York to Buffalo to attend the annual convention. The General Electric Company threw open its factory for the inspection of the members, and a handsome pamphlet was distributed, which gave an excellent idea of many features to be seen, and formed a pleasing memento of the trip.

New Publications

Practical Electric Railway Handbook, by Albert B. Herrick. 413 pages. Illustrated. Price, $3. Published by the Street Railway Publishing Company, New York.

The author of this book is a consulting electric railway engineer of long standing. His close contact with railway affairs during an experience of twenty years has given him an insight into the needs of operating street railway men, which has enabled him to produce a book not only of great benefit to the managers and superintendents of electric lines who wish to have a form of ready reference wherein they can easily find the solution of the numerous problems continually confronting them, but invaluable to the younger element of railway engineers to whom such a book presents the practical side of the subject in a clear and concise manner hitherto unattained. Mr. Herrick has carefully excluded from his handbook all material which was not of vital importance to electric railway work, and in this way a volume has resulted which is scarcely half an inch thick, and can be conveniently carried in the pocket—making a most useful companion to the engineer, whether at his desk or out on the road. Although a technical book, the text has been made so easy to understand that all connected with street railway operation can read it intelligently. As is usual in this class of book, free use has been made of all standard publications, whether from the class papers, books or manufacturers' circulars, everything being, however, apparently rewrittten to obtain the greatest number of facts in the smallest space. The volume is divided into seven sections and two appendices, as follows: Section I., General Tables; section II., Testing; section III., The Track; section IV., The Station; section V., The Line; section VI., The Car House; section VII., The Repair Shop; section VIII., The Equipment; section IX., The Operation. Appendices: I., Storage Batteries; II., Conduit Systems.

The "Engineering" and Electric Traction Pocket Book, by Philip Dawson. Second edition. 1305 pages, including upward of 1300 figures and 947 tables. Morocco. Price, $4. Published by "Engineering," 35 Bedford Street, Strand, London, and John Wiley & Sons, 43 East Nineteenth Street, New York.

Dawson's handbook has become familiar to traction engineers through the first edition of the book, and its popularity has been so great as to call for a second edition, while the publishers announce that a German translation is in preparation. The work shows the greatest care in its compilation and in the arrangement of its tables, and covers the subject most completely, as the number of pages shows. It is hardly necessary to state at this late date that the book is a most useful one to electric railway engineers, as those who possess it are already acquainted with this fact.

Business of the McGuire Company

The McGuire Manufacturing Company reports a large foreign business. During the month of July the company completed orders for 190 trucks for different tramway companies in England, and during the month of August the company received orders by wire for 130 trucks, showing that the English companies appreciate the product of the company. The European McGuire Manufacturing Company is now an assured fact, having quickly organized, and having purchased a large property near Bury, where the truck heretofore furnished by the Chicago concern will be manufactured in the future.

The Chicago company has recently issued a circular that the capacity of its shops for snow sweepers is exhausted up to the first of November, but it will take orders for delivery after that date. The company also reports an unusually large sale of car fenders, having within the last month equipped the lines of Memphis, Tenn.; Dubuque, Ia., and Norfolk, Va. The company states that its stove business is up to the usual amount this year, which goes to show that many railways still prefer coal heaters to the electric.

New Book on Steam

The demand for the well-known manual on "Steam, Its Generation and Use," published by the Babcock & Wilcox Company, of New York, and the Babcock & Wilcox Company, of London, has been so great as to call for another edition, making the thirty-second which has been published since this book was first issued. Certain additions, as well as new illustrations, have been added to this manual, making it more complete than ever before, and it certainly is of great value to the engineer. The tables published are those which all steam engineers need at hand, and they are conveniently arranged, while the discussions on the general subject of steam generation is useful to the user of any type of boilers.

NEWS OF THE WEEK

Great Northern May Adopt Electricity on a Branch

It is reported in Seattle that the engineers of the Great Northern Railroad, who have been working on plans for the improvement of the operation of cars in the Cascade tunnel, have decided to report that the entire Cascade division of the road be equipped with electricity. It is not yet decided, however, whether the portion of the road to be equipped with electricity will extend from Skykomish to Leavenworth or from Everett to Wenatchee. Another question yet unsettled is the source from which the power will be taken. Water power is available along either side of the tunnel. The falls of the Tumwater, on the east of the tunnel, would furnish ample power for all time to come, or it could be obtained from the Skykomish River or Martin Creek, on the west side of the tunnel.

The Chicago & Joilet Electric Railroad

Arrangements are rapidly being perfected for placing the Chicago & Joliet Electric Railroad in operation early in September. The new road, as its title implies, is being built between Joliet and Chicago, and is now completed from Joliet to a connection with the Archer Avenue line of the Chicago City Railway at West Forty-Eighth Avenue. A bridge is now being built across the drainage canal at Sag, and upon the completion of this work, the line will be placed in operation. The line is 40 miles long, and the roadbed is rock ballasted and laid with 70-lb. rails, double track. The initial running schedule now planned between Joliet and Chicago is one hour and thirty minutes, but this will be materially reduced after the system has been in regular operation for a time. The fare will be 40 cents in each direction, and special efforts will be made to secure freight business. As soon as practicable the company expects to build a spur from the main line near Summit to Riverdale, where connection will be had with the Suburban Railway, which now connects with the Lake Street and Metropolitan Elevated roads; and thus the company will become a direct competitor of the Rock Island, Alton & Santa Fe Railroad, for through passenger and freight traffic. The Rock Island, Alton & Santa Fe Railroad pretends not to fear the competition of the electric railway, saying that the difference in time between the two lines will hold passenger traffic for it. This point is far overshadowed when the respective rates and conveniences are considered. The lowest fare by the steam railroad between the two points is now $1.06 for a one way ticket, 56 cents on twenty-five-ride tickets, and about 45 cents on monthly commutation transportation. The Chicago & Joliet Railroad is owned by the American Railways Company, which owns the local system at Joliet.

More Accident Frauds; Operators Run Down

Two men charged with making false accident claims against both the Washington Traction & Electric Company, of Washington, D. C., and the United Railways & Electric Company, of Baltimore, Md., have been arrested in Washington. The men under arrest are Louis S. Finkelstein and Simon Kupfelberger. On May 31 Finkelstein claimed to have fallen from a car at Fayette Street and Arch Street, Baltimore, and complained of a broken arm and fractured rib. He was attended by a physician who was on the car at the time, and who put his arm in plaster. Finkelstein made a claim for $800 against the company. On the following day the company's physician called on the man, but he refused to permit an examination to be made. The company wouldn't entertain the claim, and a suit was docketed about the last part of June for $10,000, but offers were made to compromise for $800, which were again rejected. In Washington Finkelstein used the name of Lewis Semmel. According to the testimony taken at the hearing in Washington, Finkelstein, who formerly lived in South Baltimore, where he kept a little store, became acquainted with a man named Abraham Feidler. He met Feidler in Washington shortly before the alleged car accident there, and, according to Feidler's story, Finkelstein asked him if he did not want to go into a scheme to make money. Finkelstein, Kupfelberger and Feidler met at Virginia Avenue and Three and a Half Street. Finkelstein suggested that the trailer be used, as being more advantageous. The men did not occupy seats together. After they had traveled a short distance, Feidler heard a man's cry; the car was stopped; Finkelstein was rolling on the ground and groaning, and Kupfelberger, an apparent stranger, was engaged in condemnation of the railway company, and afterward gave his name to the conductor as a witness. Finkelstein made a demand for damages, but, in the meantime, Feidler had visited the railway company's office, and exposed the scheme.

The Coming Convention of the New York State Street Railway Association

Announcement has already been made of the coming convention of the New York State Street Railway Association in Rochester, Sept. 10 and 11, and everything points to a most successful meeting. The executive committee has arranged a most interesting programme, and the local host, the Rochester Street Railway Company, is preparing to entertain the attendants in the hospitable way for which the manager of the company, T. J. Nicholl, and the company itself, is noted. A large attendance is expected and desired, and everyone who attends the meeting can be sure of having a profitable and pleasant trip. Special arrangements are being made by the local committee for the entertainment of lady visitors, while the others are engaged in business sessions, and it is hoped that many will attend. Among the features of the social side of the meeting there will be a special trip to Charlotte and a banquet at Ontario Beach on Tuesday evening, and a trip to Sea Breeze by electric car on Wednesday afternoon, a lunch at that place and boat ride to Charlotte. As already announced, arrangements have been made for exhibits at a hall of ample capacity near the regular convention hall, and a number of these are expected. Mr. Nicholl and the executive committee have extended a very cordial invitation to manufacturers and others interested in street railway matters, as well as street railway officials of other States, to meet the members of the New York State convention, and participate in the excursions and other entertainments.

The Change Time Has Wrought

The building of two electric railways—the Tiffin & Port Clinton Railway and the Tiffin & Southern Railway—over the old turnpike connecting Upper Sandusky, Tiffin and Fremont, Ohio, recalls a pioneer attempt to improve the conditions for public travel between these points. In 1850 the people of the villages along this route organized a turnpike company and laid out the road. It was unbroken forests in those days and saw mills were erected at various points. The road was graded and ditched, and upon the dry surface the stringers and cross ties were laid. Across these were laid the oak planks, 14 ft. long by 3 ins. thick, making a continuous platform from Upper Sandusky to the head of navigation in the Sandusky River. The road lasted for a number of years and aided greatly in the development of that section. It is interesting to note that the construction of the electric railways over the same route will cost only about half as much as would the restoration of the old road, considering the price of electric railway material and the present cost of the best oak lumber delivered at the points mentioned. It is also a fact that the cost of travel over the electric roads when completed between Tiffin and Upper Sandusky and Tiffin and Fremont will be much less than the tolls collected for the same distance over the primeval highway, as it cost $1.60 in tolls for a trip from Upper Sandusky to Fremont, requiring an entire day for horses and much longer for oxen, whereas on the electric lines the trip will take about two hours and the fare will be about 50 cents.

Senator Depew to be Railroad Day Orator

Senator Chauncey M. Depew has accepted an invitation to deliver the principal address at the Pan-American Exposition on Railroad Day, the date of which has been changed from Sept. 13 to Saturday, Sept. 14. The exercises will occur at 2:30 o'clock in the afternoon, in the Temple of Music, on the Exposition grounds. The committee counts itself fortunate in securing Mr. Depew's acceptance so soon after his return from Europe, and will be gratified to know that he gave it graciously, with characteristic courtesy and promptly, when the invitation was presented by their delegate in person. If anything were needed to assure the success of this special event in the history of the Exposition it has been afforded in the fact that Mr. Depew will be the orator of the day. His address will be that of a railroad man to railroad men. His familiarity with railroad life and its varied phases and his great capacity at all times to be entertaining and instructive will undoubtedly make it the most notable of the Exposition season. The railroad officials in charge of arrangements for the observation of the day have been working like beavers for its success ever since the work was assigned to them, and they mean to make it the greatest day in the history of the Exposition, especially in point of attendance. Excursions will probably be run from nearby points, and it is confidently predicted that they will put anywhere from 150,000 to 200,000 people on the grounds.

Mayor Vetoes Milwaukee Elevated Franchise

Mayor Rose, of Milwaukee, has vetoed the ordinance granting a franchise for an elevated road on the south side of the city to the Milwaukee, Burlington & Lake Geneva Railroad Company, passed by the Council on Aug. 26. The Mayor's message to the Council is long, and recites in detail the provisions of the franchise. A number of reasons are given for the veto, one of the principal ones being this section of the ordinance: "The time, however, during which any legal proceedings shall be pending whereby the said company, its successors, or assigns, shall be prevented from or delayed in constructing its said road, or any part thereof, in the said city shall not be included in the time herein prescribed for the completion of said road, and shall be allowed to said company in addition to the time prescribed for the completion thereof." The Mayor argues that a suit can be started by guaranteeing expenses to the citizen bringing the action, and that the franchise can be kept alive an indefinite time in that manner without a single stroke of construction work being done. He refers to the cloud on the title to land affected by the possible erection of the road, and says that this would affect land six blocks each way from the right of way. He claims that the franchise is in effect a street railway franchise, and that the fare is fixed at 5 cents, while the grant is perpetual. In this connection he refers to the street railway franchise held by the Milwaukee Electric Railway & Lighting Company, laying particular stress upon its 4-cent fare provision. In concluding he says that "there has been too much mystery, too much secrecy, too much uncertainty" in connection with the ordinance. It is expected that the ordinance will be passed over the veto.

"Brassy Eye"

Reports from an Eastern city state that there is now prevalent among conductors and motormen in that city a peculiar disease of the eye that has come to be known among the men as the "brassy eye." When the disease made its appearance the experts pronounced it conjunctivitis, a common disease of the eye, but after a more extended study it was pronounced chilkitis, an inflammation due to brass poisoning. The symptoms of the disease resemble a slight inflammation of the eye, such as might be due to the presence of any small foreign body. After a few hours the inflammation increases, and is accompanied by severe pain, the sufferer being almost unable to see. An excessive flow of tears accompanies this stage of the disease. As the disease progresses the inflamed condition of the conjunctiva covers the whole mucous membrane, producing finally a continuous flow of mucous and a blurred vision, remaining some time for days. The oculists were completely puzzled when the first case was reported, and it is said that the real cause of the disease was discovered by a member of a hospital staff, who noticed a motorman rubbing his eyes with his hand. The motorman became effected, and next day appeared at the hospital to be treated. The motormen are seldom afflicted with the disease, as they usually wear gloves. The conductors are, however, more liable to be afflicted with the disease. In shinning along the footboard and performing their other duties their hands are most liable to become covered with verdigris, which is easily communicated to the eye.

Keep the Children on the Sidewalk

President Greatsinger, of the Brooklyn Rapid Transit Company, last week had a conference with the deputy police commissioner of New York, in which he suggested that the police aid in preventing accidents in the future, pointing out that many accidents were due to children playing on the streets where cars are operated. Especially during the summer vacation are the children troublesome, and the suggestion of Mr. Greatsinger has met with the approval of the police officials, for orders have been issued to the police to drive back onto the sidewalk all the children found playing in the street. It is more than likely that many of the accidents to the youth of the large cities are the direct result of a game of "run-sheep-run," "two-old-cat" or some other game in which the participants are most likely to take to the street in order to avoid "being caught," and a note of warning from the police will no doubt result in these games being conducted in streets with no car line. There is, however, a certain class of venturesome children who, despite the entreaties of pedestrians and occasional severe punishment at the hands of their parents, take special delight in seeking a trolley line, and there cutting up various pranks, continually harassing the motorman and making him hail with delight the close of the vacation season, when, at least for a portion of the day, he will be relieved of a continual source of annoyance. A policeman in uniform, however, usually strikes terror to the hearts of characters of this class, and the new orders will certainly result in eliminating these characters and minimizing the accidents.

Gigantic Power Plant for Omaha

The efforts now being made to consolidate the street railway, electric light and water interests, of Omaha, Neb., and vicinity, are attracting special attention, as the plans for the consolidation include the construction of a large new power plant from which the consolidated properties will be operated. The plans for constructing this plant provide for the construction of an enormous dam about 4 miles south of Fremont, Neb. The dam itself will cost approximately $3,500,000. It will be but 25 ft. wide at its base, but 1260 ft. across at the top, which will lie about 30 ft. above the peak of the bluffs. A waterfall of 157 ft. will be obtained by the construction of the dam, and the transmission line to Omaha will be about 28 miles long. To secure water to fill the dam, which will create a lake 4 miles long by 1½ miles wide and 137 ft. in depth at the dam, the Platte River will be tapped several miles west of the site of the dam, and the water conducted by a canal into the lake, which the dam will form. It is proposed to make of the lake formed by the dam an ideal summer resort, which will attract the people from Omaha, South Omaha and Council Bluffs, and thus render the electric railway which it is proposed to construct between Omaha and Fremont and to the dam a profitable adjunct to the power canal and dam. The cost of the plant, together with the receiving and distributing plant to be constructed at Omaha, is, according to the plans already drawn, approximately $1,250,000. The plans for the consolidation, in fact, include the union of interests in the cities of Omaha, South Omaha and Fremont, Neb., and Council Bluffs, Ia. The companies comprised in the proposed consolidation are the Omaha Street Railway Company, which operates the electric lines in Omaha, South Omaha, Dundee and Benson; the Omaha & Council Bluffs Street Railway & Bridge Company, which owns and operates the electric lines of Council Bluffs, and from that city to Lake Manawa, and also the big drawbridge across the Missouri River; the Suburban Railway Company, which owns an electric railway between Omaha and Council Bluffs and the immense bridge spanning the Missouri, known as the East Omaha bridge; the Council Bluffs Electric Light Company, the New Omaha Thomson-Houston Electric Light Company, holding the franchises of Omaha and South Omaha; the Fremont Street Railway Company, the Omaha Water Company and the Council Bluffs Water Company. The plans of the promoters, as already stated, also include the construction of an electric railway between Omaha and Fremont, a distance of 35 miles.

Papers at the October Convention

The list of papers to be presented at the meeting of the American Street Railway Association in New York next October has been made public by the secretary, and is as follows:

"Street Railways: A Review of the Past and a Forecast of the Future."

"The Adoption of Electric Signals on Suburban and Interurban Railways, Single or Double Track, and Their Economy of Operation."

"The Value of Storage Batteries as Auxiliaries to Power Plants."

"The Public, the Operator and the Company."

"The Best Manner and Mode of Conducting the Return Circuit to the Power House."

"The American Street Railway Association: The Purposes of Its Organization and the Benefits Accruing to Investors in, and Operators of, Street Railway Properties by Membership Therein."

"The Economies Resulting from the Use of Four Motors Instead of Two on Double Motor Equipments."

"The Best Form of Car for City Service: A Consideration of the Various Types of Car as to Size of Car and Arrangement of Seats, Including Best Types of Brakes and Wheels."

"Practical Results Obtained from Three-Phase Transmission and Rotary Transformers or Motor Generators in Transmitting Power on Railway Lines."

"Relations of Interurban and City Railways."

"The Modern Power House, Including the Use of Cooling Towers for Condensing Purposes."

The headquarters of the association will be at the Murray Hill Hotel.

The passenger associations have granted the usual rates of one fare and one-third for the round trip, on the certificate plan. To secure this reduction it is necessary to obtain a certificate from the agent when the railroad ticket is purchased, and to deposit it with the clerk at the entrance to the hall when the delegate registers.

No stopover is allowed on return tickets except at Buffalo, where stopover of ten days will be allowed on tickets from New York. Upon arrival at Buffalo the delegate must proceed immediately to the Joint Ticket Agency, 50 Exchange Street, and leave the transportation on deposit with Harry T. Smith, joint agent. A fee of $1 will be charged for this extension. If the delegate desires to stop over at any other place he must do so on his going trip.

President Vreeland's Clambake

On Aug. 24, at the invitation of Mrs. H. H. Vreeland, the staff of the Metropolitan Street Railway Company and a few invited guests paid their third annual visit to President Vreeland's country seat, "Rest a While," at Brewster, N. Y.

The party, numbering over a hundred, left on a special car from the Grand Central Depot at 9 a. m., arriving at Brewster at 11. They were met at the station by President Vreeland, County Treasurer Wells, ex-Assemblyman Addis, Postmaster Schove, and other officials. Besides the members of the system, General Manager Bronson, of the Harlem division of the New York Central, was present and looked after the personal supervision and comfort of the party. Carriages were in waiting, and they were driven to the shores of Lake Tonetta. There President Vreeland had provided boats, fishing tackle, etc., for the party. At noon, under a large tent, which had been provided for the purpose, a genuine old-fashioned Rhode Island Clambake was served. President Vreeland cordially greeted his guests and assured them of his hearty good will, and said that to their co-operation was largely due the success the Metropolitan system had attained. As he was about to take his seat a telegram was handed to him from ex-Secretary Whitney, of Saratoga, expressing his regret at his inability to be present and congratulating him and his colleagues. Later it was announced that Vice-President Hasbrouck had offered a prize for the one who could eat the most clams, which was awarded to H. A. Robinson, solicitor for the company.

At 4 o'clock the party took conveyances to President Vreeland's home, where Mrs. Vreeland held a reception and a luncheon was served.

During the day the Brewster band played popular selections, assisted by a colored quartette. Although it rained severely during the day, everyone thoroughly enjoyed himself.

While the party left Brewster on a special train at 8 o'clock, it did not arrive until 2:30 next morning, owing to several washouts on the New York Central, and it was after 4 o'clock before many of the party got home.

Among those present were: C. E. Warren, secretary and treasurer; Oren Root, Jr., assistant general manager; D. C. Moorehead, auditor; M. G. Starrett, chief engineer; W. A. Pearson, electrical engineer; T. A. Delaney, superintendent of transportation; D. B. Hasbrouck, vice-president; H. A. Robinson, solicitor; T. A. Millen, general master mechanic; A. C. Tully, purchasing agent.

PERSONAL MENTION

MR. WALTER F. SAUVILLE, brother of Mr. H. F. Sauville, secretary of the Morris Electric Company, New York, sailed on Friday, Aug. 30, for Demarara, British Guiana, where he will be employed under Mr. H. P. Bruce on the tramway system of that city. Mr. Sauville has had considerable experience in railway construction work, having held positions with many of the Pennsylvania roads, etc.

MR. ERNEST GONZENBACH, who, for the past year and a half, has held the position of electrical engineer with the Albany & Hudson Railway & Power Company, left that company's employ on Sept. 1. Mr. Gonzenbach will take up the construction work for the Cleveland Construction Company on the Aurora, Elgin & Chicago Railway, but before going West he will devote two or three months to the construction of the Mineola, Hempstead & Freeport Railway, on Long Island, of which Mr. J. E. Ensign is president.

MR. FRANK E. SCOVILL, secretary and superintendent of the Austin (Tex.) Rapid Transit Company, has finally succeeded in getting that property into such shape that it has had the most successful summer in its existence. In the management of the Austin road Mr. Scovill has had many discouraging conditions to contend with single handed, but has always been equal to the task. For example, at the time the Austin municipal dam broke the road was without power (save mules) until a steam plant could be built. Mr. Scovill is taking a much-deserved rest and recreation trip in the East.

MR. L. R. POMEROY has just been appointed special representative of the railway department of the General Electric Company, with headquarters in New York. Mr. Pomeroy is an expert steam railroad engineer, and will give the greater part of his time to the application of electricity to steam railroad conditions. He is a member of the Association of Railroad Master Mechanics, as well as an associate member of the American Society of Civil Engineers and the American Society of Mechanical Engineers, and has lately been assistant to the general manager of the Schenectady Locomotive Works. Previous to his association with the latter company he was connected with the engineering department of the Cambria Steel Company. He will bring to the company a special knowledge of the needs and requirements in the way of the application of electricity of the steam railroad companies, which will be of great assistance to them in selecting the apparatus which they wish to use.

MR. L. D. MATHES, general superintendent of the Norfolk & Atlantic Terminal Railway Company, whose system is described elsewhere in this issue, has been prominently identified with the electric railways in the neighborhood of Norfolk, to whose success he has been a large contributor. Mr. Mathes is thirty years of age, and was educated at the University of Tennessee. His first mechanical experience was in the shops of the Memphis & Charleston Railroad, at Memphis, Tenn. Perceiving the opening which existed in the electrical field, he joined the forces of the Edison General Electric Company, and with that company, its successor, the General Electric Company, and with the Westinghouse Electric & Manufacturing Company, he engaged for five years in the construction, equipment and operation of electric railways in various parts of the country. Deciding then to take up the operation side, he accepted the position of general foreman on the Buffalo & Niagara Falls Electric Railway, under General Manager Burt Van Horn. Later he was appointed superintendent of the Norfolk & Ocean View Railway, and remained in this capacity for two and a half years. This road was one of the earliest to do very much of a freight business. Mr. Mathes saw the opportunity and improved it, much to the benefit of the road of which he was in charge. The financial results of this policy were so successful that the road was taken from the hands of the receiver, who had charge of it, and was transferred to the original owners. Mr. Mathes then accepted the position of general superintendent of the Charleston & Seashore Railway, of Charleston, S. C., which he occupied one year, and then resigned to accept that of general superintendent of the Norfolk & Atlantic Terminal Company. He has been fortunate in being able to combine practical experience with all features of electric railway construction and operation with the commercial instinct of being able to improve opportunities presented to the road of which he had been superintendent. The Norfolk & Atlantic Terminal Company, besides handling a large amount of freight, also does a considerable excursion and tourist business, and this has required a special knowledge of the best methods of advertising for traffic and establishing special attractions, in both of which Mr. Mathes has accomplished much for his company.

L. D. MATHES